MOSSES

WITH HAND-LENS AND MICROSCOPE

A NON-TECHNICAL HAND-BOOK OF THE MORE COMMON MOSSES OF THE NORTHEASTERN UNITED STATES

BY

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Preface

Mosses are individually so small and inconspicuous that the effect which they have as a mass in creating and enhancing the beauty of natural scenery is often overlooked. Yet, if one recalls the desolate and uninviting appearance of a wood in which the mosses have been destroyed by fire, or observes carefully the part which mosses play in completing the attractions of mountain scenery, he will feel like saying a hearty amen to Ruskin's enthusiastic words in the closing paragraphs of his essay on "Leaves Motionless."

The freshness which a summer shower brings to the landscape is largely due to the unfolding of the mosses on tree and fence and boulder, from patches of lifeless brown into soft cushions of living green.

Many lovers of nature have observed the beauty of mosses and have collected them for their beauty alone. Many more would have collected and studied them had not the difficulties been so numerous and hard to overcome. Until very recently there has been no literature in the English language that was suited to the needs of the beginner. Owing to the small size of most mosses, the characters which separate species and even genera are so largely microscopic that a compound microscope has been considered an absolute necessity for their study.

Many years of study of mosses in the field and in herbaria have convinced the author that any person of average intelligence can easily learn to recognize seventy-five to one hundred common mosses with the aid of an ordinary hand-lens of ten to fifteen diameters magnifying power, and twice that number by the aid of a few simple structures easily determined with the compound microscope.

The purpose of this work is to give, by drawings and descriptions, the information necessary to enable any one interested to become acquainted with the more common mosses with the least possible outlay of time, patience, and money.

Mosses with Hand-lens and Microscope has been inspired by the success of "Mosses with a Hand-lens," and is an attempt to extend the same methods to a wider field in which the compound microscope can be utilized. The number of species included has been more than doubled, and microscopic distinctions have been freely utilized when hand-lens distinctions were insufficient or unsatisfactory.

Nearly all the common mosses of the Gray's Manual region have been included, as well as some of the rarer forms. There are doubtless many other forms worthy of being included, but I have chosen to ignore those species which were practically unknown to me, as what I could say of them would be of little value to any one. Moreover, this book has no pretensions to being a complete manual; it is intended as a help to the students of our moss flora. Quite a large number of doubtful or doubtfully identified forms, especially those named by Professor Kindberg, have been omitted.

I have not attempted the exhaustive descriptions of species so much in vogue with monographers and German authors, as it would increase the size of the book beyond all convenience. The characters given are the most important and distinctive and are those by means of which I, myself, recognize the species. Those characters which are especially distinctive I have endeavored to render prominent by printing in italics. The one aim has been to make it easily possible to recognize a plant and distinguish it from its near allies. In common and easily recognized genera like *Polytrichum*, far less description and illustration are necessary than in treating some of the smaller rarer and more complex genera of other families.

Each family (with one or two exceptions) and the larger genera at least are illustrated by a full-page plate, giving fully all the important details of structure. Many of these plates are reproduced from that unrivaled work, "The Bryologia Europea." The plates in this work are the finest ever made, and the work not only is very costly but also out of print. Not only are these plates superior to any that I could have had made, but by using them I have been enabled to produce this work at a cost otherwise impossible, and thus to bring it within the reach of a much larger number of students. Numbers of plates have also been reproduced in whole or in part from Sullivant's "Icones," and its Supplement, and a few figures from other sources.

New drawings, photographs, and sun prints have been made wherever their use seemed necessary and helpful, especially to illustrate critical points that could not clearly be brought out by description.

I have endeavored to elaborate the descriptions of plant families after the manner which has proved so valuable in the study of the flowering plants. Special attention has also been given to general structure and life histories, and these two features of this book are designed to serve as a text-book on mosses in schools and colleges, and suggestions have been given as to the best material and methods. The glossary has been entirely rearranged in alphabetical order and several terms have been added. No attempt has been made to manufacture English names, as I have become convinced of the inutility of such ready-made names.

Introduction

So many different kinds of plants are called mosses that it may be well to clear the field by defining the true mosses as distinguished from the other plants popularly called mosses.

The seaweeds, or marine algæ, are often known as sea mosses, but no true moss grows in salt water.

The moss which drapes the trees in swampy regions of the South is not a true moss, but a flowering plant bearing flowers and seeds like a rose or a geranium.

Lichens are frequently confused with mosses, but they never bear leaves and never are of a bright green, but a grayish or brownish green, rarely black or bright colored. The majority of species consist of a flat, thin body, usually prostrate and closely applied to the substance upon which the plant grows (substratum). The "Reindeer Moss" is a lichen with shrubby hollow stems; the gray "moss" that hangs from the limbs of trees in northern swamps is also a lichen.

The Hepaticæ, or liverworts, are most closely allied to the mosses, and some species are difficult to distinguish from them. In general, however, the liverworts consist of a flat expanded body like a bright green lichen, or, if leafy, the leaves are arranged in two rows on opposite sides of the stem and in the same plane, giving the plant a flattened appearance unlike the great majority of mosses. In fruit, the capsule opens by four valves instead of by a lid, as in the mosses.

The terms used in describing mosses are fully defined and illustrated in the glossary, and the student should make himself familiar with the principal terms as early in his study of the mosses as practicable.

The beginner in the study of mosses should be content with the study of well-developed fruiting specimens. Imperfect or non-fruiting mosses often prove an insoluble puzzle to the advanced student and would be nothing but a source of discouragement to the beginner. Some rare mosses of the more difficult genera, like Hypnum and Bryum, are not included in this book, because they cannot be recognized with any degree of certainty without the aid of full and technical descriptions aided by comparison with authentic specimens.

Almost any form of simple microscope will serve for the hand-lens work of this book, but to obtain the best results it should be of a construction suitable for carrying in the pocket into the field. It is also very desirable that the student have a lens that can be used on a stand as a dissecting microscope. Lenses are easily obtainable that can be used both as a pocket and as a dissecting microscope. The lens should be ten to fifteen diameters magnifying power and with as large a field as one can afford. High powers of the compound microscope are not necessary. The author likes a one-half and a one-sixth objective, with a low-power eyepiece.

Much more definite data are needed with reference to the habitats and time of maturing spores of even our common mosses. The author has intended to give these as fully as the existing data would permit. In using this book as a guide to the best seasons for collecting any given species, it must be borne in mind that the seasons are a month or so earlier in southern New York and New Jersey than in northern New England and Canada. In the former locality the earliest date given is the best; in the latter locality, the latest.

Classification and Nomenclature

The classification adopted follows quite closely that in Dixon and Jameson's "Handbook of British Mosses."

As this work is intended chiefly for the student of mosses, I have made as few changes in nomenclature as is consistent with clearness and a moderate interpretation of the necessities of the situation. The principle of priority has been allowed great weight, but usage also has its claims and a name long in common use has not been discarded unless convenience and clearness seemed to demand it. Where changes have been made, or where changes made by recent writers have not been followed, I have attempted in most cases to give my reasons.

The following is a synopsis of the system of classification followed in this work:

CLASS MUSCI

ORDER I. SPHAGNALES

Family 1. Sphagnaceæ.

ORDER II. ANDREÆALES

Family 2. Andreæaceæ.

ORDER III. BRYALES

Suborder I. Nematodonteæ

Family 3. Georgiaceæ.
Family 4. Polytrichaceæ.
Family 5. Buxbaumiaceæ.

Suborder II. Arthrodonteæ

GROUP 1. APLOLEPIDEÆ —

Family 6. Fissidentaceæ.
Family 7. Dicranaceæ.
Family 8. Grimmiaceæ.
Family 9. Ephemeraceæ.
Family 10. Tortulaceæ.
Family 11. Encalyptaceæ.

GROUP 2. DIPLOLEPIDEÆ.

Subgroup Acrocarpæ —

Family 12. Orthotrichaceæ.
Family 13. Schistostegaceæ.
Family 14. Splachnaceæ.
Family 15. Funariaceæ.
Family 16. Meesiaceæ.
Family 17. Timmiaceæ.
Family 18. Aulacomniaceæ.
Family 19. Bartramiaceæ.
Family 20. Bryaceæ.

Subgroup Pleurocarpæ —

Family 21. Leskeaceæ.
Family 22. Hypnaceæ.
Family 23. Pterygophyllaceæ.
Family 24. Fabroniaceæ.
Family 25. Neckeraceæ.
Family 26. Leucodontaceæ.
Family 27. Fontinalaceæ.

It will be noticed that pleurocarpous mosses include the same families as in the older classifications, but the acrocarpous mosses, as here defined and correlated, include only the double peristomed Acrocarpi of the older classification, which included families 2–10 inclusive. While this older classification was exceedingly convenient and will doubtless survive in popular usage for some time, yet the classification as given above is so much superior that it must be adopted in all scientific usage.

The pronunciation of the scientific names is indicated by the same signs as in the recent works on the flowering plants.

(`) Indicates the accent and the long, broad, open, or close English sound of the vowel.

(´) Indicates the accent and the short English sound.

In the pronunciation of the scientific names it is well to remember that the best authorities give the English pronunciation of the Latin with the accent according to the rules of Latin grammar. The Roman pronunciation, so much in vogue in schools and colleges, is sure at some early date to supersede the English, but at present the English has the weight of authority.

The Collection and Preservation of Mosses

Every one intending to study mosses will find a collection of dried specimens invaluable, and a collection is more easily made and cared for than with any other group of plants. Insects trouble the specimens little or not at all, and most species of mosses are normally subjected to so great extremes of drought and moisture that they readily soak out in good condition for study, no matter how dried, provided only that they are dry enough to prevent moulding. Most specimens of mosses in the older herbaria are pressed out of all semblance to their natural appearance and, besides, are very imperfectly labeled. The only reason for pressing specimens of mosses is that they may be stored satisfactorily in the herbarium. Each species has a distinctive look when naturally dried *in situ*, and the pressure should not be great enough to obliterate this. Note the difference between plants of Hedwigia dried under pressure and dried in the open, and you will easily see how important proper drying is for the student, especially one who is monographing a genus. My own practice is to place the mosses in an ordinary plant-press and press with medium pressure for twenty-four hours, and then remove and dry in the open air. Mosses growing in thin mats are best spread out in the drying papers in their natural position, care being taken to remove any surplus of adherent substratum, soil, rotten wood, etc., also any other species that may be intertangled with the one it is desired to collect. If the mats are thick and consist principally of erect stems, it is better to break them up into vertical sections or slices before pressing. The substratum, the habitat, the locality, the date, and the name of the collector should be noted for each specimen, and either put in with the specimens or else recorded in a note-book, numbered to correspond to numbers attached to the specimens. The name of the person identifying the plant should be written on the label also. Many times it is also important to give the altitude at which the specimens were collected. The following is a good sample label.

NORTH AMERICAN MUSCI

Pseudoleskea rigescens (*Wils.*) *Lindb.*

Bark of Alder Trees. Alt. 1,800 ft.

Beaver Meadows, Vancouver Id., Aug. 26, 1901.

Coll. J. W. Bailey. *Det. G. N. Best.*

How to Mount Mosses

The most artistic way of mounting mosses is to glue the specimens to small cards, which can be fastened to regular herbarium paper, or perhaps it will be found more satisfactory to glue directly to the herbarium sheet. Mr. C. G. Pringle mounts his on cards, as does Dr. John K. Small, who has the neatest appearing collection of mosses the author has ever seen. An ideal way would be to have a duplicate of each glued specimen in an envelope beside it for study, so that the appearance need not be spoiled by breaking off bits for microscopic examination. However, I do not know of any collection in America thus arranged. The great majority of moss collectors simply inclose the specimen in an envelope made for the purpose, and glue the envelope to the herbarium sheet, putting the label on the outside of the envelope. There are several styles of envelopes in use,—one a rectangular piece of paper folded across so that the lower edge reaches within an inch or so of the upper edge. This edge is then folded down and the ends folded under. The only objection to this style of envelope is the time needed to open and refold the envelope for the examination of the specimen. These envelopes should be of different sizes to fit the size of the specimen.

Many use half-size herbarium paper, $11\frac{1}{2} \times 8\frac{1}{4}$ inches, and I should recommend this for amateur work, unless a large collection is planned. If there are only one or two specimens of each species they look lonesome on a full-sized sheet, to say nothing of wasted space and increased cost.

In mounting mosses on cards, I thin the ordinary liquid glue with vinegar, using about twenty-five per cent of vinegar to seventy-five per cent of glue. I then spread a thin layer of this on a dinner-plate and carefully place the specimen to be mounted on the plate, when it becomes well smeared with glue on the under side. The specimen is then placed on the card and put under light pressure until dry. It is a good plan to put clean white newspaper over the specimens and change after a few hours, to prevent any accidental surplus of glue from becoming attached to undesirable objects. For cards, ordinary herbarium paper cut to a suitable size is very satisfactory.

Some of my foreign correspondents say that insects are likely to attack the glue if used in the above manner. All danger of this can be obviated by putting a little corrosive sublimate or some other poison in the glue. If one prefers, the cards can be readily fastened onto the mounting paper by four oblique slits, cut so as to receive the corners of the card. In this way the specimens can be transferred without mutilation of the mounting paper.

Methods of Manipulation

If the moss be fresh and moist it is all ready for operations. Dried specimens should be softened by boiling or by a longer soaking in cold water. The parts to be studied can be boiled in water on a slide by holding it over an alcohol lamp, but it is much better to boil the whole plant. If apparatus for boiling the plant is not at hand the plant can be immersed in a cup of boiling water. This will also serve to drive out the air-bubbles that will cling if cold water be used. Any dirt or foreign material should first be dissected out and washed away. If the stage of one's dissecting microscope is not large enough for these preliminary operations, a piece of window glass laid over white paper and a tripod lens will be found very convenient.

One should have the following implements if possible: A pair of fine-pointed forceps, with comparatively large surface of contact at the points; a pair of small, fine-pointed, sharp scissors; dissecting needles; a sharp scalpel or razor, and a stick of pith.

The leaves should be removed with the forceps by seizing them near their bases and stripping downward, or by laying on glass and scraping downward, i. e., from top to bottom, on the stems with a sharp scalpel; the leaves thus removed are then put in a drop of water on a slide and covered with a cover glass; in this drop of water should be placed also a portion of the branch from which the leaves have been stripped. An examination of this last will show whether the bases of the leaves are decurrent or not, and will give a profile view of the leaves that will tell whether there are any teeth or papillæ on their backs. With the Hair-caps and their allies and some other mosses, a cross-section of the leaves is often necessary to definitely determine the species. This often seems very difficult to a beginner, but is really quite simple unless very beautiful sections are desired. The most common method is to split a stick of pith a little distance and insert a bunch of leaves in the cleft, pressing the sides together with the thumb and finger of the left hand. Then cut thin sections of pith and leaves with a very sharp razor or scalpel. The pith should be thoroughly moistened and there should be water on the upper surface of the razor to float away the sections cut. After a number of sections have been made, all the mass of pith and leaf-sections should be removed to a drop of water on a slide, and the pith and large pieces of leaves should be removed. Pith can be obtained from young elder shoots or the stems of the flowering raspberry, or, if nothing better is at hand, the pith of a cornstalk can be used. Mrs. Britton thinks this method is "more bother than it is worth for all simple leaf-sections"* but recommends it for other sections. She places a number of the leaves side by side in the same direction, so that they may be easily held firm with the thumb-nail of the left hand—"begin cutting at the tips of the leaves" (using a razor or sharp knife), "moving the nail from side to side and working downward to the lower half of the leaf." I have often used another method with success. Grasp a bunch of leaves between the thumb and fore-finger of the left hand, and with the scissors (which must be sharp) cut section after section from the bunch as thin as possible, and among the mass of sections will be found some that will show the desired structures. If the leaves are very small, a whole stem or branch covered with leaves can be sectioned without first removing the leaves.

"The preparation of cross sections of the leaves is a somewhat more delicate task. I again select three or four of the best leaves, and transfer them to another slip into a little water. Under the dissecting lens I now endeavor to hold them with bent needle down into the water on the slip, bases toward me and to the left, apex away from me and toward the right. This, with the left hand. Then I cut with a chop-knife motion across the leaves, endeavoring to cut very thin, parallel slices. The scalpel, of course, must be kept very sharp, and I always keep a fine hone and razor strop on my work-table. The difficulty of this operation, which is viewed through the lens, is fast diminished by practice. It arises from the surface tension of the water, which is somewhat violently disturbed by the touch of the scalpel, on the edge of which a meniscus leaps up to a microscopically considerable height, causing the small moss pieces to dance a lively jig for a moment, and throwing them into confusion. With this disturbance one soon learns to reckon, in this process of working. The thinnest sections are soon selected, and are lifted with needle and scalpel on to another slip into a drop of water or glycerine, and covered with a circle."†

To study the peristome and annulus, etc.; if the operculum still remains, remove it with forceps or dissecting needle, carefully saving it on the slide; cut the capsule lengthwise with the scissors and spread out each half on the slide, one outside up and the other the inside up; or the capsule can be first split and the pieces of operculum removed afterwards. This prevents any loss of minute parts. If the spores obscure the parts, a minute's boiling over the lamp will scatter them. The walls of the capsule will often curl up so strongly as to make it necessary to split them with the dissecting needles to cause them to lie flat.

I find that the easiest way to determine the gross structure of the inner peristome, i. e., the presence and number of the cilia, their length, etc., is to examine a deoperculate capsule dry, without cover, under about 200 diameters. This is specially helpful in case of old and very brittle peristomes.

In order to see the stomata it will be necessary to split the base of the cap-

*"Observer," for May, 1894. †J. M. Holzinger, in the "Bryologist," Vol. 2, No. 4.

sule and spread it out on the slide; the exothecial walls are so thick that it is often necessary to clear up the tissues by mounting in a strong solution of glycerine.

The reproductive organs, antheridia and archegonia, are easily found in mosses, other than the Pleurocarpi, by merely dissecting away the perichætial leaves, but in the Pleurocarpi it is sometimes troublesome. I have obtained the best results by placing the plants to be examined on a piece of window glass resting on a sheet of white paper, and examining with a tripod lens. All promising buds are removed and dissected out on a slide for examination with higher powers. If one has a dissecting microscope with a large stage, it will answer all purposes, but the stage is too small on many of the commoner kinds.

All moss mounts but the most temporary should be made in a five per cent solution of glycerine, from which the water will gradually evaporate, so that the specimens can be transferred to glycerine jelly without the usual troublesome shrinkage. It is well worth one's while to make permanent glycerine jelly mounts on mica slides of all the mosses one studies. These slides, when hard, are placed in small envelopes and mounted with the specimen.

These slides are protected from injury and rendered much more convenient to use by being mounted with glue or mucilage between two strips of thin cardboard of the size of an ordinary slide, having an opening in the center just the size of the cover of the mount, or preferably a trifle smaller, so as to assist in holding the cover in place.

For making these slides, a heater such as is described in the January, 1899, "Bryologist," is very convenient, but a cup of hot water replaced at intervals does very well for warming the jelly, and a tin box with cover filled with hot water is very good for keeping the slides warm while being mounted, and for drying the water out of the preliminary five per cent glycerine mounts.

Ordinary glycerine jelly should be boiled down about half in a water-bath, or should have a small quantity of gum arabic added to it. If this be not done, the slides are too soft and will ultimately dry out in a very troublesome way. Mica, for mounts, can be cleaned by an alcohol bath of a few hours' duration, succeeded by a similar treatment with dilute hydrochloric acid and then a thorough washing in warm water.

Life-History and Structure of the Moss Plant*

Perhaps the best point to begin the study of the life-history of the moss is with the spore, a minute, brownish, one-celled body produced in large numbers in the capsule of each fruiting moss plant. This, falling upon moist earth or other suitable substratum, germinates by sending out a slender, thread-like projection, which rapidly elongates and becomes much branched, but which remains a linear aggregate (i. e., it is made up of single elongated cells attached end to end). This is known as the protonema and very closely resembles several species of algæ. Protonema may be obtained for study by sowing spores on moist soil or on unglazed pottery, treated after the manner described by Atkinson in his directions for obtaining fern prothallia.† In practice it is usually better to go to a greenhouse and gather some of the green filaments from the surface of the soil in those parts of the house that are kept most warm and moist.

Vaucheria will probably be found more abundantly than moss protonema, but it is larger and is not divided up into cells by septa. There are one or two other species of algæ common in greenhouses, but if one takes the trouble to pull up young moss plants and study the protonema attached to them, he will soon learn to recognize the unattached protonema.

If greenhouses are not readily accessible, a moist bank of bare earth, or the moist soil of a garden or cultivated field will usually furnish all that one will desire. In any case, look for very young plants, as protonema will usually be found attached to them. In this case a most interesting transition may be seen between protonema and rhizoid, one end of a filament being characteristic

* See Glossary for unexplained terms. † Atkinson's "Biology of Ferns," page 106.

EXPLANATION OF PLATE I. (From Schimper, "Recherches sur Les Mousses.")

Fig. 1. Spore of *Funaria hygrometrica*, × 400. Fig. 2. The same after soaking two days in water. Figs. 3 and 4. Germinating spores of the same moss. Fig. 5. Protonema which has arisen from the spores of the same moss. Fig. 6. Protonema giving rise to apical cells and new axes of vegetation at *a* and *á*; *s* is the original spore, which seems to be dividing as if also to give rise to a plant. Fig. 7. A young plant at *a* and an apical cell at *á*. Fig. 8. Germinating spore of *Didymodon rubellus*. Fig. 9. A young plant of the same. Figs. 10, 11, 12, 13 and 14. Spores of *Orthotrichum leiocarpum* showing different stages of germination, × 500. Fig. 15. Protonema of the same. Figs. 16, 17, 18, 19, 20 and 21. Spores of *Bryum sphagnicola* which have germinated in the capsule placed in water, × 400. Fig. 22. Spores of *Sphagnum acutifolium*, × 500. Fig. 23. Germination of the same. Fig. 24. Cell-walls of the spores of the same, shed after germination. Fig. 25. Germinating spore of the same, having shed its cell-wall. Fig. 26. A bit of a hair from the peristome of *Dawsonia*, upon which several spores have germinated, × 150. Fig. 27. Protonemal filaments, *g*; radicles, *r*; and lower part of stem, *a*, of *Schistostega osmundacea*, × 400. Fig. 28. End of a branch of the protonema of the same, more highly magnified and showing the refractive cells. Fig. 29. Plant of *Phascum serratum*, × 200. Fig. 30. Leaf of *Fissidens adiantoides* showing young plants which have arisen from spores which have fallen into the leaf.

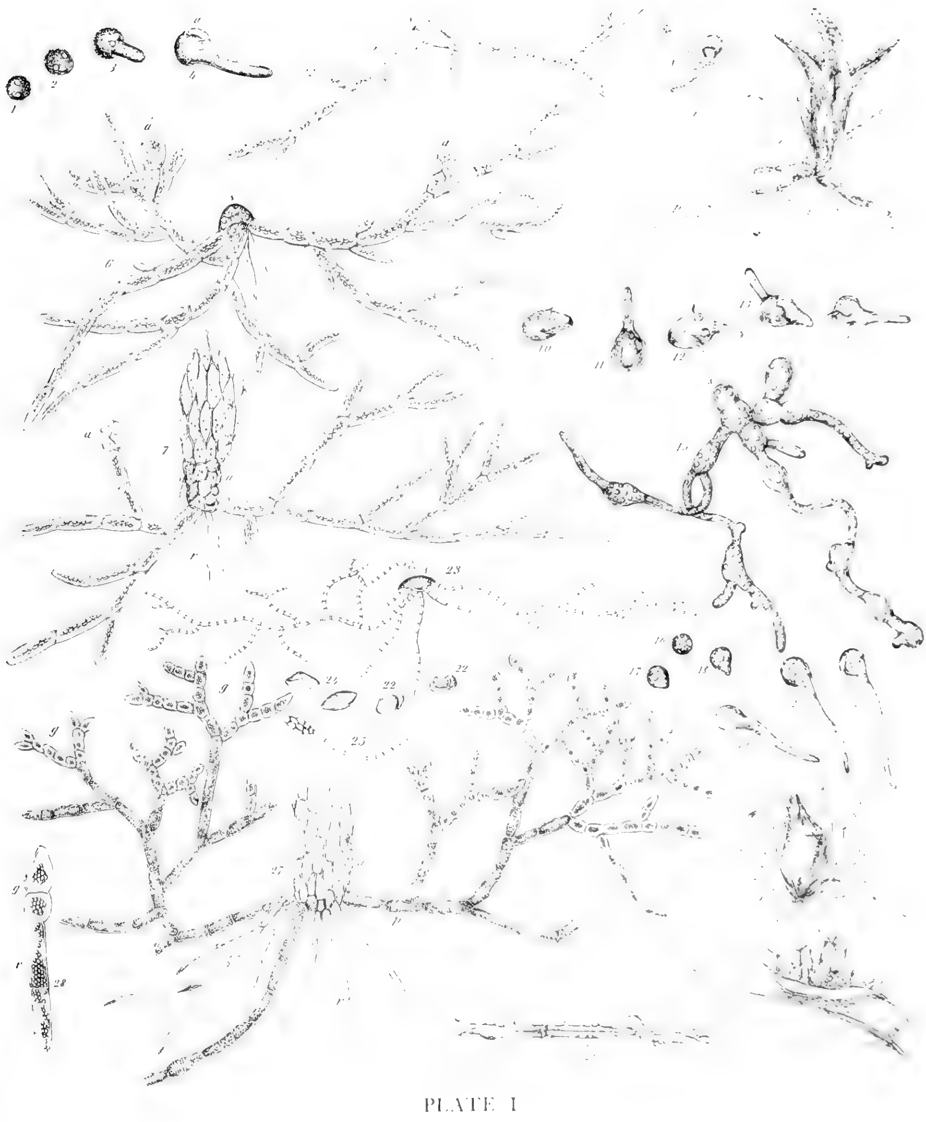


PLATE I

protonema, the other brownish, without chlorophyll, and divided by very few septa. Of course the rhizoid part was below the soil. After the protonema has reached a certain stage of development, an apical cell is produced, which forms a bud and young leaves and stem by a series of divisions in several planes.

There are some mosses that have very few leaves and rely upon a persistent protonema to do the work of leaves. Such a moss is *Pogonatum brevicaule*, which is frequent on clayey banks and by roadsides, where the soil has so recently been disturbed that other plants have not taken possession. Such a plant furnishes the very best opportunity for obtaining protonema, and, if dried specimens of this moss be soaked out, very satisfactory material can be obtained.

A specially interesting point about mosses is that the cells are so little differentiated that a cell from almost any part of the plant may produce protonema under favorable conditions. Some mosses never produce spores, but when dry become very brittle and easily break up into minute portions which serve the purpose of spores. Many mosses go so far as to produce special bodies for asexual reproduction. (See Plate II.)

"The adventitious formations which serve to propagate asexually the moss plants are of two kinds,— bulbils, sometimes called gemmæ, and brood bodies, sometimes called propagula. In their simplest form, bulbils are little buds without apparent central axes, and usually appear on the stem, as in *Webera annotina*, but may be located on any part of the moss plant. When shed, sometimes even before, they produce rhizoids and grow directly into the vegetative plant. In their higher development, with rudimentary stems and leaves, they appear in bud-like aggregations on the ends of stems, as in *Leskea nervosa*, sometimes on branches as well. In their highest development, their character as shoots becomes apparent, with stems and leaves, as in *Dicranum flagellare*, grow-

EXPLANATION OF PLATE II. (Schimper, "Recherches.") Asexual reproduction by various methods.

Figs. 1, 2, 3, 4 and 5. Radicular brood bodies (Brutknollen) of *Funaria hygrometrica*, showing different stages of development, × 250. Fig. 6. Lower part of a leaf of *Orthotrichum obtusifolium*, showing brood bodies in different stages of development, × 100. Fig. 7 shows one of these bodies with the beginnings of protonema, × 500. Fig. 8. A young plant of the same species developing from a radicular brood body. Fig. 9. Leaf of *Orthotrichum Lyelii* bearing numerous brood bodies, of which two have developed into radicles bearing radicular brood bodies, × 60. Fig. 10 shows a portion of the same leaf, × 250. Fig. 11 shows a young plant of this species developed from one of these radicular brood bodies, *a*, × 300. Fig. 12. Extremity of a leaf of *Orthotrichum phyllanthum* with propagula, × 100. Fig. 13 shows two of the same propagula more highly magnified. Fig. 14. Perichætium of *Leucobryum glaucum*, at the summit of which radicular tomentum and young plants have developed. Fig. 15 shows a single one of these plants more highly magnified. Fig. 16. A portion of a rhizoid of *Phascum serratum*, which has sent up a branch which in turn has developed protonema, on which are brood bodies and young plants in various stages of development. Figs. 17, 18 and 19. Brood bodies formed in the axils of the leaves of *Bryum erythrocarpum*. Fig. 20. Branch of *Webera* (*Pohlia*) *annotina* with a bulbil. Fig. 21 shows a bulbil, × 60. Fig. 22. Upper portion of a stem of *Aulacomnium androgynum*, showing a pseudopodium, × 15. Figs. 23, 24 and 25. Brood bodies from the same in various stages of development. Fig. 26. Upper end of a branch of *Georgia pellucida*, showing the cup-shaped involucre containing brood bodies. Fig. 27. An isolated involucre. Figs. 28, 29 and 30. Brood bodies removed from the involucre. Fig. 31. Leaf of *Funaria hygrometrica*, in which several of the basal cells have developed protonemal filaments.

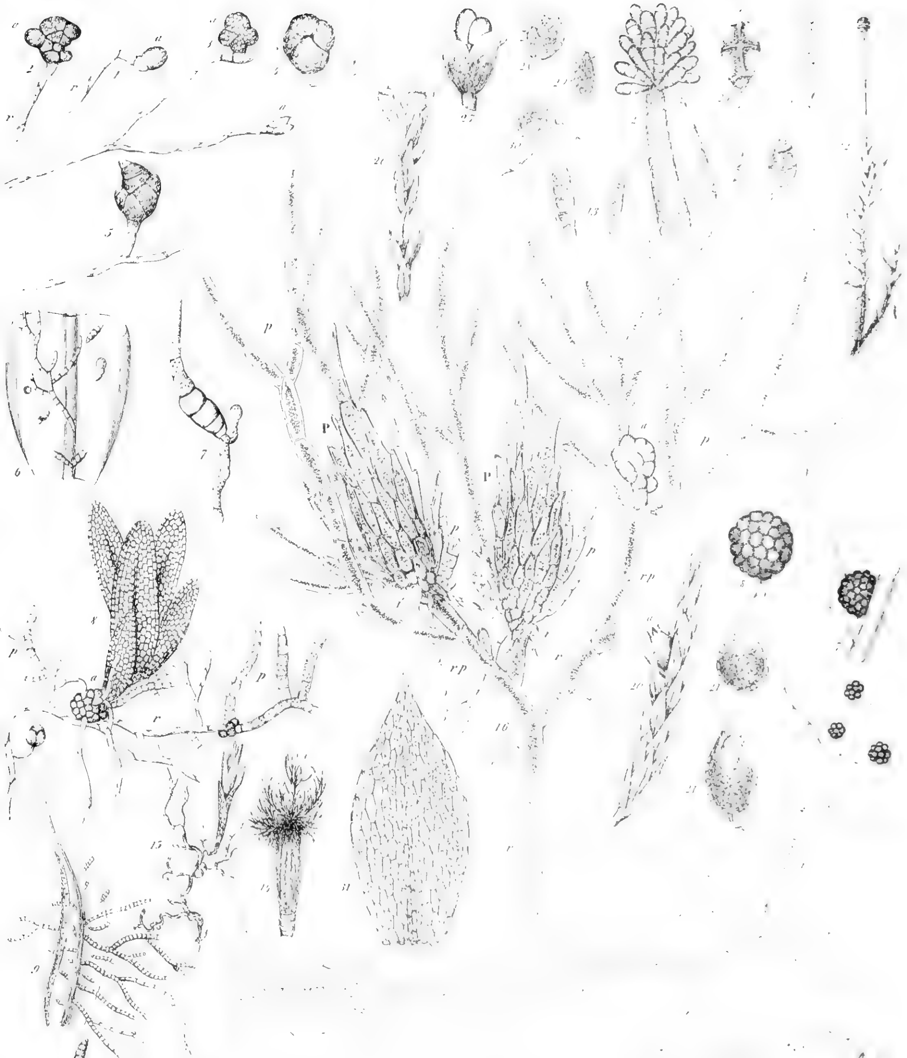


PLATE II

ing into plants, however, in precisely the same manner as is done by the simplest forms.

"Brood bodies are polymorphous and variously located. In their simplest form they are deciduous rhizo-protenemata, which appear in clusters on stems, often on midveins, as in *Plagiothecium Roeseanum*. They are, however, usually more complex in structure, and are sometimes borne on specialized stems and branches, the pseudopodia, as in *Aulacomnium palustre;* or in a cup-shaped involucre, as in *Georgia pellucida;* or on rhizoids (Brutknollen), as in some of the Barbulæ; or on the excurrent costa, as in *Ulota phyllantha;* or on the paraphyses, as in *Pottia riparia;* or on the upper surface of leaves, as in *Tortula papillosa;* or on both surfaces, as in *Orthotrichum Lyellii;* or in fasciculate clusters on the midrib at the base of the leaves, as in *Grimmia torquata*. In whatever form or position they appear, their function is the same, the reproduction of the parent plant, which they accomplish by producing protenemata."*

Brood bodies are abundant on the rhizoids of Funaria in the greenhouses, and are easily obtained by pulling up the young plants and carefully washing off the adhering soil.

For young plants, the greenhouse is by far the most satisfactory place to visit. Here will be found young plants of *Funaria*, *Physcomitrium*, *Leptobryum*, and other less easily recognized species. Often the young buds with but two or three leaves may be found on the protonema attached to these young plants. Young plants may also be found in the situations mentioned under protonema. Spring is the best season for obtaining young plants out-of-doors, but a careful search will usually discover them at any season when the ground is not covered with snow.

The leaves of mosses, as a rule, are but one cell in thickness, except at the midrib and occasionally around the margin. Many species with small leaves lack even the midrib. The thickened margin is usually found only in leaves of comparatively large size, like those of *Mnium* and *Bryum*, in which cases the thickened margin serves as an additional support. The cells of the midrib (costa) and the thickened margin are usually longer and narrower than the other cells in the same leaves.

For class use, several kinds of leaves should be obtained in order to show the variations in structure†: *Mnium*, to show hexagonal cells, costa and thickened margin; some of the smaller *Hypnums*, to show ecostate leaves; *Catharinea* or *Polytrichum*, to show the peculiar lamellæ rising from the upper side of the costa to furnish an additional surface for the absorption of light (the sex are best seen in cross-section but can be seen on a leaf mounted entire); the leaves of *Thuidium* or *Thelia*, to show the papillæ so common on many moss leaves;

* Dr. G. N. Best, in the January, 1901, "Bryologist."

† For illustrations, see the figures and plates in the text.

also leaves of *Dicranum*, *Rhacomitrium*, *Sphagnum* and *Fissidens*, to show their special peculiarities.

In determining species, the position and arrangement of the leaves are of great value. Unless otherwise stated, the leaves are arranged equally around the stem. In some cases they are distichous and complanate, but many species have the leaves complanate, i. e., arranged in one plane like the pinnæ of a fern frond, whose leaves are really arranged in several rows but have become twisted around so as to lie in one plane, much after the manner of the Prickly Lettuce. *Plagiothecium* furnishes a good illustration of such a case.

Leaves which are turned to one side instead of standing straight out from the base are called secund, which is often used as a synonym for homomalous. Homomalous means that all the leaves are secund in one direction, as in *Hypnum uncinatum*.

The position and amount of concavity, or of folding, varies a great deal according to whether the plant is wet or dry. These characters are best observed with a strong hand-lens, with the leaves all in position and as near a normal condition as possible. Leaves selected for study should always be taken from the median portion of a stem or branch, as those at the apex and, more especially, those at the base are always very different in character from the typical leaves.

Many species of mosses bear on the stems among the leaves other structures known as paraphyllia. These may be thread-like and simple or branched, fimbriate like the lip of an orchid, or like minute leaves. (See illustrations to the key of *Thuidium*.)

The moss has no true roots, only rhizoids. It lacks also the vascular bundles so characteristic of the higher plants, but in many species the stem possesses a well-marked central strand of narrow elongated cells, which serve to carry water lengthwise through the stems. This central strand is usually correlated with the presence of a costa in the leaf, but there are some cases where one is present and the other lacking. In many cases the central strand is continued into the costa in the same manner that the vascular bundles of the higher plants are continued into the midribs of the leaves. The other tissues, shown in Fig. 14 of the glossary, are characteristic of all moss stems, although the outer layers are often reduced in number or in thickness of cell-wall.

The moss plant, as here described, is the gametophyte, or sexual generation, corresponding to the prothallial stage of the fern, and, like the fern prothallus, bearing archegonia and antheridia. These are usually borne in clusters, surrounded by leaves. The plants may be either monoicous or dioicous.

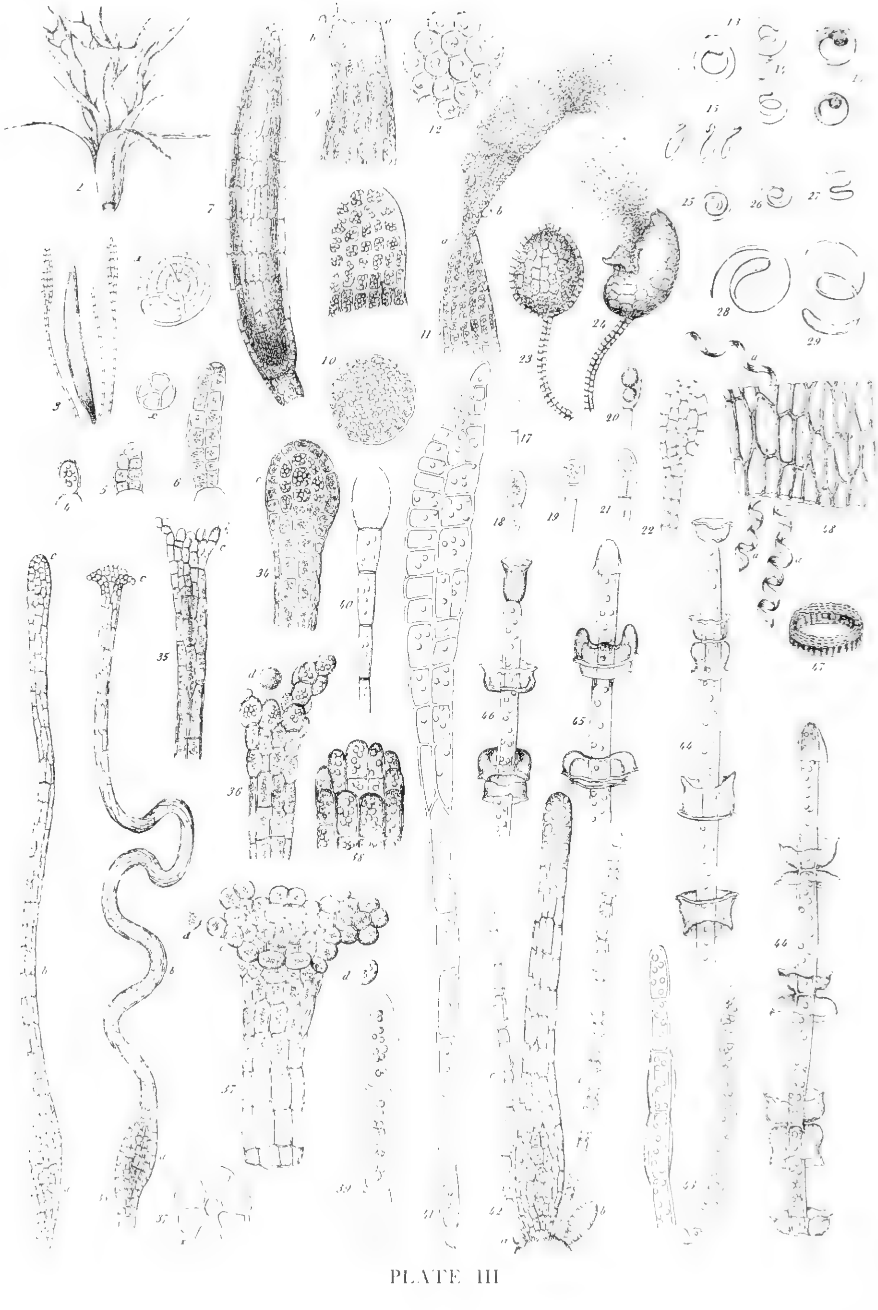


PLATE III

In nearly all the mosses excepting *Sphagnum* and the PLEUROCARPI, the archegonia and usually the antheridia are borne at the ends of the stems. But in the PLEUROCARPI they are borne in axillary buds, or short branches, which are often called flowers, as are also the terminal clusters of reproductive organs in the other mosses.

The egg-cell in the archegonium is fertilized by an antherozoid swimming in the dew or rain to the archegonium and down its neck, just as in the ferns.

After fertilization, the egg grows in a manner similar to that in the ferns, by absorbing nutrition from the gametophyte; but, unlike the fern, the sporophyte developed from this fertilized egg is almost entirely dependent on the gametophyte for its nutrition during its entire existence, and might almost be said to be parasitic upon it.

These actively swimming antherozoids are extremely interesting microscopical objects under the higher powers, 400 to 500 or more diameters, but I have always had difficulty in obtaining them in good condition. The time of fertilization of the different species of mosses varies, so that it would be possible to obtain the motile antherozoids at any season of the year if one could know just when to look for them. One must watch any given species with a great deal of care, or the first indication of the presence of the reproductive bodies will be the young "lances" of the sporophyte. The same species varies so, according to season and situation of the plant, that one can never depend on any given date for any species. The young sporophytes of *Polytrichum commune*, for instance, may appear at any time from November, in New York City, to May, in Vermont.

EXPLANATION OF PLATE III. (Schimper, "Recherches.")

Fig. 2. The male head of *Polytrichum juniperinum*, $\times$ 10. Fig. 3. Antheridia and paraphysis of the same, $\times$ 50. Fig. 4. The first beginnings of an antheridium of *Polytrichum formosum*, merely a single cell with chlorophyll grains, $\times$ 150. Figs. 5, 6 and 7 show successive stages in the development of the same. Fig. 10 shows the upper end of a nearly mature antheridium and a cross-section of the same. Fig. 9 shows an antheridium after the escape of its contents. Fig. 11 at the moment of the escape of the antherozoids. Fig. 12 shows a mass of antherozoids still in their cells, which are yet attached to each other as in the antheridium, $\times$ 400. Figs. 13, 14 and 15. Motile antherozoids in various positions, $\times$ 600. Fig. 16. Two of the same treated with iodine; the cell with its mucilaginous contents is contracted and attached to the spiral fiber. Figs. 17, 18, 19, 20, 21 and 22. Different phases of the development of the antheridia of *Sphagnum cymbifolium*. Fig. 23. Antheridia of *Sphagnum* before its rupture, $\times$ 150. Fig. 24. The same at the moment of the escape of antherozoids. Fig. 25. Antherozoid in its cell, as seen by Schimper. Figs. 26, 27, 28 and 29. Antherozoids free, as seen by Unger. Fig. 32. A perfect archegonium of the same, $\times$ 150. Fig. 33. The same after fertilization. Fig. 34. The apex of the archegonium, a little earlier than in 33, $\times$ 250. Figs. 35, 36 and 37. Different views of the same, showing in the last two the detachment of the upper cells. Fig. 37 *x*. Transverse section of the neck of the archegonium. Fig. 38. Portion of the neck of the archegonium, $\times$ 300. Fig. 39. Upper portion of a filiform paraphysis from an antheridial head of the same moss, showing a conspicuous layer of extra-cellular substance, $\times$ 500. Fig. 40. A club-shaped paraphysis from the same head. Fig. 41. Clavate paraphysis from the antheridial "flower" of *Funaria hygrometrica*, $\times$ 40. Fig. 42. Archegonium of *Webera sessilis* with the beginnings of archegonia at *a* and *b* and paraphyses at *c c*. Fig. 43. Paraphyses of the same before decortication. Figs. 44, 45 and 46 show the same after decortication. Fig. 47. Transverse section through a young calyptra of *Mnium hornum* taken near the top. Fig. 48. A portion of the same, $\times$ 600, showing the spiral cells unravelled at *a a a*.

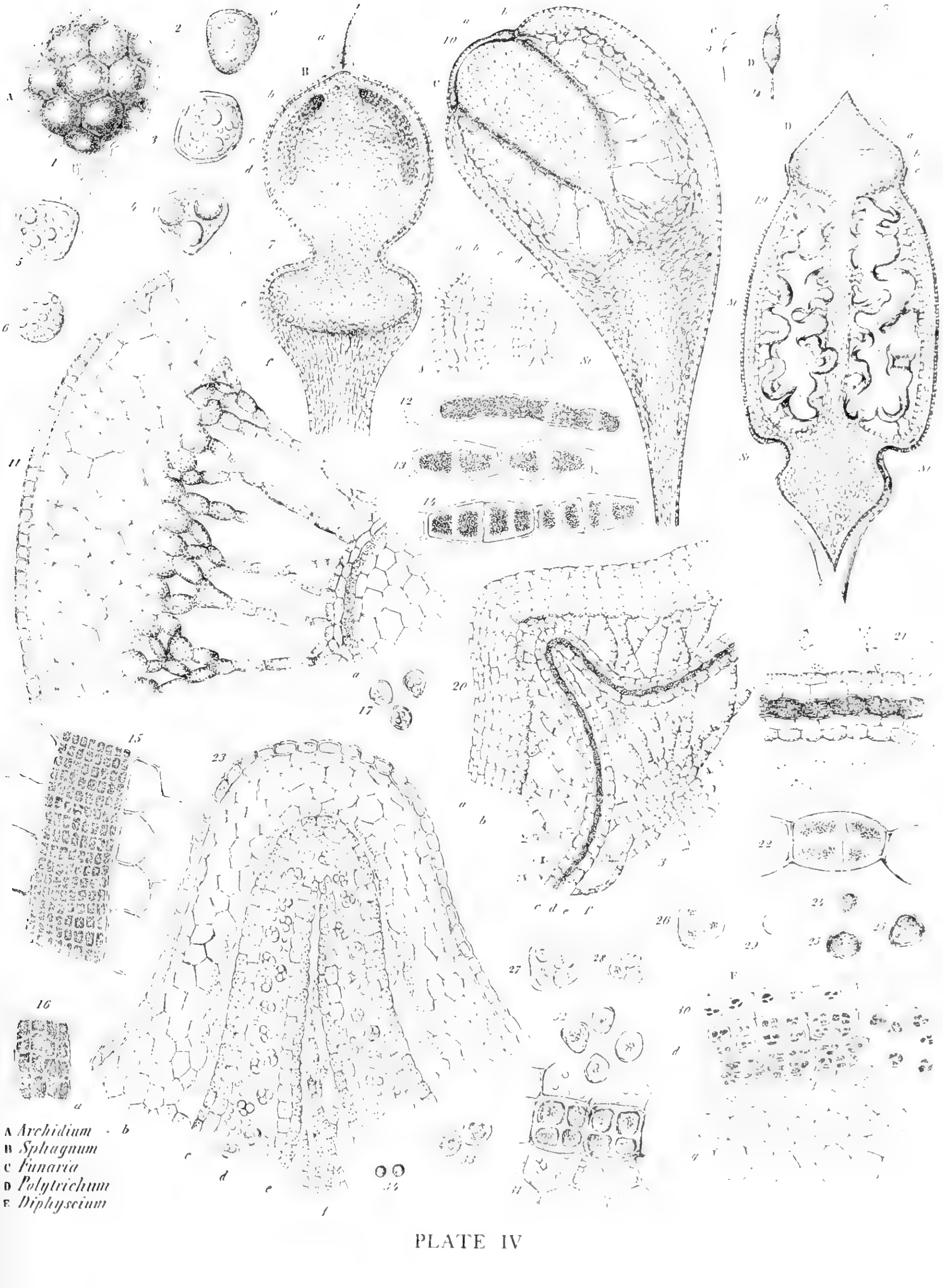
In order to get the best results, the plants should be collected a few days before the antheridia are ripe and kept moderately dry for a few days,—not dry enough to completely dry the plants; then, when the plants are put in water, the antherozoids will break out in swarms. This, of course, is a result of adaptation to the conditions of nature, for if the antheridia were to open in a dry time they would entirely fail of performing their function. I have had the best success with *Polytrichum juniperinum*. Collect a week or ten days after the snow has melted from over it and treat as directed above, and a fair degree of success is pretty sure to follow.

The sporophyte, when fully developed, consists of a slender, bristle-like stalk, the seta,* imbedded at its lower end in the tissues of the plant and bearing at its upper end the spore-case (sporangium, or capsule). Over the upper end of the capsule in young sporophytes is a little cap, or hood, the calyptra, which is formed of the upper part of the archegonium somewhat enlarged, and torn off from its base by the elongation of the infant sporophyte. The calyptra falls off easily at maturity and the capsule usually opens by a circular lid (operculum) which is easily detached from the lower portion of the capsule (urn) when the spores are fully ripe. The spores then escape through the opening thus made; their escape is not usually unrestricted, but is regulated by a fringe of fine teeth (the peristome) around the mouth of the urn.

* See Glossary.

EXPLANATION OF PLATE IV. (Schimper, "Recherches.")

Fig. 1. Capsule of *Archidium* in longitudinal section, × 125. Figs. 2, 3, 4 and 5. Spores of the same showing drops of oil in the interior and fragments of the mother-cell at *a*, × 250. Fig. 6. Contents of a spore. Fig. 7. A longitudinal section of a young capsule of *Sphagnum acutifolium* showing at *a* the remains of the archegonium, the basal membrane of which surrounds the young sporophyte entirely. This membrane ruptures later on in the development of the sporophyte and forms the calyptra. At *c* is clearly seen the line of demarcation between the lower end of the seta (sporophyte) and the moss plant (gametophyte). Fig. 8. Portion of a longitudinal section of a capsule of *Webera sessilis*, × 250; *a*, exothecial wall of the capsule, *c; b*, loose tissue uniting the interior exothecial layer of the capsule with the exterior wall of the archesporium; *d*, mother-cells showing in their interior the granules which later unite into four groups to form the spores; *e*, interior wall of the archesporium; *f*, tissue of the columella. Fig. 9. Capsule of *Funaria hygrometrica*, natural size. Fig. 10 shows a longitudinal section through the same, × 100; *a*, operculum; *b*, annulus; *st*, neck of the capsule in the region where stomata are found. Fig. 11. A fifth-part of a transverse section of the same (× 250) at a little earlier stage of its development; *a*, layer of primary mother-cells. Fig. 12. Four primary mother-cells, of which the two at the right have their contents divided into two groups, × 500. Fig. 13 shows two primary mother-cells more highly magnified. In one of the two, groups of granules have become separated by a cell-wall. Fig. 14 shows the division of the primary mother-cell at the right into four primary mother-cells of the third degree. Figs. 15 and 16. The fourth and last degree of subdivision of the primary mother-cells. Fig. 17. The cells in which the spores are formed. Figs. 18, 19, 20, 21, 22, 23, 24 and 25 show the same details of *Polytrichum formosum* as have already been explained under *Funaria*. The mother-cells, with their contained spores, are shown in Fig. 23 and more enlarged in Figs. 26, 27 and 28. Fig. 29 shows a mother-cell after the emission of its contents. (Schimper states that Figs. 22–29 are all × 900, but it appears as if there was some mistake if one compares 23 with 27.) Fig. 30. Portion of a transverse section of a very young capsule of *Webera sessilis* showing a portion of the columella and some of the mother-cells at the moment of leaving the primary mother-cells; the contents of the former are already divided into the four parts which form the spores. Figs. 31, 32 and 33 show a portion of the same archesporium with the spore of mother-cells in various phases of development, × 900. Fig. 34 shows perfect spores of the same moss.



A *Archidium*
B *Sphagnum*
C *Funaria*
D *Polytrichum*
E *Diphyscium*

PLATE IV

The life-history of the moss might be compared with that of the fern in a tabular manner, thus:

	Moss	Fern
Gametophyte	spore	spore
	protonema	protonemal filament from the spore
	apical cell	apical cell
	buds which develop into the moss plant bearing	prothallium
	archegonia and antheridia	archegonia and antheridia
	egg-cell fertilized	egg-cell fertilized
Sporophyte	becomes oösperm	oösperm
	seta and capsule	fern plant and sporangia
	spores	spores

The notable thing about this comparison is that in the moss the gametophyte is the lasting, nutrition-getting part of the plant, while in the fern it is the sporophyte which is permanent and obtains the most nutrition.

The structure of the mature capsule (Plate IV) is worthy of a little more careful attention. A longitudinal section through the middle of the capsule shows an outer or exothecial layer of thick-walled cells, inside this a few layers of thinner-walled parenchymatous tissue, then a layer of looser absorptive tissue, with very large intercellular spaces for the circulation of the air and carbon dioxide. Just inside this absorptive tissue and separated from it by only one or two cells, is the archesporium, or spore-bearing layers, in which all the spores are produced, and in the center a mass or column of parenchymatous tissue, known as the columella, which extends beyond the spore-bearing layer into the cavity of the operculum. In some cases, the operculum remains permanently attached to the columella after dehiscence. As is shown in the figure of *Archidium*, in Plate IV, some of these characters are wanting in the simpler forms.

In the exothecial wall of the neck or base of the capsule there are usually stomata which serve to admit air and CO_2 to the absorptive layers. The number of the stomata is very variable and the guard-cells are often confluent, so that the stoma appears to be surrounded by a single cell of the shape of an old-fashioned doughnut. The stomata may be either superficial or immersed, i. e., sunk in the wall of the capsule and partially covered by other exothecial cells. The position of the stomata in this respect is often of the greatest value in determining species, especially in *Orthotrichum*. (Fig. 1 and glossary Figs. 42, 43.)

The CO_2, taken in through these stomata and assimilated by the loose absorptive layer within, constitutes practically all the nutrition taken in directly by the sporophyte. The remainder of its nutrition is taken in from the gametophyte through the base of the seta, though there is no more organic connection between gametophyte and sporophyte than between the placenta and uterus in the mammalia.

Between the edge of the urn and the operculum there is usually one or two rows of peculiarly elastic and hygroscopic cells, known as the annulus, which aids in the removal of the operculum when the spores are mature. The cells of the annulus are usually rounded, not angular, at their upper extremity, and their cavities are usually very small.

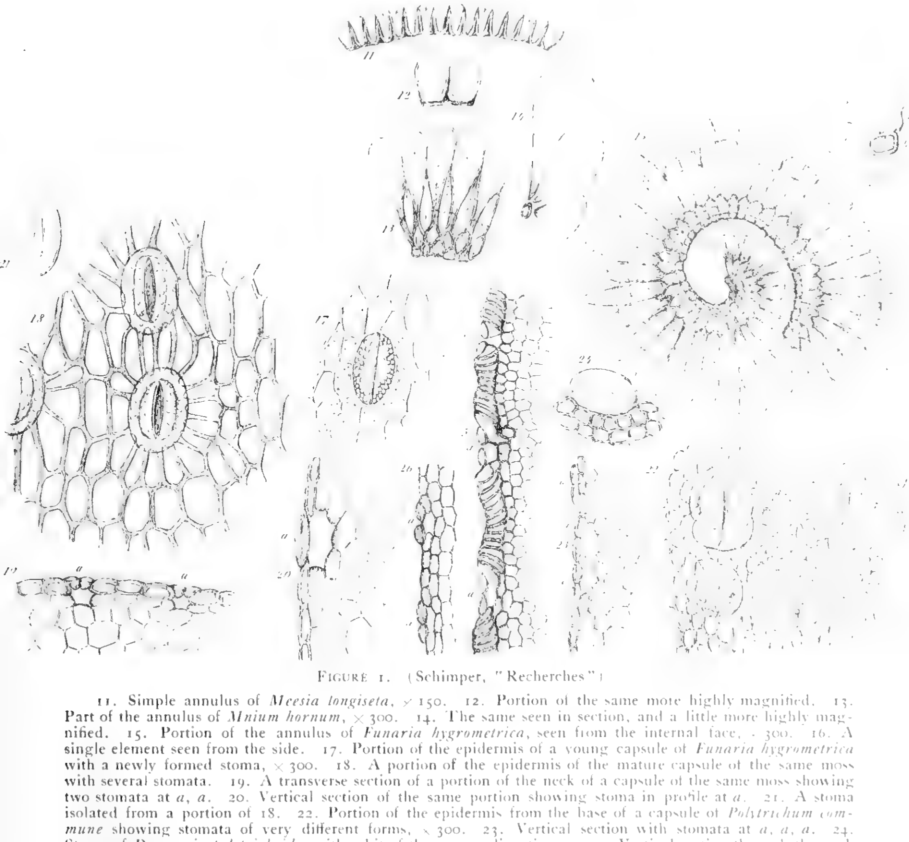


FIGURE 1. (Schimper, "Recherches")

11. Simple annulus of *Meesia longiseta*, × 150. 12. Portion of the same more highly magnified. 13. Part of the annulus of *Mnium hornum*, × 300. 14. The same seen in section, and a little more highly magnified. 15. Portion of the annulus of *Funaria hygrometrica*, seen from the internal face, × 300. 16. A single element seen from the side. 17. Portion of the epidermis of a young capsule of *Funaria hygrometrica* with a newly formed stoma, × 300. 18. A portion of the epidermis of the mature capsule of the same moss with several stomata. 19. A transverse section of a portion of the neck of a capsule of the same moss showing two stomata at *a*, *a*. 20. Vertical section of the same portion showing stoma in profile at *a*. 21. A stoma isolated from a portion of 18. 22. Portion of the epidermis from the base of a capsule of *Polytrichum commune* showing stomata of very different forms, × 300. 23. Vertical section with stomata at *a*, *a*, *a*. 24. Stoma of *Dawsonia polytrichoides* with a bit of the surrounding tissue. 25. Vertical section through the neck of *Lyellia crispa*. 26. Vertical section through stomata of *Dawsonia*.

The peristome of mosses is one of the most beautiful and interesting structures of vegetable life. The teeth vary in number from four to sixty-four, always being some multiple of four. They are often most beautifully sculptured and colored, making microscopic objects of a great diversity of form and coloring. The markings, like those of the diatoms, are produced by differences in the thickening of the cell-walls. As the structure of the peristome has been found to give the most satisfactory indications of the relationships of mosses, and is, therefore, one of the most important factors to be considered in classification, it is of great importance to the student to thoroughly understand it.

The simplest type of peristome is that of *Georgia*, in which the tissue lying within the operculum divides almost equally into four sectors (Fig. 2). In *Polytrichum* and its allies the teeth number thirty-two or sixty-four, and consist of elongated processes, triangular in cross-section, made up of long, hollow fibers formed by the absorption of the end walls of the cells which constituted the tissue in the earlier stages of its development. In both of these families the teeth consist of bundles of cellular tissue, and are without joints or external markings other than those caused by the outlines of the cells.

In almost all the other families of peristomate mosses the peristomes are not made up of cells but consist solely of cell-walls, on one or both faces of which there are engraved plates, or lamellæ, consisting of lignin deposited by the protoplasm which at first filled the cell cavities. The other walls of the cells, from which the peristomes are made, are absorbed before the maturing of the spores and the falling of the operculum.

For types of peristomes for general study *Georgia*, *Polytrichum*, *Webera sessilis*, *Dicranum* and *Dicranella* or *Fissidens*, *Barbula*, *Grimmia*, *Orthotrichum*, *Funaria*, *Mnium* or *Bryum*, *Hypnum*, *Leskea* and *Fontinalis* are recommended. These are common forms.

If one is curious to pursue the matter farther *Buxbaumia indusiata*, *Cinclidium* and *Dawsonia* are recommended. An account of the structure of each of these peristomes will be found here or in the systematic part of this work; but the general account of the structure, functions and adaptations of the peristome will be best given in this connection.

EXPLANATION OF PLATE V. (Schimper, "Recherches.") Peristomes of various mosses

Fig. 1. Of *Georgia*. Figs. 2 and 3. *Tortula atrovirens*. Fig. 4. Portion of that of *Cinclidotus riparius*. Fig. 5. Of *Tortula ruralis*, × 50. Fig. 6. Of *Tortula canescens*, × 150. Fig. 7. Of *Rhacomitrium canescens*, × 25. Fig. 8. One-fourth of that of *Fissidens adiantoides*, × 50. Fig. 9. Portion of that of *Orthotrichum stramineum*. Figs. 10 and 11. Of *Splachnum sphaericum*, in a moist and dry state, respectively. Fig. 12. Of *Tayloria splachnoides*, × 590. Fig. 13. Of *Catharinea undulata*, × 50. Fig. 14. Of *Cinclidium stygium*, × 50. Fig. 15. Of *Buxbaumia aphylla*, × 50. Fig. 16. Of *Dawsonia polytrichoides*, × 50. Fig. 17. Of *Fontinalis antipyretica*, × 50. Figs. 18 and 19 show portions of the outer and inner peristomes of the last, × 300 Fig. 20. Portion of a tooth of *Dichelyma falcatum*. Fig. 21. Portion of the inner peristome of the last, × 300. Fig. 22. Portion of the double peristome of *Mnium hornum*. Fig. 23. Portion of the double peristome of *Funaria hygrometrica* showing the segments opposite the teeth instead of alternating with them as in *Mnium*. Fig. 24. Portion of the membrane of the inner peristome of *Buxbaumia aphylla*, × 200.

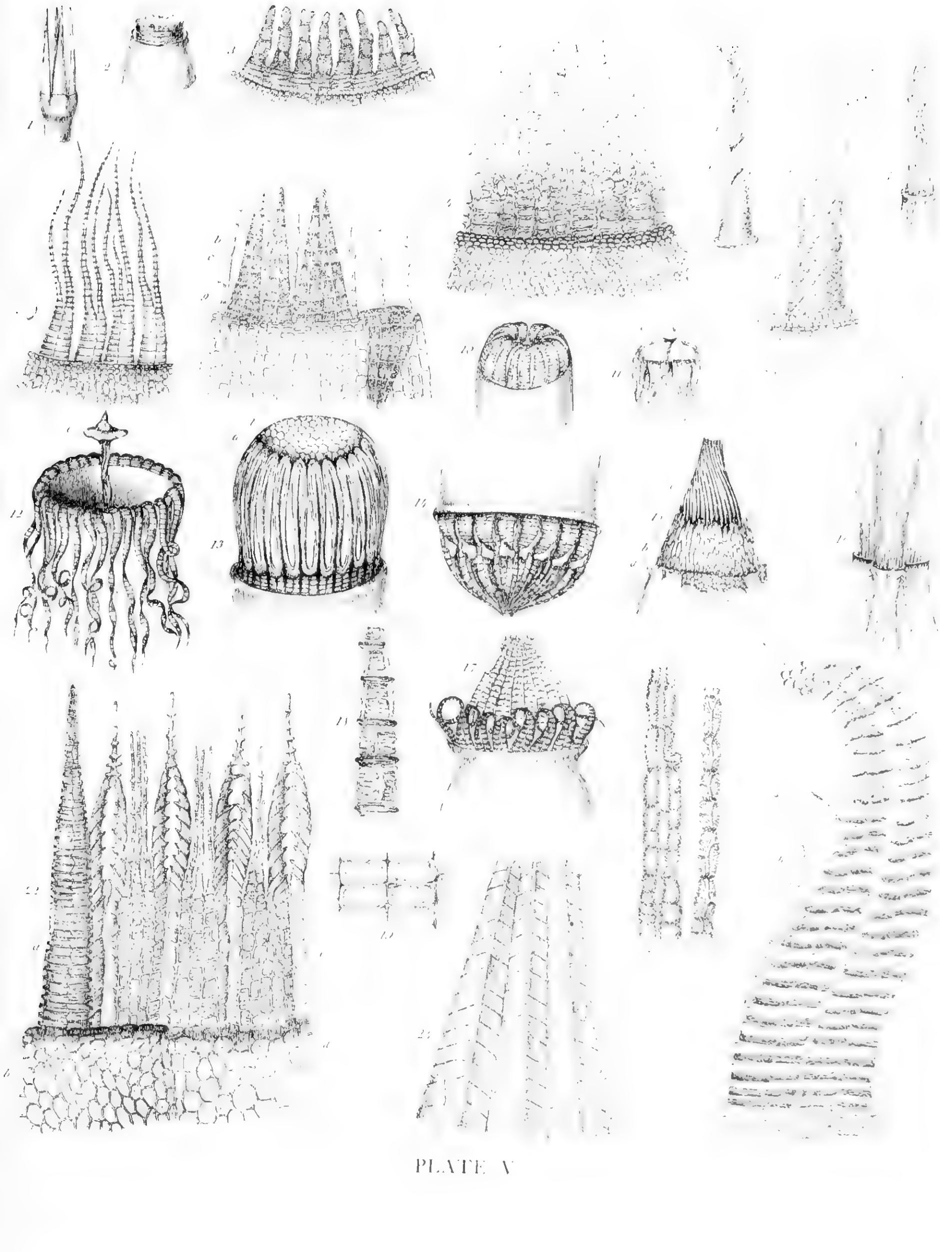


PLATE V

It has long been recognized that moss peristomes are strongly hygroscopic i. e., respond by active motions to any changes in the amount of moisture in their tissues. It has also been recognized in a general way that the peristome played some part in the distribution of the spores, and that its hygroscopic activity aids in this work; but very little attention seems to have been paid to the details or to the extreme nicety with which the peristome in different species has been adapted to do its work.

The spores of mosses must depend largely upon currents of air for distribution, hence they must be securely protected from rain or dew, which would mass and clot them together so that they would fall directly to the ground as soon as liberated, to say nothing of the danger of premature germination and decay.

Then, again, the spores must be liberated in small quantities, so that they will not all be discharged at once but take advantage of breezes from different directions and be sown at various seasons. They must also be well separated or sifted, so as to be as widely separated as possible when they finally alight. This sifting of the spores is accomplished by various interesting devices which are specially prominent in mosses with pendent or horizontal capsules. In mosses with a double peristome the inner peristome is usually the sieve, while the outer protects from water by closing hygroscopically in wet weather. In mosses with a single peristome both functions are often performed in a very interesting manner by the single row of teeth.

In mosses with upright capsules there is less need of a so finely meshed sieve, as the spores will not fall out but will be shaken out after the manner of lily seeds. To assist in this shaking, the seta is often almost as elastic when dry as a steel wire, and if bent to one side flies back with a jerk when released, which scatters a small cloud of spores. In wet weather not only do the peristomes close, much after the manner of chickweed pods, but the seta become soft and flaccid. As the highest development of this sifting arrangement is of no special advantage to mosses with an erect capsule, the inner peristome has become more or less vestigial in those mosses which have erect capsules, although they may be most closely related to species having cernuous or pendent capsules with a highly developed inner peristome. Philibert, in his masterly treatment of the structure of the peristome, calls attention to this correlation of symmetric erect capsule with a degenerate peristome, but gave no explanation for the very evident facts. In this connection he mentions *Anomodon viticulosus*, *Habrodon Notarisii* and *Pylaisia polyantha*, calling attention not so much to the inner peristome as to the disappearance of the fine horizontal lines which mark the lower outer lamellæ of the typical hypnaceous peristome. Most striking illustrations of the correlation of the erect capsule with an imperfectly developed inner peristome are furnished by *Brachythecium acuminatum* and its allies, *Plagiothecium latebricolor*, and the genera *Pylaisia*, *Entodon*, *Orthothecium*, *Isothecium* and *Homalothecium*. This also explains why *Thuidium* and its allies have a perfectly developed inner peristome, while most of the *Leskeaceæ*, having erect capsules, have also imperfectly developed peristomes. I am inclined to think that this principle, modified by an annual habit of growth, or a very low minute growth, or both, will explain the lack, partial or complete, of a peristome in *Physcomitrium*, *Pottia*, *Pleuridium*, *Mollia viridula*, and other species of a similar habit and structure. It will also explain the degenerate condition of the peristome in *Orthotrichum* and its allies. However, it seems very probable that we do not yet fully understand why mosses like *Pleuridium* do not seek the assistance of a peristome in their spore distribution, and I would suggest that this question offers a fascinating field for investigation.

An apparent exception to the perfect development of the inner peristome in plants with pendent capsules is found in some species of *Pohlia*, notably *P. acuminata*, Hornsch. The lack of cilia may possibly be explained by the very slender capsule with narrow mouth—structural characters which would tend to retard the escape of the spores.

Another peculiar and interesting fact is the similarity of capsule form and peristome structure in mosses that grow on trees, even though they belong to widely different groups and families. Such mosses nearly always have ovoid symmetric capsules and the inner peristome much less highly developed than in closely related forms having a different habitat. Compare in this respect *Orthotrichum*, *Pylaisia*, *Burnettia* (*Homalothecium*) *subcapillatum*, *Leskea*, *Thelia*, *Anomodon*, *Leucodon* and *Neckera*. This, of course, does not apply to mosses growing at the base of trees, but only to those that are truly trunk-growing species.

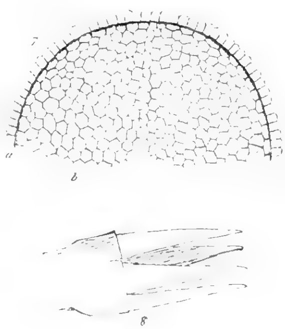


FIGURE 2

7. Half of a section of the peristome and operculum of *Georgia* (*Tetraphis*); *a*. Operculum composed of a single layer of cells; *b*. Tissue which fills the operculum and which splits into four parts to form the peristome. 8. Peristome of *Georgia*, × 40.

In *Georgia* the capsules are erect, and its four teeth well separated when dry, as seen in Fig. 3, 3. Dip one of the dry capsules in warm water for a moment and see the peristome close like a tiny vise, giving an almost comical impression of grim determination. (Fig. 3, 4.)

In *Polytrichum* the teeth are sixty-four in number, and of themselves are usually so short that they would have little effect on spore distribution, but they are all attached, by their tips, to the expanded membranous upper end of the columella, forming a most effective and ingenious pepper-box, entirely automatic in action. When the weather is dry, the

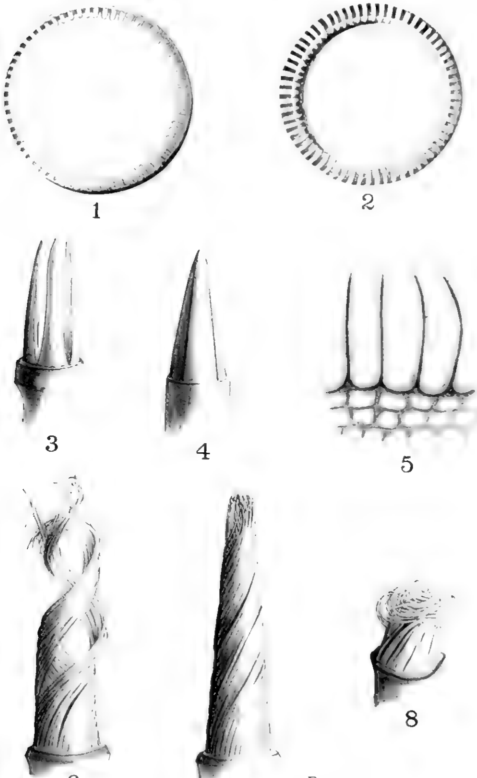


FIGURE 3

1. Moist peristome of *Polytrichum Ohioense*, R. & C. 2. The same dry. 3. Dry peristome of *Georgia*. 4. The same wet. 5. Four teeth of the peristome of *Catharinea undulata* (L.), Web. & Mohr. 8. Dry peristome of *Barbula amplexa*, Lesq. 7. A perfect peristome of the same moistened. 6. An older peristome of the same moistened. 6, 7, and 8 represent different positions of the peristome of *Barbula amplexa*, Lesq.* 7 shows the peristome immediately after the removal of the operculum. 8 shows the appearance of the operculum of a dry capsule from which the spores are escaping. The loosely twisted mesh of the narrow teeth forms a perfect sieve to control the escape of the spores. If you place a peristome in this condition under the microscope without mounting medium or cover-glass and breathe upon it the teeth will straighten perceptibly. If you dip it in warm water it will assume the original position shown in 7, if it be comparatively fresh; if it be rather old and somewhat broken it may look like 6. The perfect cone in 7 is, of course, a waterproof covering for the spores inside.

teeth become shrunken in width, and strongly incurved; the columella also shrinks, pulling the ends of the teeth inwards (Fig. 3, 2). This leaves ample room for the spores to be shaken through the openings between the teeth. The columella shrinks more at the margin than in the central portion, causing it to assume the shape of a pie-plate. This upturned margin of the columella also enables the teeth to remain attached to its edge in their changed position. In species of this family with more nearly erect capsules the teeth are longer and often fewer in number, making the escape of the spores easier.

If you take a capsule in the condition represented in Fig. 3, 2, and place it in warm water for a few minutes, it will assume the appearance shown in 1, and no spore can be shaken out; although a careful examination of the contents of the capsule will show that the spores are not wetted, as when mounted in water they are still surrounded by an envelope of air.

The pepper-box is closed, but how? Kerner von Marilaun† states that the teeth, when wet, curve inwards so strongly that the columella is pressed against the mouth of

*As the peristomes were drawn by reflected light, the basal membrane was scarcely noticeable.

†Nat. Hist. Plants, 2; 814.

the capsule, closing it effectually. Five minutes' study, however, will show any one that the teeth do not curve in when wet, but, instead, straighten up and outwards; the columella also expands and becomes of nearly the same diameter as the capsule. This makes the openings lateral instead of terminal. The teeth expand enough laterally so that not a single drop of water can enter or a spore escape. In addition, the spores seem to be protected by the nature of their outer surface, for it takes a very long soaking to wet them so that they can be satisfactorily mounted in water for microscopic study.

In those species of *Polytrichum* whose ripe capsules become horizontal or pendent (*P. commune*, *P. juniperinum*, *P. strictum*, *P. piliferum*), there is a crest down the inner face of the teeth which bears cells which are free at their outer ends, or these cells may be united to each other by their extremities. Lindberg, who was the first to accurately describe these structures, compares them to a minute stag's horn attached to the inner surface of each tooth. I do not consider it proven that these crests are accessories developed to prevent a too free delivery of spores in species with pendent capsules, but I do consider the suggestion one worthy of serious consideration.

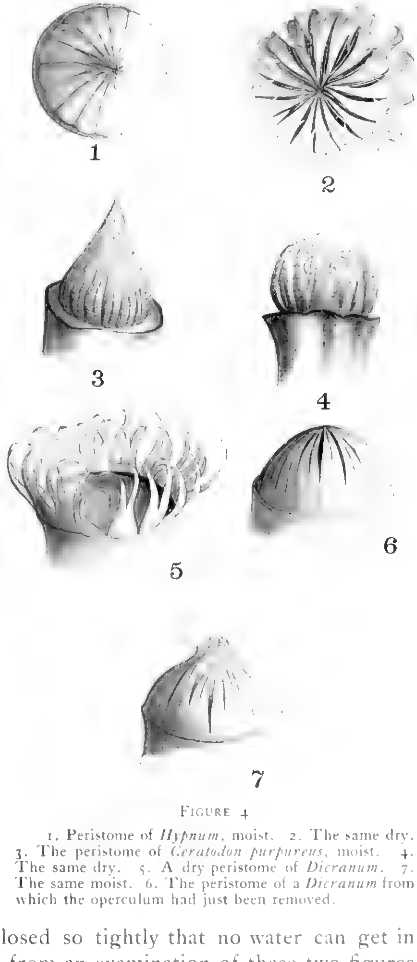


FIGURE 4

1. Peristome of *Hypnum*, moist. 2. The same dry. 3. The peristome of *Ceratodon purpureus*, moist. 4. The same dry. 5. A dry peristome of *Dicranum*. 7. The same moist. 6. The peristome of a *Dicranum* from which the operculum had just been removed.

Fig. 4, 2, shows the peristome of *Hypnum* in its dry state. Note how the cilia fill the spaces between the segments, forming a perfect sieve. 1 shows the same peristome wet and closed so tightly that no water can get in or spores get out. One can easily see from an examination of these two figures the advantage of having the segments alternate with the teeth.

This illustration is from a *Hypnum* with a strongly curved capsule. If an illustration were chosen from a species with an erect capsule the cilia would, in most cases, be more or less rudimentary and the segments narrowed, as is explained in the beginning of this topic.

In the same figure, 4, the dry peristome of *Ceratodon purpureus* is shown. The loosely incurved teeth form a capital sieve. 3 shows the same dry. The peristome of *Dicranum*, shown in 5, 6, and 7, is very similar to that of *Ceratodon*, only the teeth are broader and less incurved when dry.

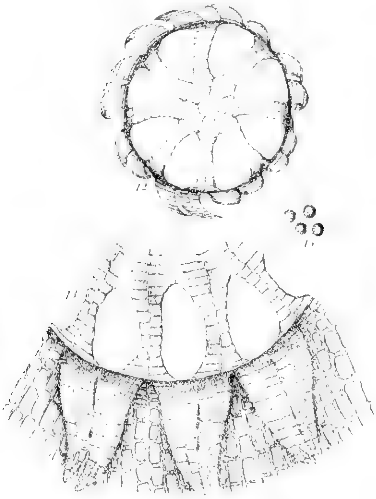


FIGURE 5
Peristome of *Orthotrichum callistomum* (Bry. Eur.)

In *Fontinalis*, which is always submerged, the peristome consists of a network, through the meshes of which the spores gradually escape. In *Cinclidium* the inner peristome is a dome-like structure with apertures near the base, which are opened and closed by the hygroscopic teeth of the outer peristome. (See Plate V.)

A peculiar peristome of much the same structure, but from a moss of an entirely different family, is found in the European moss, *Orthotrichum callistomum* Fisch. These last two are so curious yet so beautifully adapted for their work that it seems almost like a fairy tale, and would be scarcely credible if told of some rare unknown tropical plant instead of having been seen and described by several of the most matter-of-fact botanists. A somewhat similar arrangement is found in *Cinclidium stygium*. (See Plate V.)

Professor Karl Goebel, of the University of Munich, in his "Organography of Plants" has made a classification of moss peristomes according to their adaptations for spore distribution. The following is abbreviated from his work:

1. Mosses with a single peristome that is reflexed when dry, but when moist serves to close the mouth of the capsule, e. g., the *Weisieæ* in the *Tortulaceæ*.

2. Single peristomes that twist up and form a sieve when dry but close the opening when moist, e. g., *Ceratodon*, *Dicranum*.

3. Double peristomes in which the outer is reflexed when dry and the inner acts as a retainer of the spores, or rather a sieve. Under this class he names several types: *Orthotrichum*, *Funaria*, *Conostomum*, *Hypnaceæ*, *Fontinalis*.

4. In this class the columella acts as a stopper. It may remain attached to the operculum, which then closes the opening by the swelling of the capsule in moist weather, or it may partially plug the opening as in *Pottia*, or it may become expanded at the end into an epiphragm attached to the teeth as in *Polytrichum*.

Professor Goebel also suggests that the peristome may have originated from a moss in which the capsule dehisced by splitting along the sides, as in the *Hepaticæ*, but with the ends of the valves remaining attached.

The adaptations of the peristome having been studied the structure of the various types will next be considered.

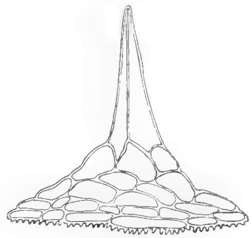


FIG. 6. Cross-section of a tooth of *Polytrichum commune*.

The peristome teeth of the *Polytrichaceæ*, like those of *Georgia*, have none of the joints or articulations which are so conspicuous in the teeth of most mosses. For this reason, as previously stated, Mitten has united these two orders into a group which he calls NEMATODONTEÆ in contrast to the ARTHRODONTEÆ, or jointed-toothed mosses. As in *Georgia*, the teeth of the Hair-caps consist of a solid mass of cells, as is well shown in Fig. 6, which shows a cross-section of a tooth of *Polytrichum commune*. These cells are very narrow, elongated, and without transverse walls, these probably having been absorbed during the earlier stages of development. These cells thus form narrow, elongated fibers, passing up one side of the tooth, forming an arch and then passing down the other side, across through the basal membrane to the next tooth and then up that, and so on. If one were to take a pen and trace a continuous line around the edges of the teeth it would well represent the course of these fibrous cells, which are illustrated in cross-section in our figure. (Plate V, Fig. 13.) These lines can be easily seen by examining the peristome under the compound microscope. The continuous fibers are best seen near the edge of the tooth.

The Arthrodonteæ are divided into two groups, the APLOLEPIDEÆ, mosses with a single peristome, and the DIPLOLEPIDEÆ, mosses with a double peristome. The teeth of the *Aplolepideæ* are usually sixteen, either entire or cleft down the middle, sometimes being cleft to the base, making thirty-two teeth instead of sixteen.

In the *Diplolepideæ* the outer row of teeth appears much like the peristome in the *Aplolepideæ*, and almost always consists of sixteen teeth; the inner usually consists of sixteen thin colorless elongated triangular segments, alternating with the teeth of the outer peristome and united at bases into a membrane which is often nearly half the height of the segments themselves, and continuous around the mouth of the capsule. Between the segments and attached to the basal membrane there are usually one or more slender hair-like cilia. The segments of the inner peristome are often more or less split along their keeled median line, much after the manner of the teeth of the peristome of the *Aplolepideæ;* for this reason and several other more cogent reasons, the two are supposed to be homologous in spite of their dissimilar appearance. (See also page 36.)

The foundation for all the peristomes of the Arthrodonteæ is a layer of sixteen large cells lying in a circle just under the operculum. Four of these cells are shown in the accompanying cut of the cross-section (Fig. 7, 3 and 4), through the capsule of *Mnium* and six in the cut of *Barbula.* The peristomes are formed by the thickening on both faces of the inner and outer walls of these cells in the *Diplolepideæ*, of which *Mnium* is a type, but in the *Aplolepideæ*, of which *Barbula* is a type, the thickening is deposited on the ventral or

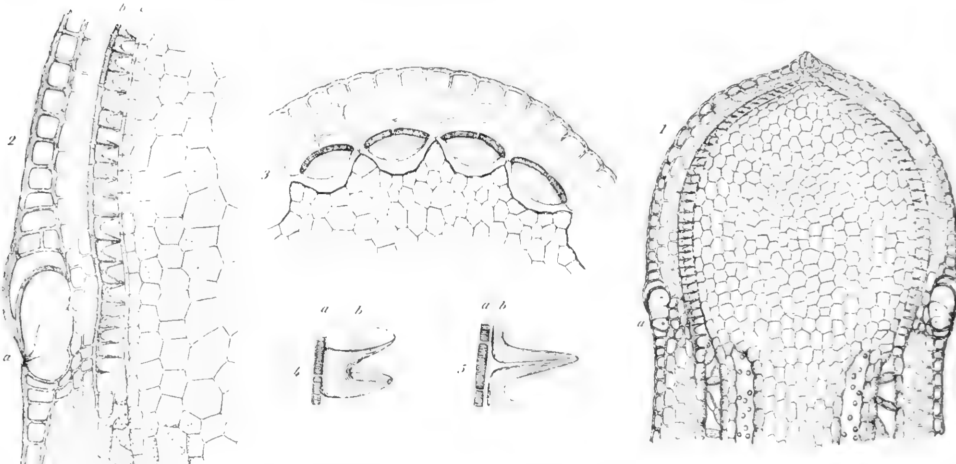


FIGURE 7. (Schimper, "Recherches.")

1. Transverse section through the upper part of a nearly mature capsule of *Mnium hornum*. This figure shows the upper portion of the archesporium with several spores; the columella occupies the upper portion inside the peristome; the annulus is shown at the junction of the operculum with the mouth of the capsule, × 120. 2. A portion of this section, × 500; *a*, annulus; *b*, outer peristome; *c*, inner peristome. This section shows clearly the method of formation of the double peristome. The teeth of the outer peristome are formed by thickenings, or "plates," laid down on the inner and outer faces of the outer wall of a layer of cells extending around the capsule; these thickenings are continued along the top and bottom walls of these cells to form the transverse bars or trabeculæ. The inner wall of this same layer of cells becomes thickened to form the inner peristome. 3 shows one-fourth of a cross-section through the same capsule and gives a good idea of the way the thickenings on the top and bottom walls project into the cells, and of the keel-shaped form of the segments or sections of the inner peristome. 4 shows a single joint of a tooth; *a* is the deposit laid down on the dorsal wall of the cell and *b* shows the deposit made on the inside. 5 shows the deposit laid down on both sides of one of the bottom (or top) walls of these cells at *b*, and the external deposit at *a*.

inner wall only. In *Barbula subulata* this row of large cells is matched by another lying just inside it and in the adjoining (Fig. 8) corners of this double row of cells, as shown in the cut; these bundles of four split radially into two teeth, thus making the thirty-two teeth of *Barbula*. The basal membrane in *Barbula* is formed by the thickening of the tangential walls of these sixteen cells, instead of the thickening being deposited in the same manner as shown in the cut.

In the corresponding cut of *Mnium hornum* the inner and outer walls of these sixteen cells are both thickened, the cavities of these rows of cells being nearly filled, as seen in cross-section, by the deposit on the inner face of the outer wall, which also is applied to the horizontal walls of the cells composing these rows in a manner best understood by reference to the figures of the longitudinal section. (Fig. 7, 2.)

FIGURE 8

This row of sixteen large cells is in *Mnium hornum*, as well as in most of the *Diplolepideæ*, bordered on its outer side by a row of thirty-two cells, and the median line, which is easily seen on each tooth, is where the vertical wall separating two of these cells is joined to the wall which is thickened to form the teeth, thus separating the external thickenings into two rows of plates, (Plate V, Fig. 22, *a*), while on the inner surface there is but one row of plates.

It will need no explanation to show that the cross markings on the teeth are caused by the top and bottom walls of the cells, of which the teeth are the thickened vertical walls. The inner peristome is made by the much slighter thickening of the inner walls of these sixteen cells on both faces. The number of cells directly inside these sixteen is much greater than in *Barbula*. This section is made through the basal membrane of the inner peristome, but the keels extending out to the intervals between the teeth represent the segments of the inner peristome, while the cilia are formed by the thickening of the other portion of the inner wall of the large cell adjacent to points where it is joined to the walls of the cells lying just inside. The number of cilia is thus dependent upon the number of cells, and this may vary in different sections of the same peristome, as shown in the cut. (See also, Plate V. Fig. 22, *e*.) The cilia separate from the segments and from each other by the walls in the intervals, being absorbed instead of being thickened as in the basal membrane. When the cilia are appendiculate the thickening extends for a short distance along the horizontal walls which join them. The teeth separate from each other and the segments by the absorption of the T-shaped bit of membrane joining them. This is shown in the cut by a very thin line. As the section is taken through the region of the basal membrane the inner cell walls of the peristomial layer are uniformly thickened. In the region of the cilia this would not be so.

The peristomes of the *Hypnaceæ* are almost exactly like those of *Mnium*, except that the outer basal plates of the teeth are ruled with very fine horizontal lines, as shown in the cut of *Raphidostegium recurvans*. These are often lacking, however, in degenerate peristomes of this family.

In *Pylaisia Schimperi*, *P. intricata*, and *Burnettia* (*Homalothecium*) *subcapillatum* the membrane joining the teeth to the endostome fails to be absorbed, and hence the two are adherent.

In *Funaria* the segments are formed by the thickening of the ventral or inner walls of the sixteen cells, instead of adjoining portions of two cells as in *Mnium;* hence in *Funaria* the segments are directly opposite the teeth instead of alternating with them. Moreover, the exterior surface of the segments consists of a single row of plates instead of a double row, as in *Mnium;* this last follows as a necessity from the position of the segments. Referring again to the cross-section of the operculate capsule of *Barbula*, it will be seen that the thickenings which form the peristome teeth are all on the inner wall of the row of sixteen cells. In *Dicranum* and most of the *Aplolepideæ* the outer side of the teeth consists of a single row of plates, like the segments in *Funaria*. The median line is the line of junction of the two rows of plates which form the inner side of the tooth. For these reasons and some others not so easily explained, Philibert has concluded that the peristome of the *Aplolepideæ* is homologous with the inner peristome of the *Diplolepideæ*. For this reason it seems objectionable to speak of the endostome.

The peristomes of the *Buxbaumiaceæ* are intermediate between the arthrodont and the nematodont types, and in the limits of the single genus *Encalypta*, as defined by Schimper, there is an almost complete series connecting the two. The elaboration of these is too complicated and lengthy a matter for a work of the scope of this book. For those who wish to pursue the matter farther I would recommend Philibert's classical articles in the "Revue Bryologique" or my own less pretentious efforts in the "Bryologist."

Illustrated Glossary of Bryological Terms*

This is not intended to be an exhaustive glossary of botanical terms, but a glossary of those terms which are either confined to bryological works or are used in a somewhat different meaning when applied to mosses. Thus the common terms descriptive of leaves are omitted, except acumen and a few others that are used in a peculiar or unusual way by some authors. Very few terms are here defined that are sufficiently well explained in the common phanerogamic botanies like Gray, Wood, or Britton and Brown.

Braithwaite's "British Moss Flora," Lesquereux and James' "Manual," and Dixon and Jameson's "Handbook of British Mosses" have been largely consulted, and an attempt has been made to determine the meaning of each term according to the usage of all the authors accessible.

For most of the cuts we are indebted to the kindness of Mr. H. N. Dixon, Mr. Jameson, and their publishers, who have very kindly allowed us the use of the cuts in their "Handbook of British Mosses," a work which should be in the hands of every moss student whether English or American. Figs. 43 and 46 are from Mrs. Britton's "Observer" article, by consent. Terms whose meaning can be made sufficiently clear by definition are not illustrated as a rule.

Acicular, needle-shaped. Applied to the beak of the operculum.

Acrocarpous, having the sporophyte terminal on a stem or ordinary branch. Acrocarpous mosses can usually be easily distinguished by the erect habit, as shown in the figure. (Fig. 1.) The old sporophyte often seems lateral in acrocarpous mosses, because the stem grows on the next year from a point just below the base of the sporophyte.

FIG. 1

Acumen, the gradually tapering narrow point of an acuminate leaf. (Fig. 2, *b.*)

Acuminate, a term usually applied to leaves that gradually taper to a narrow point. A few recent writers use terms as applying only to those leaves that are not uniformly narrowed and limit the term acumen to that part of the apex beyond the point where the narrowing begins to be less abrupt. According to these authors a leaf uniformly narrowed would not be acuminate, no matter how slender the apex. The author has followed this usage to some extent in previous writings, but general usage does not seem to sanction this restriction of the term.

FIG. 2

Acumination. See *acumen* and *acuminate*.

Aggregate, clustered; usually applied to two or more sporophytes from one perichætium.

Alar cells, the cells at the basal angles of the leaf, commonly different from the cells of the

*The figures of the Glossary are numbered independently of the rest of the book.

main part of the leaf, being shorter and often nearly square, or inflated and hyaline, and often highly colored. (Fig. 3.)

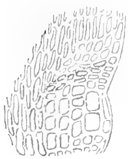


FIG. 3

Amentula, applied to the special antheridia-bearing branches of *Sphagnum*.

Amphithecium, the outer layers of cells of the sporangium.

Angular cells. See *Alar cells*.

Androgynous, with antheridia and archegonia in the same cluster of leaves; i. e., either synoicous or paroicous.

Annulus, a specialized ring of vesicular cells between the mouth of the capsule and the lid. These cells are often highly elastic and aid in removing the lid when the spores are ripe; they have a peculiar appearance, which is well illustrated in Fig. 4.


FIG. 4


FIG. 5

Antheridium, the male reproductive organ containing the antherozoids. (Fig. 5.)

Antherozoid, the small flagellate male cell which escapes from the antheridium, and in wet weather swims to the archegonium and down its neck to the egg-cell in the bottom.

Apical cells, the cells composing the apex of the leaf. They are often broader and shorter than the cells of the middle of the leaf.

Apophysis. See *hypophysis*, the more correct term according to Braithwaite.

Appendiculate cilia, cilia with small transverse spurs attached at intervals along the margin. (Fig. 6.) As these bars sometimes extend inward instead of laterally, they are not always visible in a strictly dorsal view.


FIG. 6


FIG. 7

Archegonium, the flask-shaped female reproductive organ. (Fig. 7.) See, also, *antherozoid*.

Arcuate (capsule), bent in a curve like a bow. (Fig. 8.)

Areolation, the network formed by the outlines of the cells of a leaf.

Articulate (teeth of peristome), marked by cross-bars as in Figs. 9 and 34.

Astomous (capsule), without a mouth. Used of capsules which have no regularly dehiscent lid.

Auricles, small lobes at the basal angles of the leaf, usually consisting of cells differing from those of the main part of the leaf in size or shape or both. (Fig. 3 and Fig. 2, *a*.) Properly used only when there is an outward curve in the outline of the leaf at the base, as in the figures, but often used loosely to denote the basal angles of widely decurrent leaves.

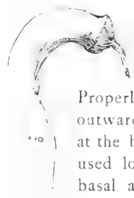


FIG. 8

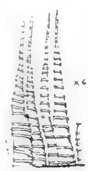


FIG. 9

Autoicous or *autœcious*, having male and female organs on the same plant. According to Braithwaite, there are three forms.

1. *Cladautoicous*, with the male organs on a special proper branch.

2. *Gonioautoicous*, with the male organs in a bud-like cluster, and axillary on a female branch.

3. *Rhizautoicous*, male branch very short and cohering to the female by the rhizoids.

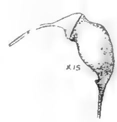


FIG. 10


FIG. 11

Basal or *basilar cells*, cells at the base or insertion of the leaf, often of different shape and color from those of the main part of the leaf.

Beak, prolonged narrow tip of the operculum. The opercula in Figs. 8 and 10 are strongly beaked.

Bicostate, having a double costa, which is usually much shorter than in leaves having a single costa.

Bifarious, growing in two ranks.

Bi-sexual, synoicous.

Bistratose, of two layers of cells. (Fig. 11.)

Bordered, having a margin different from the rest of the leaf. In Mnium and Bryum the border consists of a few rows of greatly elongated cells, often in two or more layers. (Fig. 12). In some species of Fissidens (which see) the border is of a different color, but with little difference in cell structure.

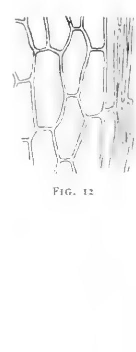


FIG. 12

Bracts, a term applied to the leaves surrounding the reproductive organs. Those surrounding the antheridia are called perigonial bracts or leaves, and those surrounding the archegonia and base of seta are called perichætial.

Bulbil, a minute bulb or bulb-shaped body, usually produced for asexual reproduction. See page 18; also end of glossary.

Cæspitose, forming matted tufts or cushions; e. g., *Leucobryum*.

Calyptra, the thin veil or hood covering the mouth of the capsule. (Figs. 13 and 29.)

FIG. 13

Canaliculate, channeled. Applied to leaves with margins incurved, so as to give them a channel-like form; e. g., the upper part of the leaves of *Dicranum fuscescens*. A more complete inrolling until the margins meet would make the leaf tubulose.

Cancellate, latticed. Used of the endostome of the Fontinalaceæ.

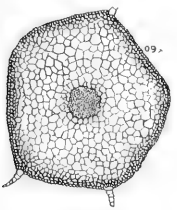


FIG 14

Canescent, rather hoary; e. g., *Racomitrium canescens*.

Capitulum, a rounded head.

Capsule, the enlarged distal end of the sporophyte; it contains the spores, and is sometimes known as the sporangium. (Figs. 8, 10, 15, 23, and 28.)

Carinate, keeled like a boat; e. g., segments of inner peristome in Fig. 34.

Central strand. The middle of many moss stems is made up of a bundle of much narrower and more slender cells, known as the "central strand." (Fig. 14.) This is usually continuous with the midrib or costa of the leaves, much after the manner of the vascular bundles in the higher plants.

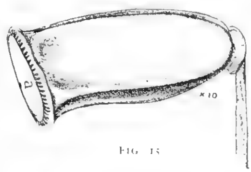


FIG. 15

Cernuous (capsule), drooping or nodding, somewhat inclined as opposed to erect. (Fig. 15.)

Cilia, hair-like threads of the endostome, alternating with the segments. (Fig. 6 and Figs. 16, *c*, and 34, *d*.)

Circinate, curved into a circle, resembling Fig. 2, but still more incurved, so that the apex is nearly or quite bent around to the leaf base; e. g., leaves of *Hypnum uncinatum*.

FIG. 16

Cirrate or *cirrhate*, applied to leaves which curl up in drying. Cirrate leaves are more regularly curled than crispate leaves.

Cirrhose, having a wavy hair point.

Cladocarpous, having the sporophyte terminating a short special fertile branch; somewhat like half-way between acrocarpous and pleurocarpous; e. g., *Fontinalis*.

Clathrate, resembling lattice-work.

Cleistocarpous, capsule opening irregularly, not by a lid or valves.

Cochleariform, rounded and concave like a spoon or ladle.

Collum, the neck or tapering base of the capsule. (See Fig. 28.)

Columella, the central axis of the capsule; around it and between it and the outer wall of the capsule are borne the spores. Sometimes the lid adheres to it and is raised upon it, as in Fig. 17.

FIG 17

Coma, *Comal tuft*, a tuft of leaves at the tip of a stem or branch.

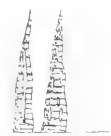


FIG. 18

Complanate (of leaves or branches), flattened out more or less in one plane.

Complicate, folded together.

Confervoid, formed of fine threads.

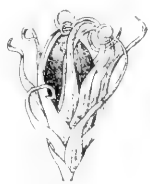
Constricted, used of capsules that become narrowed under the mouth when dry. (Fig. 10.)

Contracted. See *constricted*.

Costa, the nerve or midrib of a moss leaf.

Costate, having a costa.

Cribose (peristome teeth), perforated with small apertures. (Fig. 18.)



Crispate or *crisped*, frizzled, curled and twisted in various ways. (Fig. 19.)

Cryptopore (stoma), immersed. See *stoma*.

Cucullate, hood-shaped, the apex curved in like a slipper. (Apex of leaf in Fig. 20.)

Cucullate calyptra, a calyptra that is hood-shaped and split on one side only. (Fig. 13.)

FIG. 20

Cultriform, curved like a short, wide scimitar; e. g., the leaves of *Homalia trichomanoides Jamesii*.

Cygneous (seta), curved suddenly downward, like a swan's neck.

Cymbiform, boat-shaped (used by Dixon as a synonym of cucullate); e. g., leaves of *Sphagnum cymbifolium*. (The whole leaf in Fig. 20.)

Deoperculate, applied to a capsule after its lid has fallen off.

Dimidiate, split on one side.

Dioicous or *diœcious*, having the male and female organs on separate plants.

Distichous (of leaves), in two opposite rows on the stem.

Divisural line, the line down the teeth of a peristome, through which they split. (The zig-zag line down the middle of the teeth and the line down the middle of the segments in Fig. 34.)

Dorsal, belonging to or on the back; i. e., the face of a leaf remote from the stem.

Ecostate, lacking a costa.

Emergent or *emersed*, half uncovered; of the capsule, when the perichætial leaves reach but do not overtop it.

Endostome. See under *peristome*.

Endothecium, the inner layers of cells of the capsule.

Epiphragm, a membrane covering the mouth of the deoperculate capsule; in Polytrichum and its allies it consists of the dilated top of the columella. (Fig. 15, *a*.)

Equitant, having the leaf-bases conduplicate and sheathing, alternating one above the other on opposite sides of the stem.

FIG. 21

Erecto-patent, midway between erect and patent.

Excurrent costa, a costa running out beyond the lamina of a leaf. (Fig. 21.)

Excavate (leaf-insertion), hollowed out in a curve.

Exostome. See under *peristome*.

Exserted, elevated above the surrounding parts; of the capsule, when the perichætial leaves do not reach so high as its base.

Falcate, curved like a sickle. (Fig. 2.)

Fascicle, a bunch or cluster of leaves or branches.

Fasciculate, arranged in bunches.

Fastigiate, of branches, all reaching an equal height. (Fig. 1.)

Fenestrated, perforated.

Flagellæ, fine string-like branches; e. g., *Dicranum flagellare*.

Flexuose, bent backward and forward, or wavy.

Flowers, often applied to the reproductive organs.

Fruit, often applied to the sporophyte.

Fuscous, dull brown.

Gametophyte or *gametophore*, that part of the plant which bears the gametes or sexual cells. In mosses, all the plant except the "fruit," or seta and capsule.

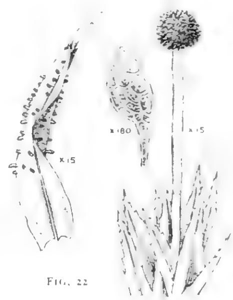


FIG. 22

Gemmæ, bud-like bodies, capable of reproducing the plant. Sometimes borne in special heads, sometimes on the surface of the leaves. (Fig. 22.)

Gemmiferous or *gemmiparous*, bearing gemmæ.

Geniculate (seta), suddenly bent, like a knee.

Gibbous (capsule), more tumid or swollen on one side than on the other. (Fig. 23.)

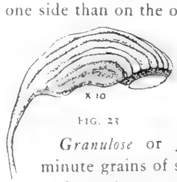


FIG. 23

Glaucous, originally applied to plants covered with a bluish white bloom, but now applied to mosses that have that color.

Granulose or *granulated*, rough as with minute grains of sand.

Gregarious, growing near together or clustered, but not in close tufts or mats.

Guides, a term applied to the large parenchyma cells seen in cross-section of the costa of many Dicrana. See, also, *stereids*.

Gymnostomous, without a peristome.

Hamate or *hamulose*, curved like a hook; more sharply and abruptly curved than in *falcate* and *circinate*.

Heteromallous (leaves or branches), turned in different directions.

FIG. 24

Homomallous, turned in the same direction.

Hygroscopic, readily absorbing water and thereby altered in form or direction. *Hygrometric* is sometimes used with a similar meaning.

Hypophysis, a swelling of the seta immediately under the capsule. (Fig. 15.)

Imbricated, closely overlapping each other like the tiles of a roof. (Fig. 24.)

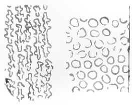


FIG. 25

Immersed, covered up; of the capsule when the perichætial leaves project beyond it.

Incrassate, of the cell-walls, thickened; of the cells, having thickened walls. (Fig. 25.)

Inflated, applied to the alar cells of leaves when enlarged much beyond the size of the neighboring cells. (Fig. 26.)

Inflorescence, often applied to the clusters of reproductive organs.

FIG. 26

Julaceous, smooth, slender and cylindric; like a catkin or a worm.

Lamellæ, thin sheets or plates of tissue; e. g., the plates arising from the costa of the hair-caps and their allies. (Fig. 27.)

Lamellate, having lamellæ.

Lamina, the blade or expanded part of the leaf as distinct from the costa.

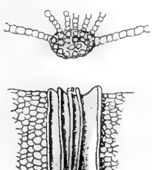


FIG. 27

Leptodermous, thin-coated; applied to capsules when soft and pliable.

Lid. See *operculum*.

Limb, the upper part of a leaf as distinct from the leaf base.

Limbate leaf, a leaf bordered by a part of another color; e. g., many species of Fissidens, which see.

Mamillate or *mammillar* (lid of the capsule), convex with a short projection in the center. (Figs. 28 and 29.)

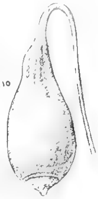


FIG. 28

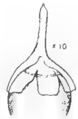


FIG. 29

Margined. See *bordered*.

Median leaf-cells, those from the middle of the leaf.

Mitriform (calyptra), cleft on two or more sides, and symmetrical. (Fig. 29.)

Monoicous or *monœcious*, having male and female organs on the same plant.

Muricate, *muriculate* (spore), rough with minute sharp points.

Muticous, not pointed.

Neck (of the capsule), the lowest part just above the point where it joins the seta. See, also, *collum*.

Nerve. See *costa*.

Nodose, covered with knots or prominences.

Nodulose, covered with very small knots or prominences (the cilia in Fig. 34).

Ochrea, a thin sheath around the base of the seta, terminating the vaginula.

Oösphere, the egg-cell or ovum found in the base of the archegonium. (Fig. 7.) After fertilization, by union with the antherozoid, it develops into the sporophyte.

Operculum, the lid which closes the capsule and, falling, permits the spores to escape. (Figs. 10, 17, and 28.)

Pachydermous, thick-skinned; applied to the walls of capsules or to cells when firm and resisting.

FIG. 3

Panduriform (of leaves), fiddle-shaped.

Papillæ, minute rounded or acute protuberances.

Papillose, rough with papillæ. (Fig. 11.) (Seta), rough with small rounded or acute protuberances. (Fig. 30.)

FIG. 31

Paraphyllia, minute leaf-like or much-branched organs among the leaves. (Fig. 31.) E. g., *Thuidium*.

Paraphyses, jointed hyaline hairs growing among the reproductive organs. (Fig. 32.)

Parenchymatous, cells with broad ends abutting on each other, not dovetailing into each other. (The large cells in Fig. 12.)

Paroicous, having its male and female organs in the same cluster, but not mixed, the antheridia being in the axils of the perichætial bracts below the archegonia. (Fig. 33.)

FIG. 32

FIG. 33

Patent, spreading at an angle of 26°–45° (Braithwaite); spreading at an angle of 45° or more (Dixon).

Patulous, more widely spreading than *patent*.

Pedicel. See *seta*.

Pendulous, somewhat hanging or drooping; more so than in *cernuous*. (Fig. 28.)

Percurrent costa, reaching to the apex of the leaf, but not beyond.

Perichætial. See *bracts*.

Perigonial. See *bracts*.

Peristome, the fringe surrounding the mouth of the capsule upon removing the lid. This fringe may consist of a single row of processes, known as *teeth*, as in Fig. 9, or of a double row as in Fig. 34. In the latter case the entire fringe is still the *peristome*, but the term is also applied in a particular sense to the outer row; the outer row is often spoken of as the *exostome* (*b*), and the inner as the *endostome* (*c*). The inner row consists of as many projections as the outer, but alternating with them; these are known as *processes* or *segments* (*c*). Between the segments there are often one or more slender hair-like processes known as *cilia*. (Fig. 34, *d*; Fig. 16, *c*.)

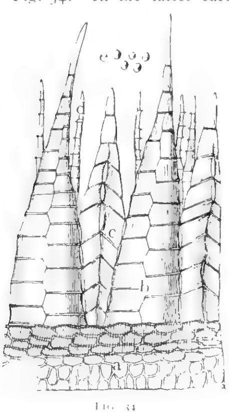


FIG. 34

Moss peristomes, viewed with a compound microscope, are among the most beautiful of natural objects. They are not composed of cells (except in the Polytrichaceæ and a few other small families), but of thickened cell-walls. The cross markings on the teeth, segments and cilia are the lines of junction of the transverse cell-walls with the longitudinal cell-walls forming the peristome. The radial walls are rarely thickened so as to appear in any way; the divisural line shows the place of their attachment to the teeth and segments.

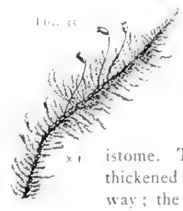


FIG. 35

The researches of Philibert have shown that the endostome, not the exostome, corresponds to the peristome of the mosses having a single row of teeth.

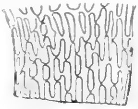


FIG. 36

Phaneropore (stoma), superficial. See *stomata*.

Pinnate, having numerous equidistant spreading branches on each side like a feather. (Fig. 35.)

Pitted cell-walls, those marked with small apertures or depressions; e. g., the cell-walls of the leaves of *Dicranum scoparium* and other species. (Fig. 36.)

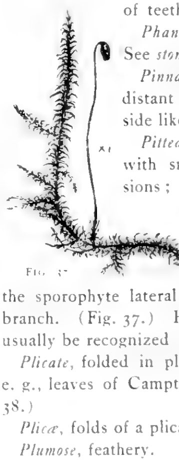


FIG. 37

Pleurocarpous, having the sporophyte lateral on a short lateral special branch. (Fig. 37.) Pleurocarpous mosses can usually be recognized by the creeping habit.

Plicate, folded in pleats or furrows; e. g., leaves of Camptothecium. (Fig. 38.)

Plicæ, folds of a plicate leaf.

Plumose, feathery.

Pluriseriate, many-ranked; i. e., as applied to leaves arranged in several rows along the stem.

Polygamous, with antheridia and archegonia disposed in various ways on the same plant.

Porose. See *pitted*.

FIG. 38

Primordial utricle, "the first layer deposited within a cell." As applied to the cells of the moss leaf it refers to the layer of protoplasm lying next the cell-wall, which often is very conspicuous when dried and shrunken away from the cell-wall. As a character for use in the identification of species it is valueless, because its appearance is due to circumstances not well understood, and is frequently present in some specimens and lacking in others of the same species.

Processes. See under *peristome.*

Proliferous, bearing young shoots from the antheridial or archegonial cluster of leaves.

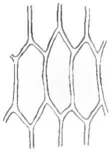


FIG. 39

Propagula. See end of glossary.

Prosenchymatous (cells), with pointed ends dovetailing into each other. (Fig. 39.)

Protonema, the green, branched, alga-like threads produced from the spore and often persistent during the lifetime of the plant produced from it. Protonema and radicles differ chiefly in the presence or absence of chlorophyll, and either may develop the other. (Fig. 40.)

FIG. 40

Pseudopodium, a leafless branch resembling a seta and often bearing gemmæ. (Fig. 22.) Of sphagnum, the stalk (false seta) bearing the capsule.

Pulvinate, like a cushion.

Quadrate (cells), square or nearly so. (Fig. 3.)

Radicles, rootlets springing from the sides and base of the stem. See also *protonema.*

Ramuli, minute branchlets.

Rhizoid. See *radicles.*

Rostellate (operculum), with a short beak.

Rostrate (operculum), with a long beak. (Figs. 8 and 10.

Rosulate, in the form of a rosette.

Rough. Same as *papillose.*

Rugose, wrinkled (in the case of leaves it is usually applied to transverse wrinkles); e. g., leaves of *Hypnum rugosum.*

FIG. 41

Scabrose. Same as *papillose.*

Secund, twisted or turned to one side. (Fig. 41); e. g., leaves of many *Hypnums.* Not necessarily curved as in the figure.

Segments. See under *peristome.*

Seta, the stalk on which the capsule is borne. (Figs. 8, 15, and 28.)

Sigmoid, curved like the letter S.

Spermatozoid. See *antherozoid.*

Sporangium, often applied to the capsule, but by some authors restricted to the spore sac, or inner sac of the capsule containing the spores.

Spores, small round bodies contained in the capsule, serving the purpose of seeds, but in no way homologous with them. (Fig. 34, *e.*)

Sporophyte or *sporophore*, the spore-bearing part or generation. In mosses it consists of the seta and capsule and constitutes the so-called fruit.

Sporogonium, the sporophyte or spore-bearing part of the moss.

Stegocarpous, having the capsule operculate.

Stereids, the small thick-walled cells seen in cross-section of the costa of some mosses, especially *Dicranum.* See the figure of the cross-section of the costa of *D. scoparium.*

Stipitate, having a short stem. Applied to antheridia and archegonia.

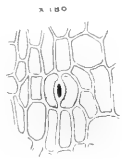


FIG. 42

Stoloniferous stem, a slender creeping stem with minute leaves.

Stomata, pores in the walls of capsules, surrounded by special guard-cells and serving the same purpose as the stomata in the epidermis of the leaves of the flowering plants. They may be superficial, as in Fig. 42, or immersed, i. e., sunken and nearly covered with other cells, as in Fig. 43.

FIG. 43

Striate, marked with striæ or slight furrows.

Struma, a goiter-like swelling on one side at the base of the capsule. (Fig. 10.)

Strumose, having a struma.

Substratum, the material upon which the plant grows.

Sulcate, deeply furrowed with longitudinal channels. As applied to leaves, both *striate* and *sulcate* really refer to the fold whose concave surface is on the inner or ventral surface of the leaf. Of the capsule, deeply furrowed. (Fig. 23.)

Synoicous or *synœcious*, having the male and the female organs mixed together in the same cluster. (Fig. 32.)

Systilius, the lid continuing fixed to the columella, and thus elevated above the capsule when dry. (Fig. 17.)

FIG. 44

Tessellate, checkered in little squares; applied particularly to the peristomes of some of the Tortulaceæ. (Fig. 44.)

Tomentose, covered with a thick felt of radicles.

Tooth. See under *peristome*.

Trabeculate (peristome teeth), with prominent transverse bars. (Fig. 9.)

Tubulose. See *canaliculate*.

Tumid, *turgid*, appearing as if swollen from pressure within.

Turbinate, top-shaped; e. g., capsule of *Bryum turbinatum*.

Twisted (seta). The seta of many mosses twists strongly in drying. If the twist is such as would be made by seizing the capsule and twisting it to the right, it is said to be twisted to the right. It is possible that this twisting of the seta aids in scattering the spores.

Umbomate, round with a projecting point in the center.

Uncinate, hooked, curved back at point. (Fig. 41.)

Undulate, with an alternately concave and convex margin, wavy; e. g., leaves of *Dicranum undulatum*.

FIG. 45

Urceolate, shaped like an urn or pitcher.

Vaginula, the cellular sheath surrounding the base of the seta, originally the lower part of the archegonium.

Veil, the calyptra.

FIG. 46

Ventral surface, the surface of a leaf next the stem.

Ventricose, bulging on one side. (Fig. 45.)

Vermicular, narrow and curved like a little worm; applied to leaf-cells.

Verruculose or *verrucose*, covered with wart-like prominences. (Fig. 46.)

Vesicular, inflated like a bladder.

Wavy. See *undulate*.

NOTE.—According to Dr. Best, Fig. 23 illustrates *brood bodies* or *propagula* rather than gemmæ. (See page 18.)

These distinctions are not made in all works on mosses and their omission from the glossary was not noted until too late for full insertion.

LIST OF THE MORE IMPORTANT WORKS ON MOSSES THAT WILL BE OF HELP TO AMERICAN STUDENTS

GENERAL WORKS

Lesquereux and James' "Manual of the Mosses of North America." The only attempt at a complete manual; inaccurate and out-of-date, but still indispensable to advanced students. S. E. Cassino & Company, Boston. $4.

Barnes and Heald's "Keys to the Genera and Species of North American Mosses." Almost a necessity for any student of North American mosses. Published by the University of Wisconsin. $1.

The files of the "Bryologist." Sample copies can be obtained of Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, N. Y.

Mrs. Britton's series of articles in the "Observer." These are out of print and can be obtained with difficulty, but are charmingly written and full of interesting information. They should be in the hands of every moss student.

"Mosses With a Hand-Lens," by the author of this work. The preface of this work gives considerable information about it. O. T. Louis, 59 Fifth Avenue, New York City. $1.10.

Dixon and Jameson's "Handbook of British Mosses" includes a very large number of our American mosses, and is a most admirable and helpful book in every way. The glossary cuts in this work are from this "Handbook." It can be obtained of O. T. Louis for about $6.

MONOGRAPHS AND SPECIAL WORKS

Mrs. Britton's "Contributions to American Bryology" in "The Contributions from the Herbarium of Columbia University." These include critical notes and monographs treating of the following genera: Orthotrichum, Scouleria, Bruchia, Physcomitrium, Weissia (Ulota), Coscinodon, Dicranella, and Leersia (Encalypta). These are published in "The Bulletin of the Torrey Botanical Club," and can be obtained of the editor of that publication for about 25 cents each.

In the same publication, Dr. G. N. Best has printed monographs of Thuidium, Claopodium, Heterocladium, and Pseudoleskea.

The author of the present work has published in the same periodical a revision of the North American Eurhynchia, and a revision of the genus Scleropodium. Also in the "Memoirs of the Torrey Botanical Club" a revision of the North American Isotheciaceæ and Brachythecia. 50 cents.

A revision of the North American species of Fissidens was published in the "Botanical Gazette," for 1897, by Professor Chas. R. Barnes. This is now out of print.

In the same publication for October, 1897, Professor L. S. Cheney published a valuable monograph of the genus Amlystegium.

In "The Bulletin of the Torrey Botanical Club" for April, 1900, Mr. S. C. Stunz published a helpful revision of the genus Neckera, under the name Eleutera.

Part VI of "Canadian Plants," by Professor John Macoun, contains a great deal of valuable information. Published by the "Canadian Geological and Natural History Survey." 25 cents.

Some copies of that monumental work on American mosses, Sullivant's "Icones Muscorum" and its "Supplement," can be had of Dr. B. L. Robinson, Cambridge, Mass., for $18.

MANUAL OF THE MORE COMMON MOSSES OF NORTHEASTERN UNITED STATES

KEY TO THE FAMILIES OF MOSSES

In using these keys the student is advised to turn to the illustrations in the main part of the book, to explain any of the characters used in the key that are not otherwise perfectly clear. A free use of the glossary is also suggested.

Two complete keys to the genera, one for fruiting and the other for sterile plants, will be given in the last part of the book.

1. Plants whitish or light gray, scarcely appearing green . . . 2.
   Plants green, yellow-green, or dark green to almost black . . 3.
2. Plants of bogs; leaves with large colorless cells surrounded by narrow green cells; capsules nearly globular, ovoid when dry and empty, without peristome . . . . *Sphagnaceæ.*
   Plants of moist shady places, growing in dense tufts or cushions; leaves showing but one kind of cells (except in section); capsules elongated, with a peristome . . . . . *Leucobryeæ* in *Dicranaceæ.*
3. Leaves in two rows, with edges apparently towards the stem . 4.
   Leaves in more than two rows, or if apparently two-ranked the edges of the leaves are not toward the stem . . . . . . 5.
4. Leaves apparently split on the inner edge and sheathing each other and the stem, costate; peristome present . . . . . *Fissidentaceæ.*
   Leaves ecostate, not split at base, but forming a continuous wing-margin along the stem in the sterile plants; peristome lacking . . . . *Schistostegaceæ.*
5. Acrocarpous . . . . 6.
   Pleurocarpous . . . . 21.
6. Plants black or blackish green; leaves with very thick cell-walls; growing on trees or rocks . . . . 7.
   Plants green to light yellow-green, or, if blackish, growing on soil . . . . 9.
7. Capsule dehiscing by four valves, as in the Hepaticeæ, almost exclusively alpine or sub-alpine . . . . *Andreæaceæ.*
   Capsule dehiscing by an operculum; peristome of 16 jointed teeth . . . . 8.
8. Peristome single (very rarely lacking), with teeth not united in pairs, but usually perforate or bifid, richly colored and rarely reflexed when dry. Plants often hoary with colorless leaf apices, nearly all growing on rocks . . . . *Grimmiaceæ.*
   Peristome double (with one or two exceptions), teeth often united in pairs, rarely perforate, usually reflexed when dry, inner peristome of linear erect segments. Plants very rarely hoary, mostly tree-growing . . . . *Orthotrichaceæ.*

9. Peristome of four large distinct unjointed teeth . . . . . . *Georgiaceæ.*
Peristome having an inner plaited cone; outer peristome of shorter jointed teeth often present. Odd plants best recognized by a reference to the illustrations . . . . *Buxbaumiaceæ.*
Peristome lacking, or of more than four teeth . . . . 10.

10. Peristome of 32 to 64 non-articulate teeth; calyptra densely hairy with long whitish hairs (except *Catharinea*); leaves with numerous vertical lamellae on the upper surface of the costa. Plants large and very often dark colored, growing on soil . . . . *Polytrichaceæ.*
Peristome when present consisting of 16 to 32 plainly articulate teeth, frequently lacking . . . . 11.

11. Minute stemless (except *Physcomitriella*) plants with cleistocarpous capsules and usually persistent protonema . . . *Ephemeraceæ.*
Plants with stems, a few cleistocarpous or gymnostomous but mostly peristomate; protonema usually evanescent . . . 12.

12. Leaves papillose, at least above (except *Aulacomnium*). Capsules strongly plicate or furrowed when dry; peristome double . . . . 13.
Plants not possessing all three of these characters . . . . . 14.

13. Capsules nearly as broad as long, subglobose; inner peristome, without cilia or with cilia little developed . . . . *Bartramiaceæ.*
Capsules longer than broad, subcylindric; cilia of inner peristome well developed . . . . *Aulacomniaceæ.*

14. Capsules cleistocarpous; leaves not papillose . . . . *Bruchia* in *Dicranaceæ.*
Capsules cleistocarpous; leaves papillose . . . . *Astomum* in *Tortulaceæ.*
Capsules gymnostomous; leaf-cells small, papillose . . . . . *Pottiæ* and *Weisiæ* in *Tortulaceæ.*
Capsules gymnostomous, leaf-cells large, smooth . . . . . . *Physcomitrium* in *Funariaceæ.*
Capsules peristomate . . . . 15.

15. Peristome single . . . . 16.
Peristome double . . . . 18.

16. Capsules with a large swollen hypophysis, which is usually larger and more conspicuous than the spore-bearing part; leaves not papillose; growing on decaying animal matter . . . . *Splachnaceæ.*
Capsules without hypophysis (some with slender necks) . . 17.

17. Leaves papillose . . . . *Tortulaceæ.*
Leaves not papillose (except in *Oncophoreæ*, one or two species of *Dicranum*, and slightly so in *Ceratodon*). See descriptions and illustrations of these forms . . . . *Dicranaceæ.*

18. Inner peristome of cilia only; plants with the habit of *Polytrichum* . . . . *Timmiaceæ.*
Inner peristome of keeled segments, with intermediate cilia often present . . . . 19.

19. Segments opposite the teeth; capsules very strongly unsymmetric with mouth one-sided . . . . *Funariaceæ.*
Segments alternate with the teeth; capsules less strongly unsymmetric . . . . 20.

20. Capsules arcuate and unsymmetric, long-necked; inner peristome of sixteen rather narrow segments as long as the teeth or longer, without intermediate cilia; leaf-cells small (except *Amblyodon*) . . . . *Meesiaceæ.*

Capsules often pendent and symmetric, sometimes slightly unsymmetric; inner peristome with well-developed cilia (except in a few rare species); leaves often bordered by a margin of narrow elongated cells . . . . *Bryaceæ.*

21. Aquatic, long and floating, with leaves straight, or plants shorter with falcate-secund leaves; capsules immersed or emergent, never exserted . . . . *Fontinalaceæ.*

Terrestrial (or a few aquatic, seldom slender or floating, with capsules exserted on long setæ) . . . . 22.

22. Leaves papillose (except species of *Myurella*); leaf-cells short, rhomoidal or subcircular . . . . *Leskeaceæ.*

Leaves not papillose, (slightly so in species of *Leptodon*, *Cryphea*, and *Bryhnia*) . . . . 23.

23. Basal joints of peristome teeth marked with very fine transverse* lines; segments of inner peristome well developed, keeled; cilia present (inner peristome without cilia and with narrow segments in many species with erect or suberect capsules. The transverse lines, even, are lacking in most of the species of the *Climaceæ* and *Pylaisiæ*.); leaf-cells elongated, sometimes rhomboidal but never rounded in the main portion of the leaf (except *Porotrichum*)† . . . . *Hypnaceæ.*

Basal joints of teeth without fine transverse lines; capsules symmetric, usually erect on straight setæ; cilia of inner peristome lacking; segments usually narrowly linear, occasionally the inner peristome almost lacking. Practically all growing on the bark of living trees . . . . . . 24.

24. Leaf-cells elongated as in the Hypnaceæ; peristome teeth often united in pairs. Rare, mostly minute mosses . . . . . *Fabroniaceæ.*

Leaf-cells short and rounded; larger plants, many very common . . . . 25.

25. Stems and branches flattened; leaves appearing two-ranked . *Neckeraceæ.*

Stems and branches nearly terete; leaves not appearing two-ranked . . . . *Leucodontaceæ.*

* See illustration of *Raphidostegium recurvans.*

† The Pterygophyllaceæ would come here if we had species of that family.

ORDER I. SPHAGNALES

Family 1. Sphagnaceae. The Peat Mosses

The Peat Mosses (Fig. 10) are so different from the other mosses that many bryologists do not consider them as mosses at all, but would put them in a separate class. Their protonema is much like the prothallium of a fern, and the stalk upon which the capsule is borne is not at all homologous with the seta of the other mosses, as it is an outgrowth from the gametophyte and not the lower portion of the sporophyte, i.e., it is developed from the moss plant instead of from the fertilized egg-cell. The structure of the leaves is also very different from that of the other mosses. The cells of the branch leaves are of two sorts, very large hyaline rhomboidal or elliptical cells with the walls spirally thickened and often perforated by round pores, and the true chlorophyllose cells, which are narrow and elongated and lie between the others. A reference to the figures (Fig. 9) will make this arrangement clear. The leaves of some species are pink or deep red and furnish microscopic mounts of very great beauty.

Although the *Sphagnaceæ* consists of but one genus, the number of species is very large and the distinctions are very puzzling, so that only two or three of the commonest and most easily recognized species are here discussed.

Economically, the Peat Mosses are of more value than any others. In many portions of Ireland and Scotland peat is almost the only fuel supply of the peasantry. In the United States there is an abundant supply of peat. Dana estimates that there are 15,000,000,000 cubic feet in Massachusetts alone. Cheaper and more satisfactory fuels are so abundant that peat is little used in this country.

The memorable coal strike of 1902–03 called attention to our enormous and easily accessible supply of fuel of this sort, and some attempts were made to utilize this source of fuel supply. During the civil war, when coal was scarce and high-priced, peat was used to a considerable extent, and if coal should again become scarce and high-priced for any considerable time there is no doubt that the peat supply of our country could be made to furnish fuel for its needs for a century or more. At present it is not likely to compete with coal, because people are unfamiliar with its use and the demand has not warranted any great investment in plants for scientifically preparing it for market. Those interested in the matter should read an article by Mr. S. Power, in the "Outlook" for January 17, 1903.

Peat Mosses grow in and near water in swamps. They keep growing at the top and dying below. Sticks, leaves, and other vegetable matter is washed in among the decaying stems. The whole mass, being saturated with water, decays slowly, leaving a black substance whose combustibility depends upon the purity of the carbon. The "muck" of the farmers is an incomplete or impure peat.

Peat Mosses grow into small ponds from the margin and frequently fill

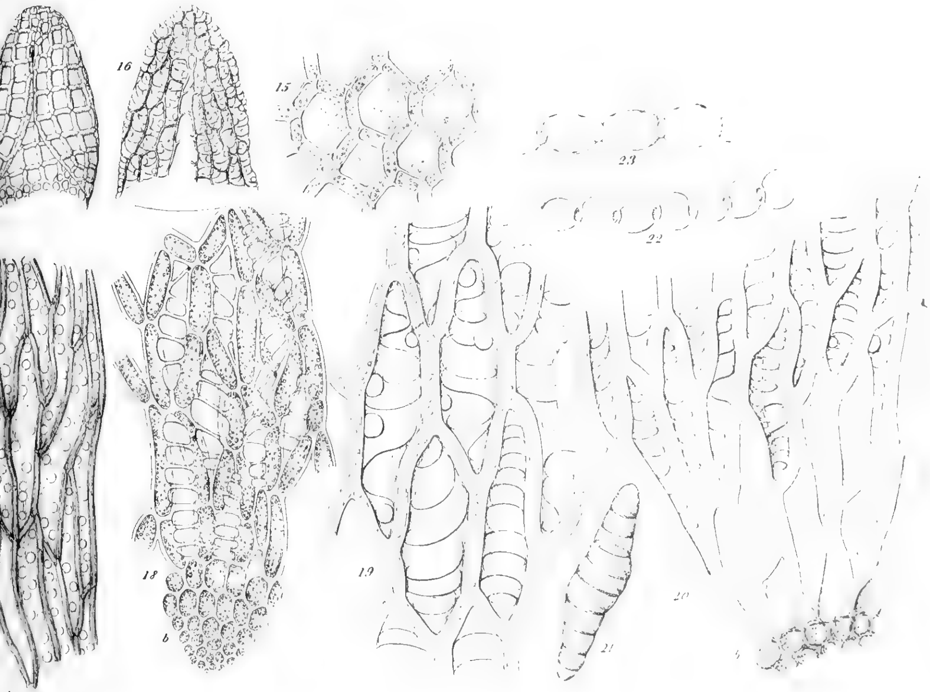


FIGURE 9. (Schimper, "Recherches")

13. Young leaf of *Sphagnum cymbifolium*, × 250. 15. Portion of 13, × 600. 16. Upper portion of a leaf of *S. cymbifolium*, × 150. 17. Portion of a leaf of *S. macrophyllum*, × 400. 18. Portion of a leaf of *S. cymbifolium* showing at *b* a portion of a transverse section of the branch upon which the leaf grew, × 600. 19. Portion of a leaf of *S. acutifolium*, × 600. 20. Basal portion of a leaf of *S. acutifolium* with a few cells from the cross-section of the branch; at 21 is shown a single large colorless cell, × 600. 22 and 23. Portions of cross-sections of a leaf of the same, × 600.

them entirely, forming quaking bogs. In other instances there is a small black pool in the center of the bog,—all that remains of a much larger body of water that once occupied the whole area now occupied by the bog.

These bogs are very treacherous, and men and animals not infrequently perish through being engulfed in the black slimy mud. There is some antiseptic property in this mud which preserves animal and vegetable tissue for a long time. Huge logs are often dug out of these swamps in a condition fit for excellent lumber. In Ireland, the body of a woman dressed in hair-cloth was unearthed from under eleven feet of peat, where it must have lain for centuries.

Peat Mosses absorb water very freely and serve to hold back the water that falls during heavy storms, preventing floods and retaining the water until it is more needed. Because of this absorbent power these mosses are much used by florists for packing flowers and by stable-men for bedding.

These mosses are easily recognized by their light gray-green color (sometimes pink or red at the top) and their peculiar shape, which is well illustrated in the figures.

Professor Goebel, in his Organography referred to on page 32, gives an interesting account of the method of spore dispersal in Sphagnum. According to him, the ripening capsule absorbs air, and when fully ripe the sun's rays dry out the moisture, causing the capsule to shrink in all directions, but a great deal more transversely than longitudinally. This gradually compresses the air until the lid of the capsule is forced off with an explosion that has thrown the spores as far as four inches.

Although Professor Goebel did not mention it, it seems to me that this explosion is very probably "touched off" by passing animals or even by sudden breezes so that the spores will find a ready means of dispersal. Certain it is that the spores will escape in dry weather, which is most favorable for wide dispersion.

SPHÁGNUM Dill.

The Peat Mosses of Europe and America are the same in the main. There are, according to recent continental authors, a great number of species, which it requires all the trained ability of an expert to recognize. But for our purposes there are two easily recognized groups, each of which contains many so-called species.

The Spoon-leaved Peat Mosses, Fig. 10, *c*, *c′*, *c″*, are easily recognized by their thick branches and their broad spoon-shaped leaves. The acute-leaved Peat Mosses are figured in *a*, *a′*, and *b*, *b*. Figure *b* represents the Acute-leaved Peat Moss which is common in all the peat bogs of Europe and America.

It is often tinged at the top with a bright red or crimson color. The Squarrose Peat Moss is one of the acute-leaved group, but is easily distinguished by the spreading tips of the leaves, as is indicated in Figs. *a*, *a'*. The branches are much stouter than in the Acute-leaved Peat Moss.

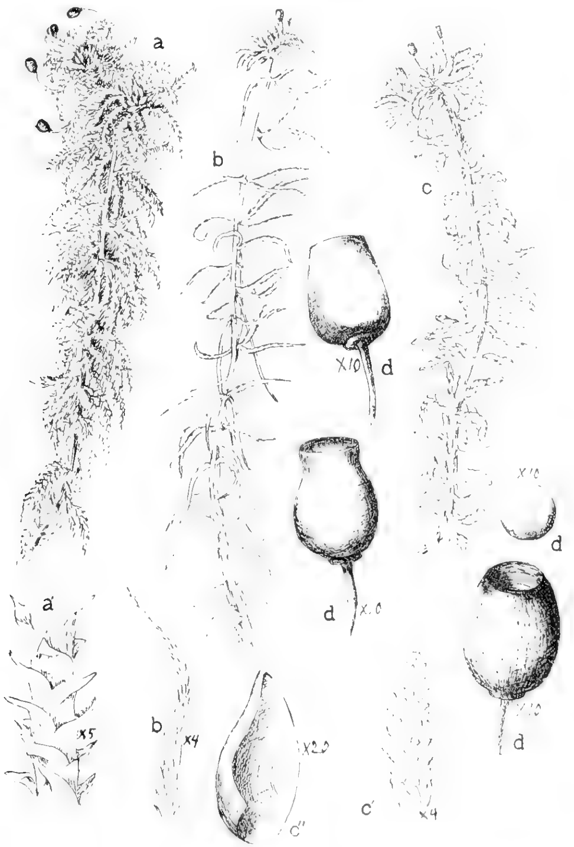


FIGURE 10

a. *Sphagnum squarrósum*, Pers. *b*. *S. acutifólium*, Ehrh. *c*. *S. cymbifólium* (Ehrh.) Hedw. *d*. Capsules of *Sphagnum*.

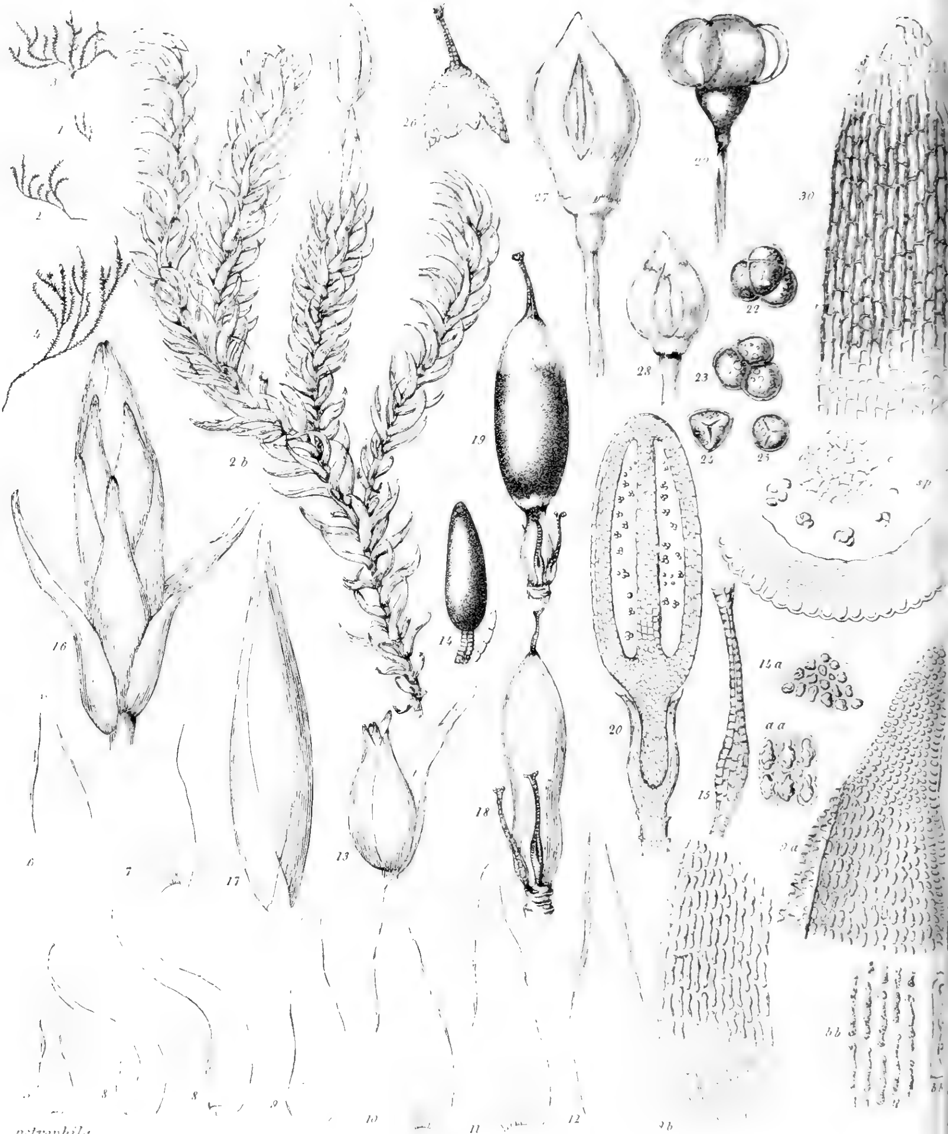


PLATE VI. (Bry. Eur.) *Andreæa petrophila*

Figs. 1, 2, 3, and 4. Plants natural size. Figs. 5, 6, 7, 8, 9, 10, 11, and 12. Different sizes and shapes of leaves. Fig. 13. Antheridial bud. Fig. 14*a*. Areolation of extreme apex of a stem leaf. Figs. 16 and 17. Archegonial bud and perigonial leaf, respectively. Figs. 18 and 19. Different stages in the development of the young sporophyte. 19*x* and 20. Transverse and longitudinal sections of the capsule. Figs. 22, 23, 24, and 25. Spores. The other figures are self-explanatory.

ORDER II. ANDREAEALES

Characterized chiefly by the dehiscence of the capsule, which splits into four valves after the manner of the Hepaticæ, the valves remaining coherent at the apex; also by the absence of any air cavity between the capsule walls and the spore sac.

Family 2. Adreaeaceae

The only family of the order. Mosses of alpine or subalpine habitat, growing upon granitic or slaty rocks; with the habit and appearance of *Grimmia*. The appearance is always dark, sometimes black, and the leaves are very brittle and so dense that they need to be soaked in a solution of caustic potash for a few moments, in order to make their structure apparent under the microscope. The presence of chlorophyll in the leaves is not apparent except in very young leaves. There is very little difference in the sporophyte in the different species.

ANDREǼA Ehrh.

The Only Genus of the Family

A. petróphila Ehrh. is common on exposed rocks in the mountains of our range. It is easily distinguished from any species of *Grimmia* or *Orthotrichum* by its lack of a costa, and it is much more slender than *Hedwigia*, and with-

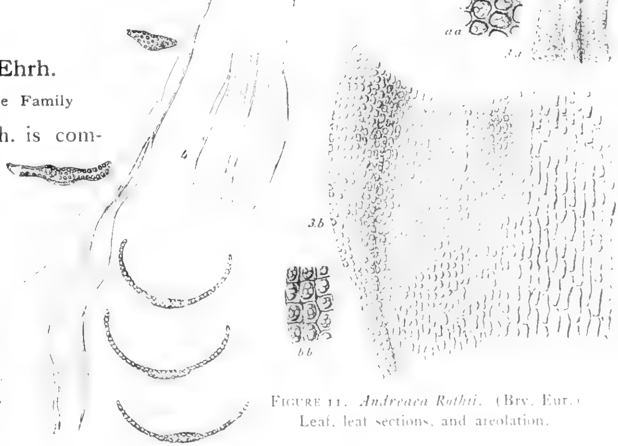


FIGURE 11. *Andreaea Rothii.* (Bry. Eur.) Leaf, leaf sections, and areolation.

out hyaline points to leaves. The other points in its structure are best made out from the illustration.

A. Róthii W. & M. (*A. rupestris* of many authors) occurs with the preceding and occasionally descends to lower levels on exposed rocks. It has been found along the Hudson, at Yonkers. It is easily distinguished from *A. petrophila* by the strong costa reaching to the apex of the leaf, or beyond.

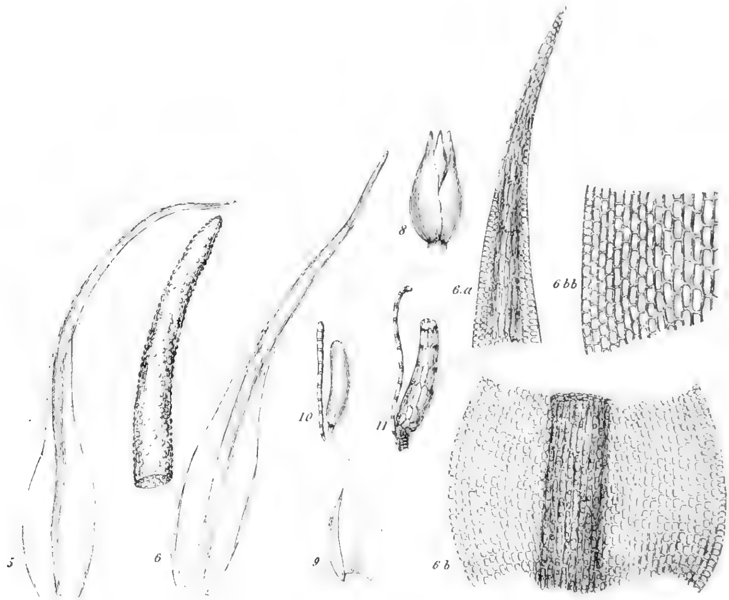


FIGURE 12. *Andreaea crassinervis.* (Bry. Eur.)

5 and 6. Leaves. 6 *a*, 6 *bb*, and 6 *b*. Areolation of apex, median margin, and base, respectively. 8, 9, 10, and 11. Antheridial bud, perigonial leaf, and different stages of antheridial development.

A. crassinérvia Bruch is so close to the last as to be with difficulty separable from it. The leaf is much more narrowly contracted above the base, so that there is little or no lamina in the upper portion. This species appears to be the least common of the three.

The last two species, if sterile, will be with difficulty distinguished from *Grimmia*, by one not familiar with them, unless comparison with authentic specimens is possible. The time of maturing spores seems to be spring in each of the three species. In *A. petrophila* they mature in May and June.

ORDER III. BRYALES

SUBORDER I. NEMATODONTEAE

Peristome teeth solid, not transversely barred (very faintly so in *Buxbaumia*), derived from several concentric series of cells of the sporogonium.

Family 3. Georgiaceae

All of our mosses belonging to this family are distinct in the four-parted peristome, each of the four teeth being composed of a solid mass of cellular tissue. (See Introduction, p. 29.) The leaves are ovate or lanceolate, smooth, costate, leaf-cells rounded-hexagonal.

GEÓRGIA Ehrh.

The botanists of preceding centuries were often under royal patronage and frequently found it convenient to pay their respects to kings and queens. Thus, Georgia is named for King George III of England, and Catharinea for Empress Catharine II of Russia.

G. pellùcida (L.) Rabenh (*Tetraphis pellucida* of many authors) is very abundant on decayed stumps in moist woods. On the western end of Long Island, where decayed wood is scarce, it grows luxuriantly on the banks of brooks in swamps, the black peaty soil being as rich in organic matter as decaying wood.

FIGURE 13

a. Georgia pellucida, × 2. *b.* Gemmiferous branch, × 2. *c.* Capsule, × 10. *d.* Peristome, × 20. See also, Plate II and Figs. 2 and 3.

The Flagellate Dicranum, which in New England grows almost exclusively on decayed wood, on Long Island and southwards has a habitat similar to that of Georgia. This goes to prove that some mosses growing on decayed wood are true saprophytes, although their saprophytism has not gone so far as to enable the plants to dispense with chlorophyll.

G. pellucida has two characteristics that will serve to make its identification easy. Its peristome consists of four long teeth that are readily distinguishable under the lens. It is the only common moss with this number of teeth in the peristome. The other character is the possession of slender branches bearing cup-like clusters of leaves. In this cluster of leaves are minute green bodies, gemmæ, which fall off and give rise to new plants in the same way that the bulblets of Cystopteris give rise to that fern.

It fruits very abundantly and the capsules persist for a year or two, so that there is no difficulty in finding or identifying it. The capsules are in the best condition late in autumn.

G. Brównii (Dicks.) C. M. (*Tetrodontium Brownianum*, Schwaegr.) is a very rare species found in less than half a dozen places in North America. It is a very small plant with a very few minute leaves at base; entire plant, including sporophyte, less than 1^{cm} in height; capsule oval, *teeth very broadly triangular*, almost equilateral. This species has been found in the mountains of Maine and New Hampshire and in Newfoundland. It often grows inverted on overhanging rocks.

Family 4. Polytrichaceae

Plants usually of a large size, the simple or slightly branched stems growing from a creeping underground stem (except *Pogonatum brevicaule* and *P. brachyphyllum*). Stems with a central woody strand, which is the nearest approach to a vascular bundle in the non-vascular cryptogams. (See Fig. 14 of Glossary.) Leaves usually narrow, with the base sheathing or at least with the basal part of the leaf hyaline with larger cells; the costa bears on its upper surface, except at the hyaline base, *longitudinal strips of tissue (lamellæ) one cell thick and attached to the upper surface of the costa by one edge; the upper cell of the lamella is often of a different shape from the others, and seen in cross-section is of great value in determining species.* The upper leaf cells are usually hexagonal. The plants are usually dioicous with the *antheridia borne in conspicuous terminal rosettes.* Capsule on a long smooth seta, large, cylindrical or prismatic, with 4–6 angles. Calyptra cucullate, *covered with a dense felt of hairs, or at least roughened at apex with short spinose projections. Peristome of 32 or 64 teeth, short, without joints, triangular in cross-section.* (See p. 33.) *Columella expanded at the top into a circular membrane, the epiphragm, which is attached to the tips of the teeth*, and helps control spore distribution. (See Fig. 3.)

The plants of this family are among our most common and conspicuous species, and the student will be sure to fall in with them in his first day's study.

KEY TO THE GENERA

1.	Capsules square or six-angled	*Polytrichum.*
	Capsules cylindric	2
2.	Calyptra hairy; leaves not crisped when dry	*Pogonatum.*
	Calyptra not hairy; leaves crisped when dry	*Catharinea.*

CATHARÍNEA Ehrh.

Leaves not sheathing and but slightly embracing the stem, lingulate or ovate-oblong, crisped when dry, with a few (1–7) narrow lamellæ; margins bordered, serrate, teeth often in pairs. Calyptra merely roughened with a few vestigial hairs. Capsule cylindric, often somewhat curved; operculum long rostrate; peristome of thirty-two teeth.

The sporophyte of the Cathariineae is in good condition from late autumn to early spring.

KEY

1.	Capsule 4 : 1; leaves not at all wavy on the margins when moist, lamellæ inconspicuous	*crispa.*
	Capsule 6–8 : 1; leaf margins wavy when moist	2.
2.	Midrib constituting $\frac{1}{8}$–$\frac{1}{10}$ of leaf	*undulata.*
	Midrib constituting $\frac{1}{3}$–$\frac{1}{4}$ of leaf	*angustata.*

C. undulàta (L.) W. & M. (Wavy Catharinea). Leaves lingulate, strongly undulate when moist and strongly spinose at the back; lamellæ, 3 to 6, 3 to 5 cells high. (See Glossary, Fig. 27.) Occasionally specimens are found with two or more setæ from a single plant.

The Wavy Catharinea is one of the very common mosses, occurring everywhere in eastern North America. It seems to be rather rare on Long Island, but in most parts of the country it is exceedingly common. It grows best on moist shady banks of brooks. It can be easily recognized by its long slender slightly curved capsules and leaves strongly crisped when dry.

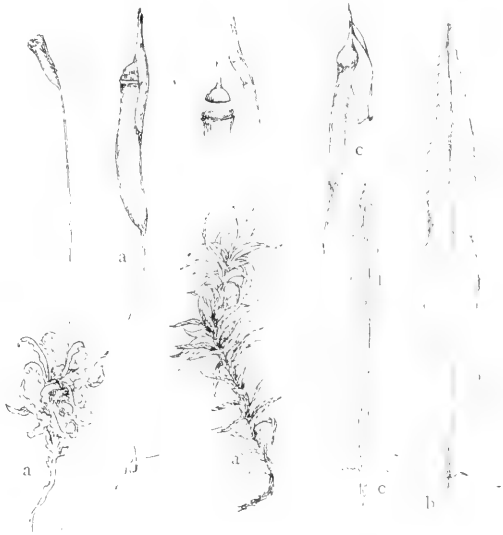


FIGURE 14

a, a, a. Catharinea undulata, wet and dry, × 2, and capsule × 5. *b.* Leaf × 10. *c, c.* Capsule and leaf of *C. angustata* × 5 and 10, respectively. See, also, Plate V, Fig. 13.

C. angustàta Brid. (Narrow-leaved Catharinea) resembles the Wavy Catharinea very closely, but grows in dryer more sandy soil, and is usually much smaller with narrower straighter capsules, as shown in the cut. The only sure way to distinguish them is by the leaves. The differences are shown in the cut. Although the leaf of the Narrow-leaved Catharinea is narrower, the midrib is much broader, constituting one-third to one-quarter the breadth of the leaf. The lamellæ are 5 to 7 and from 5 to 8 cells high.

C. críspa James is a rare species in most parts of the country, but it is common in the swamps along the south shore of Long Island. It will probably be found fairly common along the Middle Atlantic coast.

Its leaves are oval oblong, thrice as broad in proportion to their length as those of *C. undulata*, *not at all wavy when moist*, and *not spinose upon the back;* the lamellæ are *1 to 4, low and indistinct*, appearing as darker lines on the costa, but not materially increasing its apparent width. The capsule is much shorter than in either of the other species.

Sterile, this species is almost sure to be mistaken for a *Mnium*, but a careful examination of several leaves will be sure to show the presence of lamellæ.

POLÝTRICHUM Dill. The Hair-Cap Mosses

The Hair-Cap Mosses, called Bird Wheat in many localities, are the largest and most highly developed of all our mosses, and by reason of their size and common occurrence are familiar objects to nearly every one. Many an old field and meadow is carpeted with the dark rich green of the Common Hair-cap. The farmer, however, votes it a pest, as it often entirely supplants the grass over large areas of meadow.

The hairy cap that gives this genus of mosses its name is composed of long hairs growing from a little scale-like body, the calyptra proper, at the top of the capsule.

The Hair-caps, in common with most other mosses, are subject to great extremes of moisture and dryness, and their appearance when dry is very different from what it is when moist, as the leaves fold up against the stem to check the rapidity of evaporation. Some plants that do not produce a sporophyte end in a rosette of highly modified leaves. These are the male plants, and among the leaves of the rosette are numerous antheridia. The male plants of many other dioicous mosses end in a similar rosette.

Pogonatum is put with the Hair-caps by some authors, but is readily distinguished by the cylindric capsules. In other respects there is very little to distinguish the two genera.

The leaves are large, not bordered, *with a sheathing membranous base* and very numerous straight lamellæ occupying the greater part of the width of the leaf above the base; upper cell of the lamellæ differentiated.*

* In making cross-sections of the leaves to determine the nature of the terminal cells of the lamellæ, the upper portion of the leaf should be used, as these cells are not characteristic near the base.

PLATE VII. (Sulliv. "Icones.") *Catharinea crispa*

Fig. 1. Plants natural size. Figs. 2 and 3. The same magnified. Figs. 4 and 5. Stem leaves. Figs. 8 and 9 show the apex and basal cells, respectively, of the same. Figs. 10 and 11. Transverse sections of stem leaves. Figs. 6 and 7. Perigonial leaves. Fig. 19. Apex of the calyptra, with a hair from the same shown at 20. The other figures are self-explanatory.

Capsules prismatic, four- to six-angled, often nearly cubical. Peristome teeth generally sixty-four.

KEY

1.	Leaf margins serrate, not infolded	2.
	Leaf margins entire, thin and infolded	4.
2.	Terminal cell of the lamellæ flat-topped or notched in section; capsule four-angled	3.
	Terminal cell of the lamellæ rounded; capsule ovoid, obscurely 4- to 6-angled, beak long	*gracile.*
3.	Capsules cubical, beak short	*commune.*
	Capsules much longer than broad, beak long, neck tapering	*Ohioense.*
4.	Plants of dry situations, small (1^{cm} to 2^{cm}) leaves with long white awns	*piliferum.*
	Plants larger, leaves without white awns	5.
5.	Plants of lowlands without felted radicles; capsules 3^{mm} to 5^{mm} long	*juniperinum.*
	Plants of alpine or subalpine regions; stems covered with a dense felt of radicles, capsules 2^{mm} to 3^{mm} long	*strictum.*

Our species are readily divided into two groups, as shown in the key. One with serrate plane margins and the other with margins thin and infolded, not serrate except at the extreme apex. The plants are so large and the characters so well defined that there will be no need to make use of microscopic characters except perhaps in the case of *P. gracile.* These species are all earth-growing.

P. commùne L. (Common Hair-cap) is our largest moss, sometimes having stems a foot long, although usually much smaller. It is one of the most widely distributed of plants, being found in all parts of North America, in Europe and in Asia. It is also one of the very few mosses put to some economic use. The Laplanders use it to stuff pillows and beds. In England it is sometimes used for brooms.

The leaves of the Common Hair-cap are very thick and strong, with a thinner clasping base and serrate margins. The young sporophytes appear in late autumn or early spring and the capsules mature in June or early July.

The Common Hair-cap is variable in nearly all its parts. The var. *perigoniale* is a form with very long whitish membranous and long-awned perichætial leaves. The var. *uliginosum* has the leaves spreading-recurved when dry; the stems more slender and less rigid than usual. On Mt. Washington I find a form of this variety that differs from the ordinary *P. commune* mainly in the spreading-recurved leaves and smaller capsule with longer beak; calyptra not reaching below the base of the capsule when fresh and fully developed. This is, I believe, the first record of var. *uliginosum* east of the Rockies. It varies so much from the typical form of the variety that I have ventured to call it var. **uliginosum* forma *Washingtonianum.*

P. Ohioénse R. & C. (Ohio Hair-cap) without the sporophyte, is not readily distinguished from the Common, as leaves and general appearance

* See the "Bryologist," May, 1903.

FIGURE 15

1, 10, and 11. *Polytrichum Smithiæ*. 2, 3, 12, and 4. *P. Ohioense*. 5. *P. commune*. 6. *P commune*, pressed when wet with leaves expanded. 7. *P. commune uliginosum* forma *Washingtonianum*. 8. *P. commune uliginosum*, from the State of Washington. 9. *P. commune perigoniale*, showing the elongated perichætial leaves.

are very similar. But with the sporophyte present the distinctions are clear. In Figs. *b* and *d*, note that the capsule of the Common Hair-cap is almost cubical, that the lid has a very short beak, and that the capsule is entirely covered by the calyptra. The capsule of the Ohio Hair-cap (*e*) is elongated, slender, with a tapering neck; lid much longer, beaked. The lid and the calyptra of the Ohio Hair-cap fall early in June, very soon after the spores are ripe, and it is not always easy to find either in position; but, if the calyptra be found, it will be seen to cover the upper portion of the capsule only. The Common Hair-cap, although occurring in woods, is most common in open fields. The Ohio Hair-cap is most frequent in shady, more moist spots, often in deep woods.

FIGURE 16
a. Lamellæ of *P. Smithiæ*
b. Of *P. gracile*

On Mt. Mansfield, Vermont, I find a derivative of *P. Ohioense*, which I have named *P. Smithiæ*,* Grout. It is distinguished from *P. Ohioense* by its smaller

*In honor of Mrs. Annie Morrill Smith, "Bryologist," May, 1903.

size throughout (2^{cm} *high*, with leaves about 5^{mm} long, exclusive of the sheathing base; capsules 3^{mm} to 4^{mm} long), lighter color, leaves *closely appressed when dry and entirely straight.* It seems to be to *Ohioense* what *strictum* is to *juniperinum.* Forms closely approaching this have been collected on Mt. Katahdin, and it will probably be found on many of our higher mountains. In the field, it will be taken for the next, from which the flat or notched terminal cell is a sure distinction.

FIGURE 17

a. Fruiting *Polytrichum commune*, × 1, dry. *b*. The same moist with the calyptra removed. *c*. Leaf of the same, × 10 *d*. Capsule of the same, × 5. *e*. Capsule of *P. Ohioense*, × 5. *f*. Male plant of *P. commune*, × 1. *g* and *h*. *P. piliferum*, dry and wet, × 1. *o*. Leaf of *P. juniperinum*, × 10. *ó*. Portion of the same, × 30. *p*. Leaf of *P. piliferum*, × 10.

P. grácile Dicks., is a rare form, which I believe is often confused with *P. Ohioense.* The length and the number of angles of the capsule are somewhat variable and the only certain mark of distinction is the terminal cell.

P. junipérinum Willd., (Juniper Haircap), resembles *P. commune* very closely in general appearance except for the light *glaucous-green color of its open leaves*, so different from the dark green of the latter that they are strikingly distinct at a glance when moist, especially if the two species are growing intermingled, as they often do. It usually grows in drier situations than *commune.* A glance at the upper surface of margins of the leaves under a hand-lens will serve to distinguish the two species without the shadow of a doubt. This species matures its spores at about the same time as *commune* or possibly a little later.

P. Pilíferum Schreb. has the same light color as the preceding and also has its leaf-margins turned in, but the leaves differ in shape as shown in the figure, and end in long white awns. The entire plant is much smaller than in any of the other species, rarely growing larger than the figure. It also grows in much drier places than the other species, the thin layers of soil around the edges of ledges in dry pastures being a favorite habitat. It matures in June and July.

I have found this species on ledges next the bare rock, next it but farther from the ledge the Juniper Hair-cap, and in moist depressions in the ledge the Common Hair-cap, growing on the accumulated soil and humus.

P. stríctum Banks will be surely found by all mountain climbers. It is very common in open boggy places at an altitude of 3,000 feet or more. It is closely related to *P. Juniperinum*, but is readily distinguished by the *more slender, densely radiculose* stems and the *much smaller capsules.*

POGONÀTUM, Beauv.

The Pogonatums differ from the Hair-caps mainly in the cylindrical capsules, not square or angular in section. The teeth are thirty-two and the capsules are straight or curved. The spores mature in autumn or winter, except in *P. alpinum*, in which they mature about July.

KEY

1. Stems branching; terminal cell of the lamellæ ovoid, papillose . . . . 2.
   Stems simple; leaves numerous; terminal cell of the lamellæ rectangular, papillose; strictly alpine, growing close together . . . . *capillare.*
   Stems simple; leaves few, radical; protonema persistent, forming a green layer on which the plants are scattered; terminal cell of the lamellæ elliptical, smooth; plants of low and median altitudes . . . . 3.
2. Plants dark green; capsules smooth, curved . . . . *alpinum.*
   Plants glaucous; capsules papillose, erect or very nearly so . . . . *urnigerum.*
3. Leaves lanceolate-subulate, serrate . . . . *brevicaule.*
   Leaves lingulate, blunt, entire . . . . *brachyphyllum.*

P. brevicaùle (Brid.) Beauv.* [*P. tenue* (Menz.) E. G. B.] is probably the most common of our species. It grows on bare moist banks of clay or loam where other plants have not yet obtained a foothold. The plants do not grow close together, as with most mosses, but *singly and scattered, the soil between them being covered with green felt-like protonema.* All mosses grow from

*See M. Cardot's note on this species in the May, 1903, "Bryologist" just such green felt; but after the moss plant proper has developed, the protonema usually disappears. In *P. brevicaule*, however, the protonema is persistent and plays an active part in the nutrition of the plant, seeming to perform the function of leaves, for the leaves on this plant are very few and short as compared with the allied species. This is well illustrated by the figures, the dark shaded upper portion of the leaf being the only part that contains chlorophyll and therefore the only portion that performs the functions of a leaf. These marked and interesting modifications may be due to the fact that this moss grows on freshly disturbed earth, and by this method is enabled to fruit before its competitors for the space are able to develop. The capsules mature in late autumn.

FIGURE 18

a. Pogonatum tenue, × 2. *a′*. Leaf, × 15. *a″*. Capsule, × 10. *b. P. urnigerum*, × 2. *b′*. Leaf, × 10. *c. P. alpinum*, × 2. *c′*. Leaf, × 10. *c″*. Capsule, × 10.

P. brachyphýllum (Mx.), Beauv. is found on sandy and loamy soil, in the New Jersey pine barrens and southwards. It is very much like *P. brevicaule*, but is easily distinguished from it by *its entire leaves*. It need not be looked for in the northern part of our range.

P. alpinum (L.) Roehl. is common in woods and shady places, especially in elevated regions; thus, it is at once recognized by its larger size and longer curved capsule with long-beaked operculum. The leaves, also, are much longer and more slender. Without the sporophyte this species is most likely to be mistaken for some of the Hair-caps. Its capsules mature in June or early July.

P. urnigerum (L.) Beauv. grows in woods and shady places, preferring elevated regions. It is not uncommon and in some localities may be even more common than either of the species mentioned above. I, however, have met with it much less frequently. It is at once distinguished from the *P. alpinum by its straight erect capsule*, which is scarcely to be distinguished from that of *P. brevicaule*. It is usually smaller than the *P. alpinum* and much larger than the *P. brevicaule*, but is so variable that this is not to be depended upon. Its leaves, however, will serve to distinguish it readily from *P. brevicaule*, when its size is deceptive. The capsules mature in autumn.

P. capillare (Mx.), Brid. will be found on most of our higher mountain-tops. It has broad leaves like those of the *P. urnigerum*, but they are much more strongly curved when dry. It is also much smaller, with simple unbranched stems and shorter capsules.

Family 5. Buxbaumiaceae

Plants very small, almost or quite stemless; leaves few or none, growing on earth or rotten wood; perichætial leaves present but often disappearing long before the maturity of the capsule. Capsule very large in proportion to the size of the plant, oblique and asymetric. Calyptra small, conical. Peristome single or double.

A most peculiar and fantastic family, the members of which will be readily recognized by a comparison of the figures given under the species.

The peristome in this family is intermediate between that of the *Nematodonteæ* and that of the *Arthrodonteæ*, and this fact, taken in connection with the general lack of leaves, has caused this to be considered by some as a primitive type, ancestral to both *Nematodonteæ* and *Arthrodonteæ*. With this view I am unable to agree, for the following reasons: The peristome has been developed as an organ for the protection of spores from moisture and as an organ of control for spore dispersal, as stated in the introduction; but the peristome of Buxbaumia, highly developed as it is, is functionless so far as spore dispersal is concerned, as the spores escape only upon the rupture of the capsule. Furthermore, the peristome in Buxbaumia is exceedingly variable; if it were a primitive persistent type one would expect that it would have become fixed

PLATE VIII. (Reduced from the "Bryologia Europea")

B. aphylla: 1. Magnified vertical section of the capsule; 2. Annulus in vertical section more highly magnified *c*, Lower part of internal peristome; *e*, epidermis of capsule; 3. Greatly magnified portion of pseudannulus showing the rudimentary external peristome at *b* and also at Fig. 4; 5. Cells of the pseudannulus. *B. indusiata:* 1 and 2. Peristome; 3. Pseudannulus (*a*) and peristome (*b*) in vertical section; *c*. Internal peristome; 4 and 5. Teeth of external peristome; 6. Portion of the same more highly magnified; 7, 8, 9, 10, and 11. Different transverse sections of the teeth of the external peristome. ***D. foliosum*** (***Webera sessilis***): *D* 1. Peristome magnified; *D* 2. Two teeth; *D* 3. Vertical section of the peristome, operculum, and capsule wall; *D* 4. Folds of the internal peristome in transverse section; 6. Spores; 7. Vertical section through base of seta and vaginale.

by this time. These facts strongly indicate degeneracy, from a more highly developed state, and this belief is strengthened by the fact that in *Pleuridium*, *Ephemerum*, *Physcomitrium*, and *Weissia viridula*, mosses which all agree to be degenerate, the habits are much the same.

Add to this the fact that *Buxbaumia* is acknowledged to be saprophytic, and the evidence pointing toward a degenerating type seems conclusive.

In mosses with annual stems and persistent protonema the leaves always tend to become reduced in number, as their function is performed by the protonema. *Pogonatum brevicaule* affords a good illustration of that tendency in a highly organized moss. *Webera* is evidently much less degenerate than *Buxbaumia*, for the leaves are more abundant and persistent and the peristome is functional.

The outer row or rows of teeth are greatly variable in all members of the family and are almost lacking in some, but the inner cone is well developed in all.

This inner cone is composed of a thin membrane made of the thickened tangential cell-walls of one of the layers of cells, and is plaited or folded like a half-opened fan. The structure of this cone is most easily understood by consulting Plate VIII, Fig. *D* 1. The structure of this is almost exactly like that of *Buxbaumia* shown on a smaller scale at 2, under *B. indusiata*. It corresponds very closely, in structure and development, to the basal membrane of the inner peristome of *Bryum* and *Hypnum* and their allies, only in *Buxbaumia* the upper part is continuous instead of being broken up into segments and cilia.

The teeth of the outer peristome are constructed much like those of the ordinary arthrodont type. They are well illustrated in Figs. 4, 5, and 6 under *B. indusiata* and are shown in Figs. 7, 8, 9, 10, and 11. In these last figures the original cell-walls are indicated by the lighter T-shaped central portion, while the remainder consists of the thickening added on and forming the plates, or lamellæ. The top of the T is the tangential wall, while the stem is a portion of a vertical radial wall included between the lamellæ. But instead of a single row of these teeth there are several, as shown in Fig. 2, under *B. indusiata*. Outside of these teeth and between them and the outer wall of the capsules is a mass of cells which is called the crown, or pseudannulus, which may perform the functions of an annulus, but is in no way homologous with it (*B. ind.* 3). M. Philibert considered these cells and the several rows of teeth as homologous with the outer rows of cells in the teeth of the *Nematodonteæ*, the several rows of teeth being composed of the thickened papillose tangential walls of a portion of the peristomial tissue while the pseudannulus corresponds to the outer layers of the same. This view is borne out by *B. aphylla*, in which the outer teeth are almost lacking and the pseudannulus is much thicker and is thickened and papillose on its inner cell-walls.

According to this view, then, the peristome of *Buxbaumia* is formed of tissue homologous to that of the teeth of *Polytrichum* by the thickening of the tangential walls of a few rows of cells and the absorption and disappearance of the rest of the tissue.

BUXBAUMIA Haller

The drawings speak for themselves. No one who finds the queer looking objects figured here will have any difficulty in identifying them.

The leaves are few and are clustered at the base of the seta. They entirely disappear before the capsule ripens, so that the mature plant consists of only the roughened seta with a few rhizoids at the base and the queer bug-like capsule. Mrs. Britton calls the Buxbaumias "The Hump-backed Elves." To the author they look like bugs on a stick. We have two species in eastern North America, *Buxbaumia aphylla* L., and *B. indusiata* Brid.

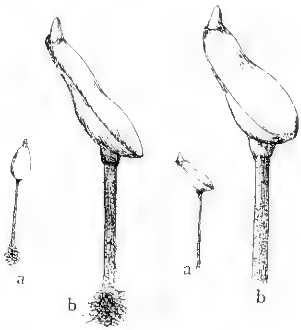


FIGURE 19

a, a. Two different views of *Buxbaumia aphylla*, × 1. *b, b.* Two different views, × 4.

B. aphýlla has the capsule red-brown, shining, strongly flattened above; stomata one-celled, immersed; outer peristome of a single series of very short teeth; spores 0.005^{mm} to 0.008^{mm} in diameter, maturing from December to April, occasionally found mature in September. Plants growing on soil.

B. indusiàta has the capsule green or yellow, dull, little flattened above; stomata two-celled, superficial; outer peristome of four concentric rows of linear teeth, of which the outer row is short and the inner more than half the length of the cone; spores twice the size of those in *B. aphylla*, maturing a month or so earlier. Plants growing on very rotten wood, rather smaller. Both species are widely distributed across the continent, but *B. aphylla* is much the more common.

WEBÈRA Ehrh*

Much more common than Buxbaumia and scarcely less interesting is the odd little Webera shown in Fig. 2. The capsules have much the same one-sided tilt, but are less irregular in outline and are partially incased in the fringed

* We have but one species of Webera, *W. séssilis* (Schmid.) Lindb.—*Diphyscium foliosum of many authors.*

perichætial leaves. The capsule resembles a grain of wheat in appearance and is almost sessile, the seta being so short as to be scarcely apparent. The leaves are persistent and the non-fruiting plants are frequently so abundant as to make a broad mat of dark green, dotted here and there with the lighter colored capsules. In looking for Webera, search for a moist bank where there is little or no tall vegetation, and which at a little distance appears dark green mottled with white. (The white is a lichen that is nearly always found with the Webera.) Webera is so common and so easily recognized that every lover of mosses should be able to collect it in his home locality. The capsules persist for a long time, but July is a good time to collect this species.

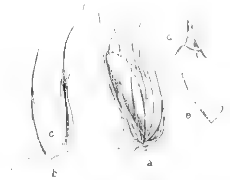


FIGURE 20

a. Webera sessilis, × 4. *b.* Leaves, × 4. *c.* Perichætial leaves, × 4. *d* and *e.* Peristome and operculum, × 10.

In Webera, as well as in Buxbaumia, the upper surface of the capsules is flattened in cross-section and the capsules all point in the direction of the light supply, often looking like soldiers in close array at "shoulder arms." Both the position of the capsule and the flattening of the upper surface is an adaptation for light absorption, but in Webera the first drops of rain that fall in a storm strike the upper surface (Vide "Goebel Organography," Pt. I, p. 237, Balfour's translation) and send the spores out in little puffs, sometimes to a height of two inches. This effect can be produced by tapping a mature deoperculate capsule lightly upon the upper side. It seems probable that the wind which accompanies summer storms serves to further disperse these spores and that the ejection of the spores ceases after the capsules are well wetted; but this needs further investigation.

It also seems perfectly sure that other agencies than raindrops will serve to force the spores out of Buxbaumia's "powder guns"; for example, the impact of the feet of large insects and other small animals. Perhaps the jet of spores may leave some clinging to the hair or fur of the animals which discharge them, and through that means may be carried for considerable distances.

In spite of my statements on a previous page, I do not feel sure that the spores of Buxbaumia may not be distributed in a similar manner, and hope that some one who has the opportunity will investigate the matter experimentally. My previous statements are based on excellent authority, but I do not feel that the subject is closed.

SUBORDER II. ARTHRODONTEAE

Peristome teeth thin, derived from the cell-walls of a single layer of cells of the sporogonium, transversely barred, sometimes entirely lacking.

GROUP 1. APLOLEPIDEAE

Peristome single, composed of two layers of plates made by a deposit on the inner and outer side of the original cell-wall. In the outer layer a single undivided plate forms the entire width of the tooth, but the inner plate is divided by a median line into two parts. The teeth are often partially split along this median line as in *Dicranum*, or entirely cleft to the base as in *Barbula*. *Ceratodon* represents an intermediate condition. With the exception of some species of *Fissidens*, our *Aplolepideæ* are acrocarpous.

Family 6. Fissidentaceae

One of the most natural and easily recognized families. It can be easily recognized even when sterile by the distichous leaves, vertically placed and arranged in one plane, apparently split along the basal portion of the upper edge and clasping the stem and the lower edge of the leaf next above. The leaf-cells are small, rounded or hexagonal. The sporophyte is lateral or terminal, exserted; peristome like that of *Dicranum*, with sixteen forked, highly colored teeth, which are often papillose above.

The peculiar structure of the leaf has been explained in several ways, but the explanation given by Robert Brown in 1819, has recently been verified by the studies of Mr. E. S. Salmon ("Annals of Botany" **13**: 103–130, 1899).

According to this theory the clasping portion of the leaf represents the original leaf, while the rest of the leaf is made up of lamellæ, one dorsal and the other terminal. This theory is strongly confirmed by the fact that these supposed lamellæ are wanting in the perigonial leaves and very much reduced in size or wanting in the lower-stem leaves. Moreover, the peristome shows this family to be closely related to the *Dicranaceæ*, in which dorsal lamellæ are often strongly developed.

Besides *Fissidens*, we have only one other genus of this family, the rare

BRYOZÍPHIUM

B. Norvégicum (Brid.) Mitt., The Sword Moss, found on shaded vertical faces of sandstone cliffs in the watershed of the Ohio and upper Mississippi rivers. The stems are flat, glossy yellow, mostly simple, about an inch long and one line broad, fastened and rooting by a bulb-like base. The capsule is without peristome, but the sporophyte is so rare that this will not trouble the collector who is fortunate enough to discover this prize. The dorsal lamella also is much less strongly developed than in *Fissidens*, but is still quite apparent. For a more complete account of this moss the student should consult "The Plant World" **1**: 1, 1897. The reasons for placing it in this family are given by E. S. Salmon in "Annals of Botany" **13**: 103–130.

FÍSSIDENS Hedw.

Three of our species, *F. Julianus*, *F. Hallianus*, and *F. grandifrons*, are aquatic or subaquatic; the others are terrestrial, growing with erect stems on damp soil and stones. All except *F. hyalinus* have strongly costate leaves. The sheathing base of the leaf is called the vaginant lamina; the terminal lamella above the costa, the vertical lamina; and the dorsal lamella, the inferior lamina. The leaves are often bordered, sometimes with a number of elongated cells, much as in *Mnium*, but, more frequently, with cells of the same shape and size but of a different color.

KEY

1.	Leaves rigid, composed of more than one layer of cells, opaque	*grandifrons.*
	Leaves soft, composed of a single layer of cells	2.
2.	Plants aquatic, filiform, floating	3.
	Plants terrestrial or submerged, not floating	4.
3.	Plants large, 2 to 6 inches long, much branched, habit of Fontinalis	*Julianus.*
	Plants small, not exceeding 1½ inches, little branched	*Hallianus.*
4.	Leaves (at least the vaginant lamina) bordered by a narrow band of elongated cells	5.
	Leaves bordered by several rows of paler, often incrassate cells of about the same size and shape as the others	6.
	Leaves not bordered (occasionally the outermost row of cells is a little paler) . . .	7.
5.	Border usually confluent at apex with the percurrent costa; antheridial buds axillary	*bryoides.*
	Border at apex narrow or wanting; antheridial buds at base of stem	*incurvus.*
6.	Leaf-cells obscure, 6 to 9 x 6 to 12μ; dioicous	*cristatus.*
	Leaf-cells distinct, 12 to 15 x 18 to 24μ; monoicous	*adiantoides.*
7.	Costa excurrent	*taxifolius.*
	Costa ending in the apex or below	8.
8.	Leaves entire	*obtusifolius.*
	Leaves serrulate	9.
9.	Costa nearly percurrent; leaf-cells 9 to 18 x 12 to 24μ	*osmundoides.*
	Costa ending some distance below apex; leaf-cells roundish, 8 to 11μ	*subbasilaris.*

F. bryoides (L.) Hedw. In American plants the border *reaches the apex* less frequently than in European specimens. The lowest leaves should not be considered in this connection, as they vary greatly from the upper. The sporophyte is *terminal* and the capsule is *erect*. I find this species often very difficult to distinguish from the next. The surest distinction is the *situation of the antheridial buds*, but Professor Barnes says that in this species these are not produced the first time the plant fruits. It is not rare, growing on moist soil; frequently found in conservatories. The spores mature in autumn (October).

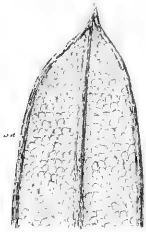
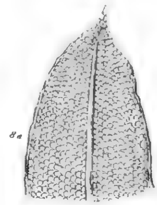


FIGURE 21
Leaf-apex of *F. bryoides*. (Bry. Eur.)

F. incúrvus Schwaegr. The border in this species is also variable and approaches the preceding in this respect. The antheridial buds are *basal* and the *capsules curved.* The spores appear to mature a little later than in the preceding. This species appears also to be less frequent. On rocks, especially sandstone. In Europe it is frequent on clay banks. Limpricht says both species have the teeth spirally thickened, which does not agree with Professor Barnes' statements in his "Revision."

Var. **minutulus** Austin is a very small form (*less than 2mm high*) also growing on rocks. The leaves are narrower than in the species and the capsule is often erect.

Var. **exiguus** Austin is a small form but larger than *minutulus;* the *costa ends in the apex* and *the border often does not extend beyond the vaginant lamina;* capsule erect or inclined. There seem to be forms intermediate between these varieties, and the fact that both varieties mature their spores *in August* leads me to believe that they are distinct from *F. incurvus*.



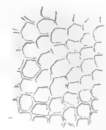


FIGURE 22
Leaf-apex and cells of *F. incurvus*. (Bry. Eur.)

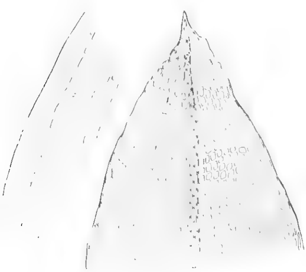
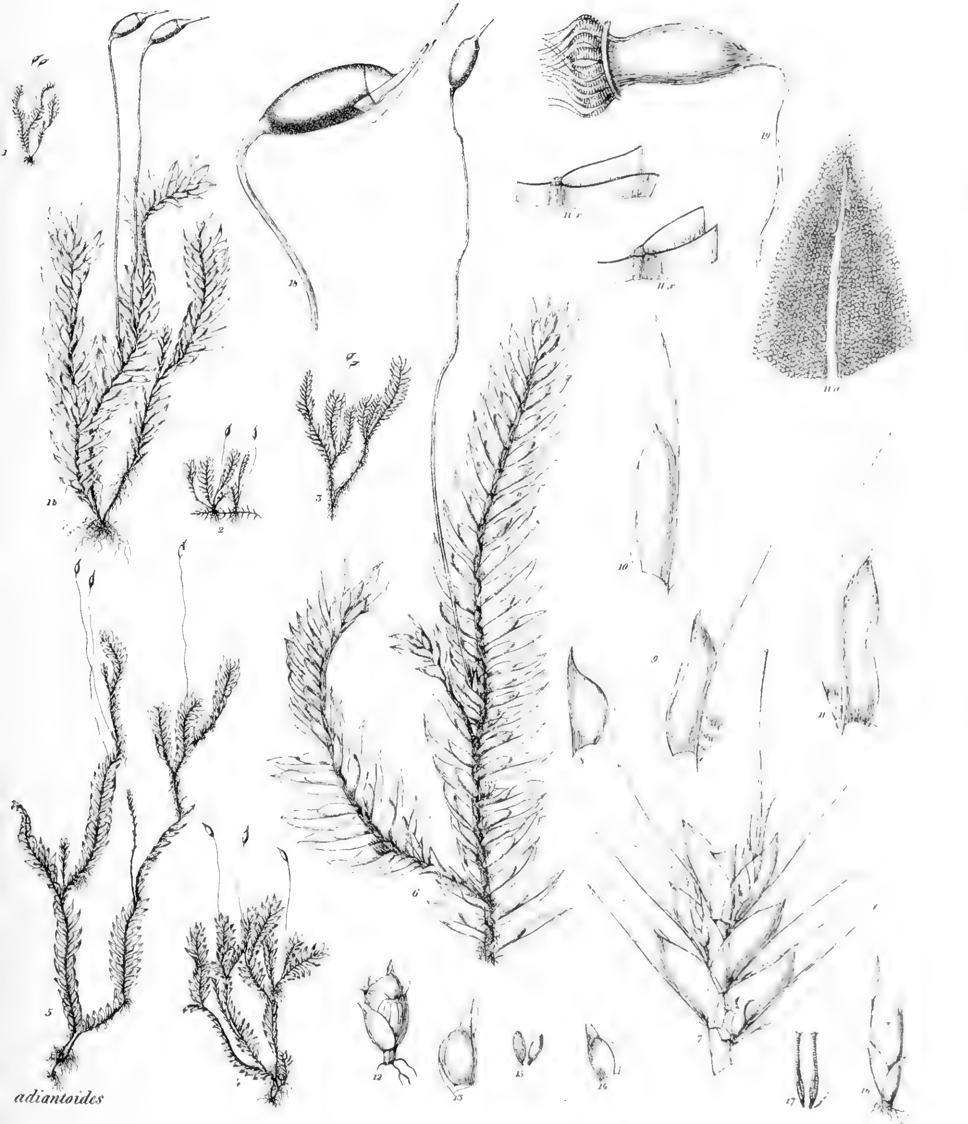


FIGURE 23
Leaf-apex and margin of *F. minutulus* (Sulliv. "Icones")

F. adiantoides (L.) Hedw. Plants reaching 10cm in height; sporophyte lateral; the leaf border is sometimes wanting and then the plants might be referred to *F. osmundioides*, as the leaf-cells are about the same size. *F. adiantoides* has leaves strongly and doubly serrate, but in *F. osmundioides* they are slightly serrulate. The position of the sporophyte, if present, will at once decide between these two species. When the leaves are normally bordered there is likely to be some trouble in distinguishing this from the next, as both are similarly bordered and have a



adiantoides

PLATE IX. *Fissidens adiantoides* (Bry. Eur.)

Figs. 1, 2, 3, 4, and 5. Plants natural size. Fig. 8. Basal leaf. Figs. 12, 13, and 14. Antheridial bud, leaves, and antheridia, respectively. Fig. 16. Archegonial bud. The other figures are self-explanatory.

lateral sporophyte and both mature their spores in *winter*. The size and appearance of the leaf-cells is always sufficient to differentiate them to one who has both species.

F. cristàtus Wils. (*F. decipiens*, DeNot.) is more slender than the preceding and rarely exceeds 3^{cm} in height. Apparently the most common species in New England. On moist soil and stones in shaded places.

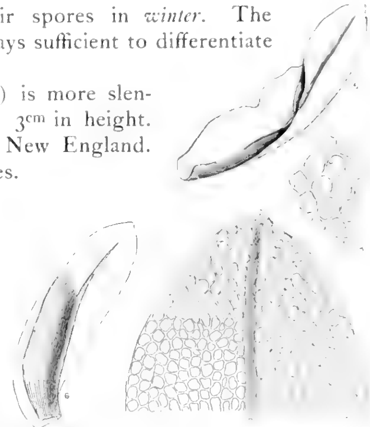


FIGURE 24
Leaves, leaf-apex and areolation of *F. obtusifolius* (Sulliv. "Icones")

If one has no means of measuring leaf-cells he can compare the leaves of all his collections which answer the descriptions of these two species with each other or with authentic specimens. The cells are so noticeably different in size that he will have little difficulty in distinguishing the larger cells of *F. adiantoides* from the smaller of *F. cristatus*.

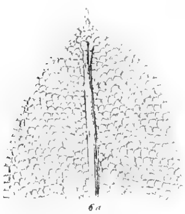


FIGURE 25
Leaf-apex of *F. osmundioides*. (Bry. Eur.)

F. obtusifòlius Wils. seems to be the rarest of our species with non-bordered leaves. It should be easily recognized by its *entire obtuse leaves*. The leaf-cells are pellucid, round-hexagonal, 7^{μ} to 11^{μ}. Dioicous; sporophyte terminal; capsule erect; operculum conic, scarcely beaked. On wet rocks. Central and southern in its range.

F. osmundoìdes (Swtz.) Hedw. 1^{cm} to 5^{cm} in height (rarely twice this): dioicous; with *terminal sporophyte;* capsule suberect or inclined; operculum with a needlelike beak nearly as long as the rest of the capsule. Spores mature in *summer* (July). Common on various substrata.

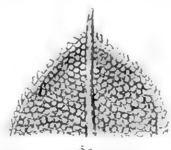


FIGURE 26
Leaf-apex of *F. taxifolius*. (Bry. Eur.)

F. taxifòlius (L.) Hedw. is usually less than *1^{cm} in height;* leaf-cells *9^{μ} to 11^{μ}* in diameter: autoicous; sporophyte lateral; capsule inclined, often cernuous; beak of operculum long, usually bent at base; spores maturing in late autumn or winter. On damp clayey soil. Its "ear-mark" is the *excurrent costa*.

FIGURE 27
Leaf-apex of *F. subbasilaris* (Sulliv. "Icones")

F. subbasilàris Hedw. This species is about the size of the preceding and also has the sporophyte lateral. The costa *ceases a considerable distance below the apex;*

leaves finely serrulate above with projecting cells; vaginant lamina long, two-thirds to three-fifths the length of the leaf; leaf-cells 8^{μ} to 11^{μ} in diameter: capsules oblong-cylindrical, straight or nearly so; beak one-half length of urn; spores maturing in winter (Jan.). On trees and rocks.

Besides the above there are two minute terrestrial species which are considered very rare, probably because they are overlooked.

F. hyalìnus Wils. and Hook. is 2^{mm} to 4^{mm} high; leaves *without costa.* It is frequently found in company with *F. taxifolius*, and when fruiting can be seen if held near the eye by reason of its red peristome.

F. Clósteri Aust. is *smaller* and has been collected but once. This was by Mr. Austin on the ground at Closter, N. J. There are only *two or three* pairs of non-bordered strongly *costate* leaves.

F. grándifrons Brid. has a very wide geographical distribution, but has not been found in fruit except in the Himalaya Mountains. It is found in very wet places, often in trickling water. The water in which it grows *always contains more or less lime in solution.* The leaves are so *opaque* that one familiar with other species of *Fissidens* need not make sections of the leaves to be sure of their structure.

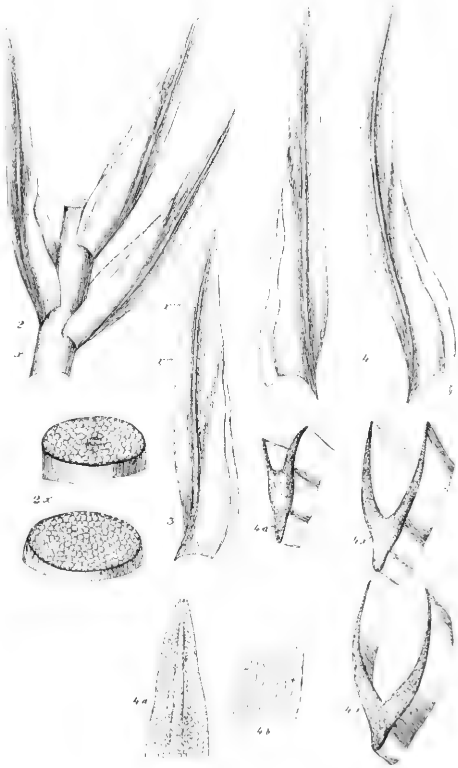


FIGURE 28

F. grandifrons. 2*x*. Cross section of stem. 4*b*. Areolation of leaf. The other figures are self-explanatory. (Bry. Eur.)

F. Juliànus (Savi.) Schimp. needs no description beyond its aquatic habitat and its Fontinalis-like habit. It is widely distributed in the United States. I have collected it in a small brook near Kingsbridge, New York City.

The degenerate peristome of this species seems clearly due to its aquatic

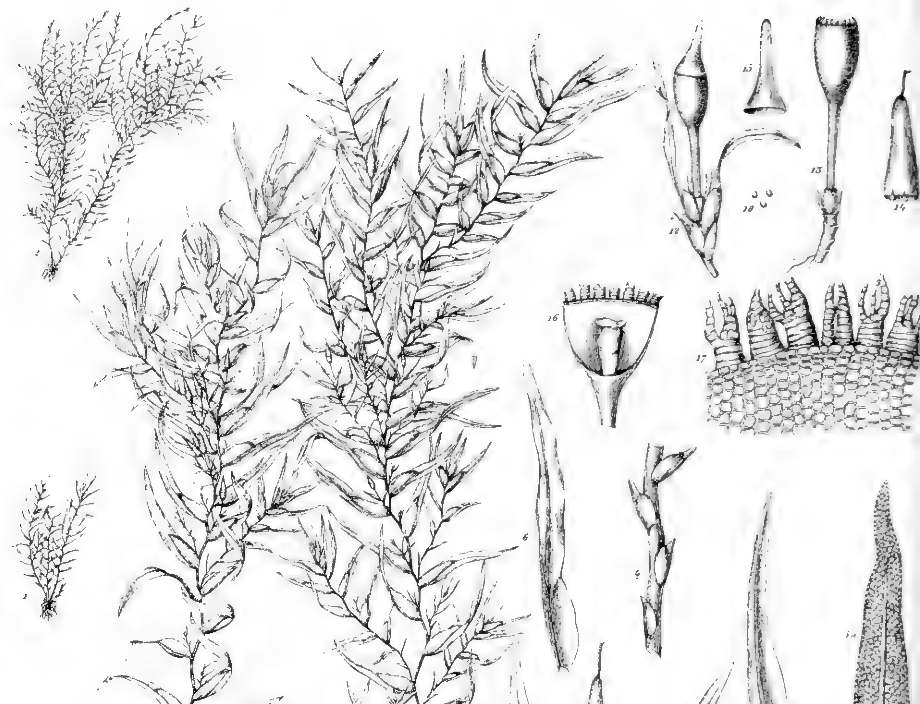


PLATE X. *Fissidens Julianus* (Bry. Eur.)

Figs. 1 to 3. Plants natural size. Fig. 4. Lower part of stem with leaves. Fig. 17. Peristome. The other figures are self-explanatory.

habitat, as all the terrestrial species of the genus have well-developed peristomes. The immature capsules frequently drop off in large numbers and not infrequently protonema and new plants develop from the calyptra, as shown in Fig. 29, taken by permission from Mrs. Britton's article on this species in the "Bryologist" for September, 1902.

FIGURE 29

F. Halliànus (Sulliv. and Lesq.) Mitt. is less truly aquatic, growing on partially submerged wood or stones or in places wet by spray or water of fluctuating height. The peristome is much more perfect than in *F. Julianus.* Easily distinguished by the characters given in the key. The range of this species is almost as great as that of the preceding but is seldom collected.

Family No. 7. Dicranaceae

Plants varying in size from exceedingly minute to several inches in height, dichotomously branched. Leaves broadly lanceolate to subulate, often sheathing at base, costate, occasionally papillose; leaf-cells quadrate, or rectangular to linear, chlorophyllose above, more elongated and with little or no chlorophyll toward the base, often with special inflated cells at the basal angles. Calyptra smooth, narrow, cucullate. Capsule on an elongated seta, narrow, oval to cylindrical, frequently cernuous and curved; operculum usually long-beaked; peristome of 16 teeth which are *cleft half-way to the base or further into two lanceolate or subulate divisions*, usually of a reddish color, transversely barred, often with fine vertical striæ between the bars. There are a few cleistocarpous species with capsules rounded and immersed or elongated and exserted.

The leaf character and the peristome when present will usually indicate the family to one who is at all familiar with it, but in some genera it is closely related to the Tortulaceæ [e. g., *Ditrichum* and *Trichostomum; Ceratodon* and *Barbula* (*Didymodon*)]. The plants of this family are inhabitants of soil and rocks, rarely growing on trees, frequently on decaying wood.

For convenience our genera may be grouped into eight tribes or subfamilies.

KEY TO SUBFAMILIES OF THE DICRANACEÆ

1. Cleistocarpous; capsules spherical and immersed or pear-shaped and sometimes slightly exserted . . . . *Bruchieæ.*
   Capsules operculate and peristomes well developed . . . . 2.

2. Plants whitish; leaves more than one cell in thickness, appearing ecostate but really consisting of the costa alone . . . . *Leucobryeæ.*
   Plants green, leaves with costa and lamina, the latter rarely more than one cell in thickness . . . . 3.
3. Plants large (with few exceptions); leaves with much enlarged and inflated alar cells . . . . *Dicraneæ.*
   Plants smaller; leaves without enlarged and inflated angular cells . . . 4.
4. Capsules with a long inflated neck, sometimes longer than the urn . . *Trematodonteæ.*
   Capsules without a long inflated neck . . . . 5.
5. Rare minute plants of high altitudes; teeth variable but not cleft to base . *Seligerieæ.*
   Peristome teeth cleft to the base into two filiform legs (except Swartzia) . *Ditricheæ, Oncophoreæ.*
   Peristome dicranoid; plants like small Dicrana in appearance . . . . . *Dicranelleæ.*
   Peristome various; upper leaf-cells minute, often papillose . . . . . . *Oncophoreæ.*

BRUCHIEÆ

Small (8^{mm} or less) yellowish- or brownish-green mosses, growing upon soil in extensive tufts. Protonema often persistent. Leaf-cells not papillose and mostly elongated-rectangular; alar cells not enlarged or inflated. Capsules cleistocarpous, subglobose and immersed, or pear-shaped and immersed to fully exserted.

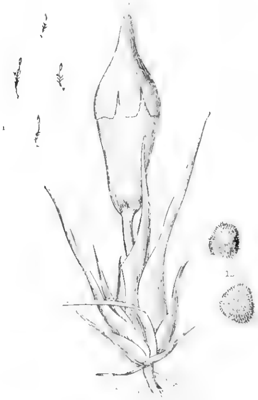


FIGURE 30. *Bruchia Sullivantii.* 1. Natural size. 2. Magnified. (Sulliv. "Icones")

We have only two genera of this subfamily, *Bruchia* and *Pleuridium.* Bruchia has capsules with a conspicuously developed neck, so that the capsules are pear-shaped. Because of this long neck the genus is often put in the *Trematodonteæ*, but it seems most convenient to follow Limpricht in this matter and certainly no violence is done to natural relationships.

BRÙCHIA Schwaegr.

With the characters of the subfamily. Distinguished from *Pleuridium* (except *P. palustre*) by the *pear-shaped capsules* and *mitrate calyptra.* Often growing with it, but distinguished easily by a hand-lens by the characters given. Our species catch the eye when growing with *Pleuridium* by reason of the partially exserted capsules.

B. Sullivántii Aust. This is perhaps our most common species, but it is collected rather infrequently. I have found it growing in rather dry fields with *Pleuridium subulatum.* It is readily distinguished from that species as noted above and besides matures its spores at least two weeks later. Under the microscope its leaves are distinguished by being subpapillose.

B. flexuòsa (Schwaegr.) Müller. This is very close to the last, too close for the comfort of the amateur. Typically, it has a much shorter and much less conspicuous neck to the capsule, so that the capsule is merely ovoid. The leaves are nearly smooth.

PLEURÍDIUM

Plants annual or perennial, in dense cushions; stems very short, simple or branching; upper leaves longer than the lower, more crowded, erect-spreading (except in *P. Sullivantii*) or secund, not crisped; costa excurrent or percurrent and forming most of the apex; capsules ovoid-globose, apiculate; calyptra cucullate (except in *P. palustre*). Growing in light sandy soil, often among grass.

The other genera most likely to be confused with *Pleuridium* are: *Archídium*, differentiated by having only about sixteen very large (25^{mm}) smooth spores and capsule not apiculate; *Pháscum cuspidatum* with a round smooth excurrent costa and upper leaf-cells rounded hexagonal and papillose on the back; some other small species of the *Tortulaceæ* which also have papillose cell-walls, or have ovate or ovoid leaves with costa vanishing or slightly percurrent; *Ephemerum*, in which the plants are stemless, being scarcely more than buds on a persistent protonema.

KEY TO THE SPECIES

1. Antheridia naked inside the perichætial leaves; stems 3^{mm} to 5^{mm} high or sometimes nearly lacking in *P. palustre* . . . . 2.
   Antheridia in the axils of the leaves; stems 5^{mm} to 10^{mm} high, branching, slender . . 3.
2. Calyptra mitriform; upper leaves suddenly subulate, base only one-fourth to one-fifth the length of the awn . . . . *palustre*.
   Calyptra cucullate; upper leaves lance-subulate, base less than one-half the length of awn . . . . *subulatum*.
   Calyptra cucullate; upper leaves ovate-subulate, base more than half the length of the awn . . . . *Ravenelii*.
3. Leaves distant, spreading, subulate, 3^{mm} long . . . . *alternifolium*.
   Leaves closely imbricate, ovate, cuspidate, 1^{mm} long . . . . *Sullivantii*.

P. subulàtum (L.) Rabenh. Down among the tufts of grass in dry and sandy fields in early spring, one can find soft silky tufts of green containing innumerable little green spheres like emerald dewdrops. These green spheres are the capsules nestling among the leaves because of the shortness of the setæ. The drawing can give no idea of the beauty of a dense tuft several inches square, fresh from the fields, wet with the spring snows and rains.

The plants are 2^{mm} to 3^{mm} high; the spores mature from April to June. Not uncommon in old fields on sandy banks, etc., less frequent northwards.

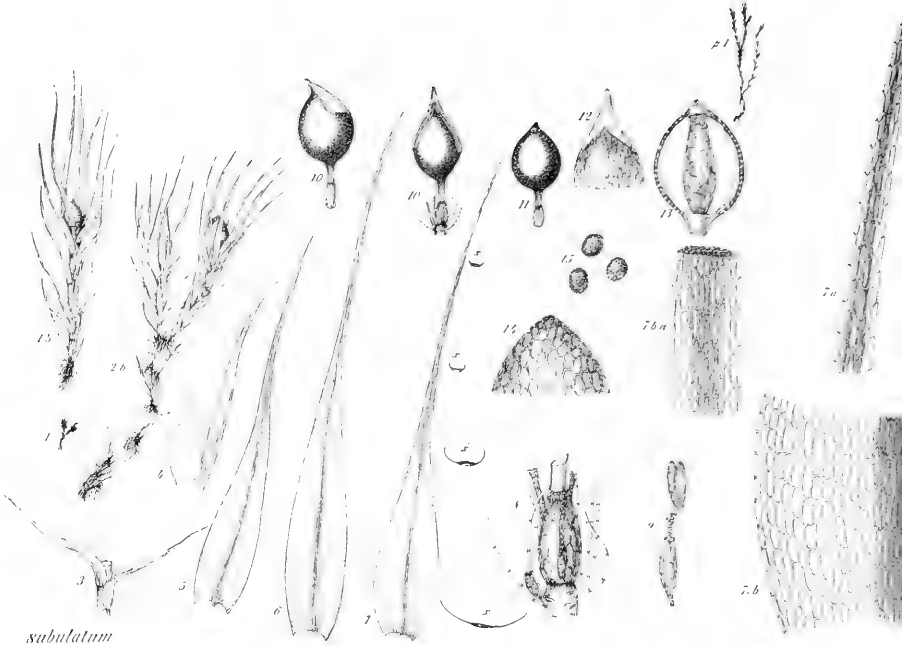


FIGURE 31. (Bry. Eur.) *Pleuridium subulatum*

1. Plant natural size. β 1. A variety. 7 *b*, 7 *ba*, and 7 *a*. Base, median portion, and apex, respectively, of leaf. 12. Calyptra. 13. Longitudinal section of capsule. 14. Areolation of capsule wall. The other figures are self-explanatory.

FIGURE 32. (Bry. Eur.) *Pleuridium alternifolium*

1 and 2. Plants natural size. 3. Shows the antheridia in the axils of the leaves. 18. Capsule in longitudinal section. 19. Areolation of capsule wall. The other figures are self-explanatory.

P. alternifòlium (Kaulf.) Rabenh., besides the characters given in the key, is a somewhat larger plant, rarely less than 5^{mm} high, and often bearing long flagelliform branches so that the whole plant may be 2^{cm} or 3^{cm} long. Some of the leaves may approach in shape those of the preceding, but the preceding has none of the suddenly narrowed leaves which are present on every fruiting plant of this species. This moss is common in sandy localities near the coast, but much less frequent inland.

DITRICHEÆ

Plants short or tall; leaves lanceolate-subulate without enlarged alar cells; capsule oval to cylindric, erect or nearly so; peristome of sixteen narrow teeth, which are often cleft to the base into thirty-two filiform cilia. (See Fig. 37.)

KEY

Leaves two-ranked, papillose on the back above . . . . *Swartzia.*
Leaves in more than two ranks, smooth . . . . *Ditrichum.*

DÍTRICHUM Timm.

KEY

Monoicous; seta yellow; costa long excurrent . . . . *pallidum.*
Dioicous; seta red or orange, sometimes brownish; costa short excurrent . . . . . . *tortile.*

Plants tufted, slender, growing on soil or rocks; upper leaf-cells narrowly rectangular; (upper quadrate in *D. tortile*) capsule on a slender straight seta, oval to cylindric, erect or slightly inclined, with an annulus; peristome erect, of sixteen long teeth, cleft into two filiform papillose divisions, which are sometimes more or less united.

The name *Leptotrichum* Hampe, is untenable, not only on grounds of priority but also because it had previously been applied to a genus of Fungi.

Leptotrichum glaucescens Hampe. is put in another genus (*Sælania*) because of its minute, not elongated leaf-cells. With the hand-lens this species is distinguishable when fresh by its glaucescence. This genus as a whole seems not far removed from *Trichostomum*, from which in general it is distinguished by the elongated leaf-cells of the upper lamina and the dicranoid shape of the leaf. Some of the species also may be mistaken for *Ceratodon*, but the larger plants with the characteristic wrinkling of their capsules when dry, and the peristome teeth curled when dry, will usually suffice to distinguish the latter.

D. pállidum (Schreb.) Hampe. is our largest common form and is distinguished by its larger size (stem 5^{mm} and seta 2^{cm} to 4^{cm} in length), longer spreading leaves, bright yellow seta, and capsule unsymmetric often slightly strumose when dry. Its spores mature about June. It is a plant of dry sandy places, and is more common in the southern part of our range.

D. tórtile (Schrad.) Hampe. is a smaller plant in appearance, for the leaves are shorter and appressed and the seta about 1^{cm} to 5^{cm} long. The capsules are erect and symmetric; the seta is sometimes orange, but is usually red or brownish. It is more common than the preceding, especially northwards. It grows in more moist places of the same general nature, being especially fond of moist banks of recently disturbed soil, which as yet have not become occupied with other vegetation. The young sporophytes sometimes bend over towards the light until they are parallel with the incident solar rays, so that the young green capsules with their abundant assimilative tissue are equally illuminated on all sides. Such plants remind one very strongly of house plants in a window. Its spores mature in autumn. This is a most variable species in pretty nearly every character, but I have never been able to find the upper leaf-cells so short as figured by Schimper; they are usually nearly twice as long as broad.

D. tortile, var. váginans (Sulliv.). The two forms illustrated by Schimper and Sullivant are so different that they seem very distinct, but a comparison of a large series of specimens shows that all the distinguishing characters are immensely variable. The variety in general has much larger and more sheathing perichætial leaves with short entire apices and the leaves are more spreading and more entire, and the color of sporophyte darker and the capsule more inclined to wrinkle when dry; indeed it may easily be mistaken for small forms of *Ceratodon* at first glance except for the difference in the time of maturing the spores. Occasionally, however, there are light-colored forms that have the other characteristics of the variety. The costa in *D. tortile* is often as stout as in the variety, although it is not indicated in the figures referred to above. The variety is similar in habit and habitat to the species and matures its spores at the same time. From my observations I am inclined to think they may frequently be found together.

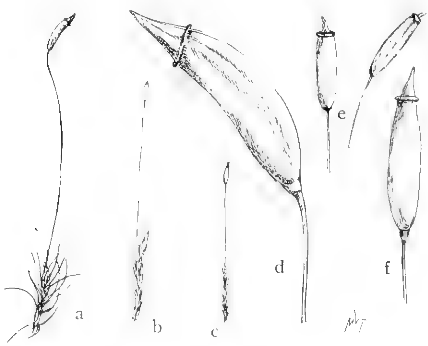


FIGURE 33

a, *b*, and *c*. *Ditrichum pallidum*, *D. tortile* var. *vaginans* and *tortile*, respectively, × 2. *d*. Capsule of *D. pallidum*, × 20. *e*. Capsules of *D. tortile* var. *vaginans*, × 10. *f*. Capsule of *D. tortile*, × 20.

SWÁRTZIA Ehrh.

Plants slender in dense silky tufts. Leaves subulate; subula papillose underneath, sheathing at base, distichous. Except for the distichous leaves much like the last. The generic name *Distichum* had been previously used for the flowering plants.

S. montàna (Lamk.) Lindb. (*Distichum capillaceum*, B. and S.), in dense silky glossy tufts, bright or dark green, stems very slender. 1 to 6 inches high; leaves abruptly spreading from a sheathing base, the spreading portion being somewhat papillose: paroicous; antheridia in the axils of the upper leaves; spores maturing in early summer. Not rare in fissures in rocks in cold and subalpine places. Dixon states that the distichous arrangement of the leaves is not very obvious in the elongated forms with distant leaves. An exceedingly pretty and interesting plant.

SUBFAMILY 3 SELIGERIEÆ

Plants minute, scarcely branched; leaves narrowly lanceolate subulate, without distinct

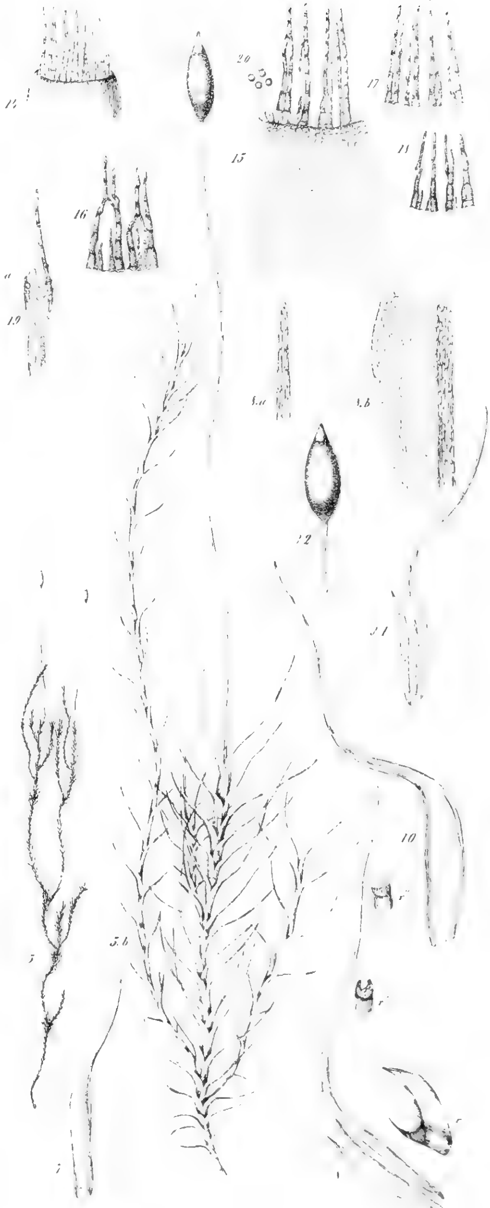


FIG. 34. (Bry. Eur.) *Swartzia montana*

The plant figured in 5 is more elongated than usual. 15 to 18. Different forms of peristome. 19. Shows a sectional view of capsule wall and peristome, with annulus at *a*. $\beta 1$ and $\beta 2$ represent the leaf and capsule of a variety.

alar cells in our species; capsule erect or nearly so; peristome of sixteen short teeth, cleft or perforated or nearly entire. Our species belonging to this subfamily are very minute plants of alpine summits or cool ravines and are so rare that no species have been treated here. We have the genera *Brachyodus*, confine to Tuckerman's ravine, Mt. Washington, and of several species of *Seligeria*.

SUBFAMILY 4. ONCOPHOREÆ

Leaves chlorophyllose, opaque, usually papillose, without distinct angular cells, the upper minute, quadrate. Capsule on a long seta, oblong or subcylindric, usually unsymmetric and inclined, usually striate and frequently strumose. The distinguishing characteristic of this subfamily is the small and rounded or quadrate often papillose cells of the upper leaf, and this character indicates a very close relationship to the *Tortulaceæ*, which is also shown in the peristomes of *Sælania* and *Ceratodon*.

FIGURE 35

Capsule × 13, leaf × 10, leaf and cells × 200 of *Oncophorus Wahlenbergii*

KEY TO THE GENERA

1.	Leaf-cells papillose; capsule not strumose	2.
	Leaf-cells smooth (except faintly so in some specimens of *Ceratodon*)	3.
2.	Peristome small, teeth narrow and undivided	*Rhabdoweisia*.
	Peristome teeth dicranoid, i. e., bifid half way (except one rare species); capsule furrowed when dry	*Oncophorus*.
	Peristome dicranoid; capsule not furrowed	*Dichodontium*.
3.	Capsules strumose; peristome dicranoid	*Oncophorus*.
	Capsules erect and symmetric; peristome teeth undivided	*Rhabdoweisia*.
	Capsules erect and symmetric; peristome teeth like those of *Ditrichum*	*Sælania*.
	Capsule unsymmetric and inclined, furrowed when dry; teeth cleft into thirty-two filiform segments	*Ceratodon*.

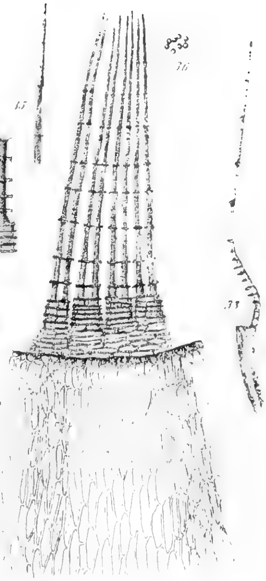
The species of *Rhabdoweisia* are rare and alpine or subalpine, growing in crevices of rocks. The *Dichodontia* are also rare and inhabitants of rocks and soil in and near beds of streams in cool situations.

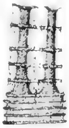
ONCÓPHORUS Brid. (*Cynodontium* Schimper)

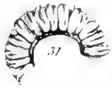
Cynodontium was at first applied to *Swartzia*. The species of this genus are as a rule alpine or subalpine, but one of the number, *O. Wahlenbérgii* Brid., is frequent enough to warrant mention here. This is a pretty little moss growing on rocks and soil in cool situations in or near the mountains. Its crisped spreading leaves with their suddenly dilated bases and the arcuate, smooth or irregularly-wrinkled, plainly strumose capsule render it easy of recognition by one who has ever seen it before.

CERÁTODON Brid.

C. purpùreus (L.) Brid., our only species, is one of the commonest of all our mosses. It is found on the edges of paths, roofs of old buildings, sand by the seashore, and in general any barren compact soil is its favorite habitat. The plants are short and grow close together, forming dense thin mats of dark green. The lance-like young sporophytes appear early in spring as soon as the snow is melted. By the middle of the summer the capsules often decay beyond recognition and the seta breaks from the plant at the touch.







Unless one has become very familiar with *Ceratodon* it is not always easy to recognize it without mature capsules.

The leaves may be entire or slightly denticulate at apex, and the costa is sometimes percurrent or even excurrent. The upper leaf-cells are sometimes slightly papillose on the under side. The stems sometimes become seven or eight centimeters long in shaded places.

FIGURE 36

Ceratodon purpureus × 2. Leaves, calyptra, and capsule × 10

When the capsules have fully matured they shrink when dry and become furrowed. This peculiar furrowing and the dark rich color of the capsules, a color called purple by the older botanists but which is really a very dark chestnut or red-brown, make it easy to recognize. The peristome is

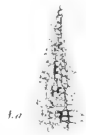


FIGURE 37

Annulus, peristome, and leaf-base and apex of *Ceratodon purpureus*.

one of the most beautiful of microscopic objects and is an inspiration in itself.

Aulacomnium palustre has a capsule furrowed in a similar manner, but it is easily distinguished by the characters noted under the description of that genus.

"There is a peculiar facies of the leaves when viewed under the microscope, which, allowing for a certain amount of variation in form and size of both leaf and areolation, is directly recognized after little practice; the margin recurved to just below the apex, then plane and toothed, is one of the most distinct and common features; when moist the leaves usually have a shiny appearance; this, taken in conjunction with their channelled surface and gradually acute outline, will serve for identification in the field."—DIXON.

SÆLÁNIA Lindb.

Formerly put with *Ditrichum* but distinct in its minute quadrate leaf-cells, which indicate its position in this subfamily. The leaves are not papillose but are covered on the back *with a cellular granulose "bloom,"* which gives the plants a glaucous appearance quite unique in the mosses. The sporophyte is relatively much shorter than in any of our species of *Ditrichum*. The stems are also longer, reaching a height of nearly two and one-half centimeters.

S. cæsia Lindb. (*Leptotrichum glaucescens* Hampe.). The only species. In dense glaucous green tufts, discolored below; antheridial buds on short branches below the perichætium; capsule erect, plicate when dry and empty; spores maturing in late summer or early autumn. A rather rare moss of cool elevated situations. Growing on soil on banks and in crevices of rocks.

SUBFAMILY 5. TREMATODONTEÆ

Plants small, cæspitose. Leaves lanceolate-subulate, without distinct angular cells. Capsules with a long inflated neck which is sometimes longer than the capsule itself. Capsule cernuous; peristome of 16 teeth which are perforate or cleft.

FIGURE 38
Trematodon ambiguus × 1, and capsule × 5

TREMÁTODON Mx.

T. ambíguus (Hedw.) Hornsch. (The Long-necked Moss) is so odd in appearance that it will need little description. It is not common, but will be met with occasionally in rather dry soil in copses and old fields where the grass is thin. Besides the long neck, the bright yellow setæ, closely resembling those of *Ditrichum pallidum*, are an additional aid in identification. The capsules mature in summer.

T. longicóllis Mx. is easily distinguished by its much longer neck, *twice the length of the rest of the capsule*, which is more cylindric than in *T. ambiguus*. Moist clayey or sandy soil in the southern part of our range and southwards.

SUBFAMILY 6. DICRANELLEÆ

Plants small, like miniature *Dicrana*, scarcely branched. Leaves smooth, lanceolate-subulate, without specialized angular cells. Capsule short, erect or inclined, frequently striate; lid beaked; peristome dicranoid, of 16 teeth, cleft to the middle into two filiform divisions.

DICRANÉLLA Schimp.

Small mosses resembling *Dicranum* in miniature, but without the enlarged angular cells. The general characters of the genus are those of the subfamily to which it belongs. The small size and narrow silky leaves, narrowed gradually or abruptly from a broader base to channeled subulate apex, render the genus easy of recognition, especially if the dicranoid capsule be present. The capsules present variations similar to those of *Dicranum*, but capsules that remain erect and symmetric when dry and empty are rare. Our species are all dioicous. Dr. Braithwaite has divided *Dicranella* into two genera, *Dicranella* and *Anisothecium*, but the distinctions are slight and they will certainly be recognized and studied much more readily by the amateur if treated as one genus.

KEY

1.	Seta yellowish, sometimes becoming dark with age	2.
	Seta red	3.
2.	Capsule oblong, tapering at the neck, sulcate, mouth incurved when dry .	*heteromalla.*
	Capsule oblong, tapering at the neck, scarcely plicate, mouth erect when dry.	*heteromalla Fitzgeraldii*
	Capsule gibbous, strumose at neck, smooth when dry	*cerviculata.*
3.	Leaves entire	4.
	Leaves serrate or denticulate	5.
4.	Leaves secund; capsule striate when dry; operculum nearly as long as urn; annulus present	*secunda.*
	Leaves scarcely secund; capsule smooth when dry; operculum ½ length of urn; annulus lacking	*varia.*
5.	Leaves subsquarrose, from a sheathing base	*Schreberi.*
	Leaves secund or erect, pellucid by reason of very large thin-walled cells.	*rufescens.*

D. heteromálla (L.) Schimp. Our only common species; found on shaded, sandy banks throughout our range. The plants are simple or forked, 1^{cm} to

PLATE XI

5^{cm} in height, and grow in dense tufts or sheets of various shades of green from bright yellowish to dark. The leaves are falcate-secund, gradually narrowed from the base so that the lower portion of the leaf has a triangular form; upper part subulate, channelled, somewhat denticulate from the middle upwards; costa percurrent or excurrent; basal leaf-cells 2 to 5 times as long as broad, rectangular. Seta *yellow*, becoming darker with age; capsule oblong to oblong-ovoid, suberect, typically slightly curved, brown when dry and empty, and furrowed and *constricted below* the mouth *with the mouth oblique in a very characteristic manner;* operculum rostrate, oblique.

The obliquity of the mouth and the deepness of the furrows in the capsule walls seem to be progressive with age. The capsules mature in November and December, but do not as a rule appear to assume their characteristic pose until spring. This fact accounts for some of the discrepancies in descriptions, especially of the varieties, although the species as a whole is exceedingly variable.

The variety **orthocárpa** (Hedw.) E. G. B. is a form with erect straight capsules and, as far as I am able to determine, is an inhabitant of elevated inland regions. The capsules, however, appear to become curved and furrowed with age.

Var. **Fitzgeráldii** (R. and C.). I cannot agree with Mrs. Britton in making this a synonym of var. *orthocarpa*, as it appears to be a southern and seaboard form, being very abundant about New York city. The capsules are only lightly striate until very old, and the mouth is slightly or not at all oblique. It has been found along Lake Champlain and may occur near the Great Lakes.

FIGURE 39

Dicranella heteromalla Fitzgeraldii. *b.* Capsule of the same × 10. *c.* Capsules of different ages.

The var. **stricta** Schimp. has straight, open-erect leaves.

The var. **interrúpta** (Hedw.) B. and S. is a large form, more branched and with the leaves sometimes in interrupted tufts.

In the Bulletin of the Torrey Botanical Club for November, 1895, Mrs. Britton describes and figures a very interesting mountain form with strongly recurved pedicels which straighten in drying so as to assume the normal form.

EXPLANATION OF PLATE XI. *Dicranella heteromalla* (L.) Schimp. (Bry. Eur

Figs. 1 and 2. Plants natural size. Figs. 3 and 3*b*. Antheridial plants. Figs. 7, 8, and 9. Perigonial leaves. Figs. 11 and 12. Perichætial leaves. The other figures are self-explanatory. Fig. *S*1 Var. *stricta* Schimp. Fig. *I*1. Var. *interrupta* (Hedw.) B. and S.

She is of the opinion that this is what has passed as *D. curvata* in the L. and J. Manual, for she has been unable to find an American specimen of that species.

D. cerviculàta (Hedw.) Schimp. grows in wet places, typically on peat. It appears to be rare. The plants are smaller in every way than the last, the leaves *are less falcate, with a half-sheathing base, often nearly entire,* leaf-cells 6 to 10 times as long as broad at the base; *capsule arcuate and gibbous, with a clearly strumose neck.* The spores mature in summer, according to European authors.

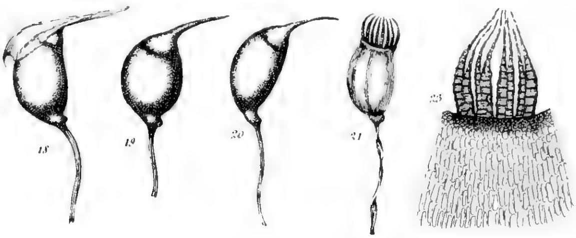


FIGURE 40

Capsules and peristome of *D. cerviculata.* (From Bry. Eur.)

Var. **Americàna** n. var. I propose this name for a form from "Wet soil about iron deposit," Katahdin Iron Works, Maine, Nov. 5, 1898. Coll. E. D. Merrill. The neck of the capsule is slightly swollen, scarcely strumose, and the spores do not mature until late autumn. Type in the herbarium of A. J. Grout.

D. ruféscens (Dicks.) Schimp. The *smallest of our species, less than* 1^{cm} *high and very slender.* Plants usually simple, yellowish green or reddish green, turning *more strongly reddish in drying;* leaves small, *pellucid by reason of the large thin-walled cells,* linear-lanceolate, gradually narrowed; costa percurrent but not excurrent; *margin plane,* denticulate above; capsule erect or inclined, *symmetric,* oval, small, urn about $\frac{2}{3}^{mm}$ long; *seta and capsule dark red,* seta *twisted to the left;* operculum short-rostrate to apiculate; spores maturing in summer. Not infrequent on bare moist earth, especially on clayey soil.

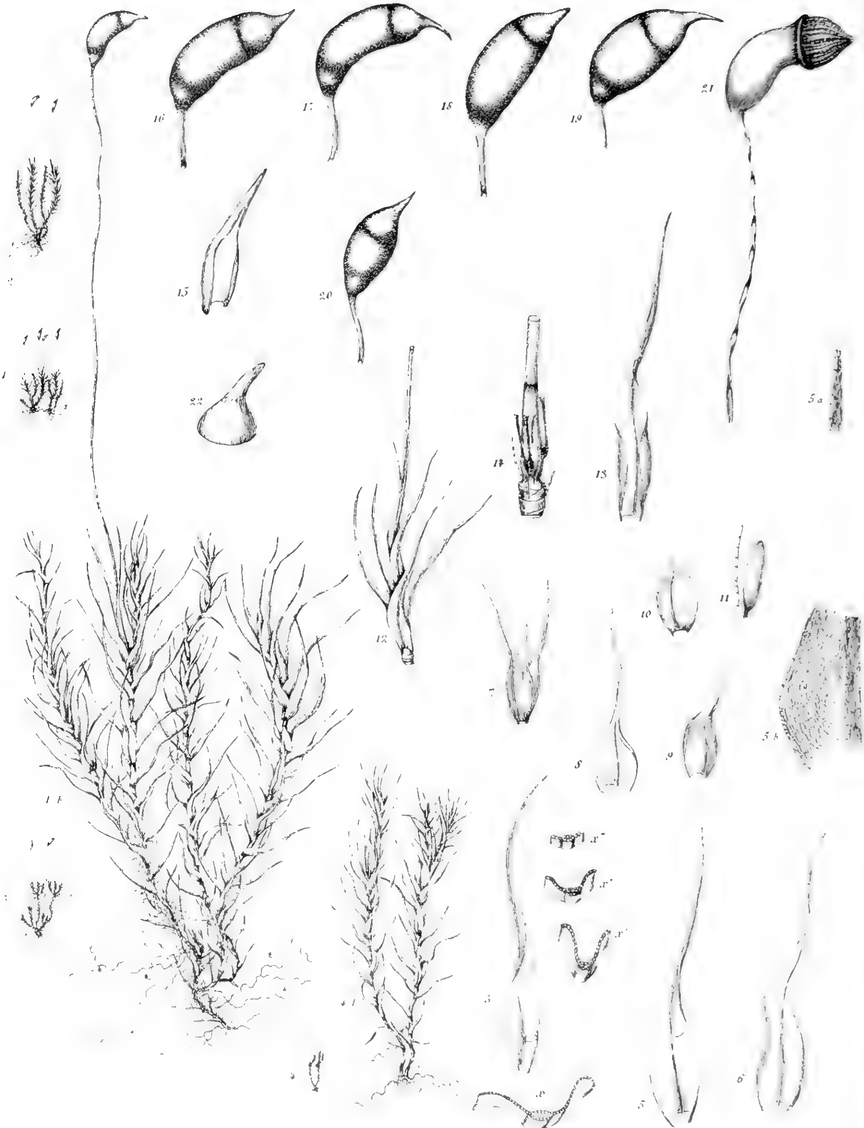
The seta of *D. heteromalla* and its varieties is twisted to the left and sometimes becomes very dark, so that forms of var. *Fitzgeraldii* may be mistaken for *D. rufescens* unless one has specimens for comparison. But *rufescens* is very much smaller and more slender, and the leaf-cells are so large and pellucid as to strike one's attention at once.

D. vària (Hedw.) Schimp. is a somewhat similar species with a similar habit, but rather less frequent. It is larger, bright or yellowish green, not *reddish,* with short, usually *branching stems;* the leaves are entire with margins *narrowly*

EXPLANATION OF PLATE XII. *Dicranella rufescens* (From Bry. Eur.)

Figs. 1 and 2. Plants natural size. Figs. 4 and 4*b*. Antheridial plants. Figs. 8 and 9. Perigonial leaves. Figs. 10 and 11. Perichætial leaves.

PLATE XII



varium

PLATE XIII

revolute; the capsule is larger and *curved*, the seta *twisted to the right;* spores maturing in autumn and winter.

The other species of *Dicranella* included in the key are alpine or subalpine forms which will rarely be met with. *D. secunda* (Swtz.) Lindb.=*D. subulata* (Hedw.) Schimp.

SUBFAMILY 7. DICRANEÆ

Common plants, large and often somewhat branched; some of the rarer species are small. Leaves narrowly lanceolate, often falcate-secund; *cells at the angles enlarged, often inflated, hyaline* or *colored.* Operculum usually long-beaked.

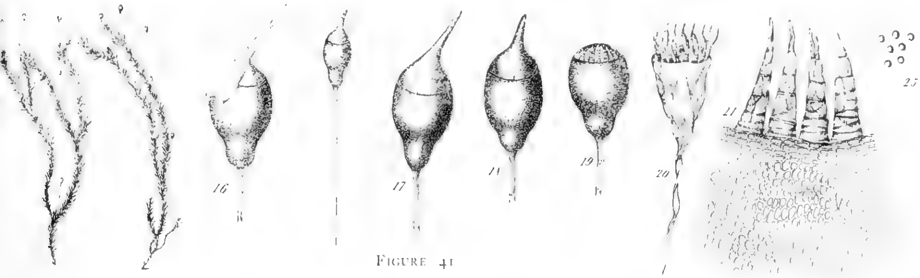
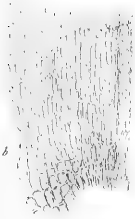


FIGURE 41

Blindia acuta Plants, capsules, peristome, leaf-apex and base. (From Bry. Eur.)



Peristome typically of 16 solid colored teeth cleft to the middle. There are several variations from this type in the matter of the division of the teeth.

Blíndia acùta (Huds.) B. and S. is a rare species of mountain rocks with capsules like those of *Seligeria*, but with longer stems and with the enlarged angular cells of this subfamily.

Blindia acuta may be confused with *Dicranum fulvellum*, from which it differs in the shorter scarcely secund leaves, with almost entire apices, more rigid aspect and longer setæ.

Campylopus is a genus of southern range which may be found along our southern borders. It is like *Dicranum*, except that the leaves are more rigid and less flexuous, generally straight; the seta curved and the capsules small, elliptic and symmetric.

EXPLANATION OF PLATE XIII. *Dicranella varia* (From Bry. Eur.)

Figs. 1 to 4. Plants natural size. Figs. 7 to 10. Perigonial leaves. The other figures are self-explanatory.

Dicranodóntium longiróstre (W. and M.) B. and S., which is not rare on rocks in the Alleghanies but is infrequent elsewhere, has the habit of a *Campylopus* but has the peristome teeth cleft nearly to the base into two filiform segments. (See *Dicranum longifolium*.)

DICRÀNUM Hedw.

Leaves smooth (papillose in *spurium*, *montanum* and occasionally in *pallidum*); lower cells rectangular, *angular conspicuously dilated*. Capsules on a straight erect seta, erect or inclined; teeth red, cleft half-way into two or occasionally three segments, vertically striate below with fine lines. (See Plate XV.)

The *Dicrana* of our region are one of the most common and beautiful elements in woodland scenery. They are, for the most part, bright yellow-green and grow in wide thick tufts or mats. The leaves are frequently more or less secund, as though the wind had blown them all in one direction. They are common on the ground, stones, rotten wood, and sometimes they occur on the base and trunks of trees. Most *Dicrana* mature their spores in autumn, but more observations are needed to give exact dates for each species.

KEY

1.	Capsule cernuous, more or less arcuate	2.
	Capsule erect, symmetric	14.
2.	Upper leaf-cells longer than broad, porose	3.
	Upper leaf-cells not porose, nearly as broad as long	5.
3.	Capsules clustered, leaves strongly transversely undulate, silky	*undulatum.*
	Capsules solitary	4.
4.	Leaves transversely undulate when moist, slightly or not at all secund, costa without lamellæ at back	*Bonjeani.*
	Leaves not at all undulate, secund, with strongly serrate lamellæ at back	*scoparium.*
5.	Leaves strongly papillose at back, little or not at all secund	*spurium.*
	Leaves not noticeably papillose (sometimes papillose in *pallidum*)	6.
6.	Capsules clustered	*Drummondii.*
	Capsules solitary (rarely two together in *Mühlenbeckii*)	7.
7.	Costa not reaching apex	*Bergeri.*
	Costa percurrent or excurrent	8.
8.	Lower leaf-cells more or less porose; capsules not strumose (except slightly so in *D. pallidum*)	9.
	Leaf-cells not at all porose; capsules strumose	12.
9.	Leaves entire or very faintly denticulate	*elongatum.*
	Leaves serrulate	10.
10.	Leaves strongly falcate-secund and crispate; costa $\frac{1}{5}$ to $\frac{2}{3}$ of the width of the leaf at base and forming all of the apex; upper leaf-cells regular	*fuscescens.*
	Leaves little or not at all secund; upper leaf-cells very irregular	11.
11.	Costa at least $\frac{1}{6}$ width of leaf at the broadest point of the leaf. Plant 3^{cm} to 6^{cm} high.	*Mühlenbeckii.*
	Costa $\frac{1}{10}$ width of leaf; plants 2^{cm} to 3^{cm} high	*pallidum.*

PLATE XIV. *Dicranodontium longirostre* (From Bry. Eur.)
Fig. 5. Lowest stem-leaf. Figs. 6, 7, and 8. Median and upper leaves. Fig. 13. Perichætial leaf.

12. Leaves falcate-secund . . . . 13.
    Leaves spreading . . . . *schisti.*
13. Leaves with distinct angular cells; capsule oblong-cylindric . . . . *Starkei.*
    Leaves with few angular cells; capsule short, obovate . . . . *falcatum.*
14. Costa ending in the serrulate apex; leaves crisped when dry . . . . 15.
    Costa excurrent; leaves scarcely altered by drying (except *D. fulvellum* and *D. fulvum*) . . . . 16.
15. Apex of leaf papillose at back; upper leaf-cells rectangular . . . . *montanum.*
    Apex of leaf not papillose; upper leaf-cells less regular; plants commonly giving off numerous axillary erect flagella bearing minute ecostate leaves . . . . . *flagellare.*
16. Costa narrow, $\frac{1}{5}$ to $\frac{1}{4}$ width of leaf at base . . . . 17.
    Costa broader, $\frac{1}{3}$ to $\frac{1}{2}$ width of leaf . . . . 18.
17. Dioicous; 3^{cm} to 4^{cm} or more high . . . . *Sauteri.*
    Autoicous; 0.5^{cm} to 2^{cm} high . . . . *fulvellum.*
18. Margin and costa of leaves entire; apex usually broken . . . . *viride.*
    Margin and costa of leaves serrulate . . . . 19.
19. Costa equaling $\frac{1}{3}$ width of leaf at the base, or less; leaves gradually narrowed to apex; all upper surface leaf-cells rectangular . . . . *fulvum.*
    Costa $\frac{1}{2}$ width of base of leaf, or more; leaves abruptly narrowed to a long slender point; all upper leaf-cells greatly elongated-linear . . . . *longifolium.*

Of the species given in the key, *Starkei*, *schisti*, *falcatum* and *fulvellum* belong to the subgenus *Arctoa*, which seems to many to be of generic rank. They are rare alpine mosses with the capsule little exserted or more exserted and strumose. The cells of the costa in *Arctoa* are all alike (homogeneous). In the other species the costa is made up of large and small cells variously disposed. (See cross-section of costa of *D. scoparium.*) *Sauteri* and *elongatum* are true *Dicrana* but are rare alpine forms.

FIGURE 42

a. Dicranum scopàrium × 1. *a'.* Capsule × 5. *b. D. fuscescens* × 1. *b'.* Capsule and calyptra × 5.

D. scopàrium (L.) Hedw. Plants large, sometimes 10^{cm} high, glossy yellowish green to brownish green, radiculose, growing in rather large tufts of medium density; leaves falcate-secund, not undulate, strongly serrate, ending in a long narrow acumen; costa flattened, bearing 4 projecting serrate lamellæ at the back above; leaf-cells all elongated and porose, packed full of chlorophyll, in the younger leaves often containing oil-globules; capsule cernuous, arcuate-cylindric, not striate, annulus lacking; spores maturing in late summer or autumn. Common across the continent on various substrata. It is almost as widely diffused as *Polytrichum commune*, being found in all portions of the northern hemisphere, North America, Europe, Asia and Japan.

A most variable species, grading into the next so that some sterile forms cannot with certainty be determined. A variety with striate capsules is not rare in New England, but so far as I can find it has not been given a name. The leaves may be nearly entire and very slightly undulate above, but these variations are rare.

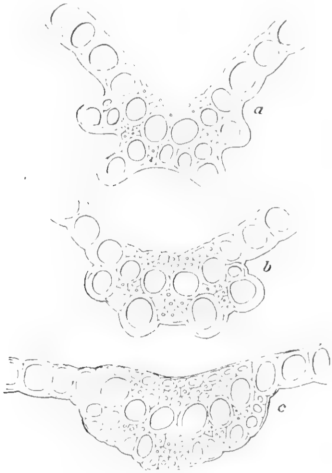


FIGURE 43

Cross sections through the costa of *Dicranum scoparium*. *a*. Near apex. *b*. Median. *c*. Near base. (After Limpricht.)

In the western part of our range one may collect *D. majus* Smith. It closely resembles *D. scoparium*, but is larger with longer and more regularly secund leaves, and has clustered setæ as in *D. undulatum*.

D. Bonjeani DeNot. (*D. palustre* LaPyl. of L. and J. Manual). Although distinct in its typical form, this species so frequently grades towards and into *D. scoparium* that the amateur is almost sure to confuse the two species. To increase the difficulty, the typical form is rarely met with, though the varieties are common. The undulations in the moist leaves, of which many authors make so much, I find utterly worthless so far as distinguishing the species is concerned, as they are so frequently barely visible even with a lens. The color is lighter than in *scoparium*, the leaves shorter, less secund and with much shorter broad apices, with the serrations on the back of the costa much less pronounced and the leaf-cells broader and shorter, especially above. The leaves are usually much more strongly serrate than is represented in the plate. Most of our American forms also have the leaves more secund; capsules usually lightly striate; spores maturing in late summer or autumn; characteristically growing in marshes in shady places.

FIGURE 44

a. Leaf × 10, leaf-cells and apex × 200 of *Dicranum Bonjeani* *b*. Same of *D. scoparium*. *c*. Same of D. *fuscescens*

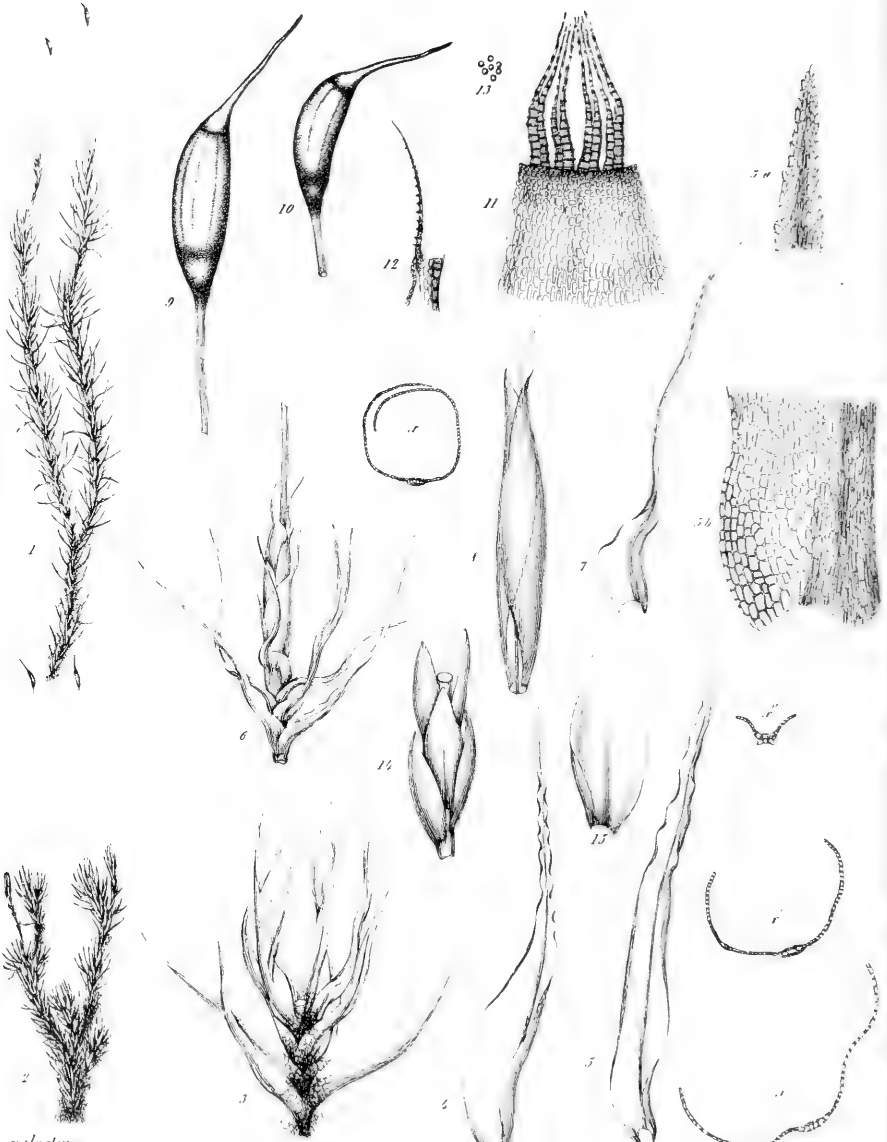


PLATE XV. *Dicranum Bonjeani* (From Bry. Eur.)

Figs. 6 to 8. Perichætial leaves. Figs. 14 and 15. Leaves of the flagellate shoots of the var. *polycladon*

Like Mr. Dixon, I have collected this species on a rotting roof (the shingled roof of an old mill in Williamsville, Vt.), and the specimens I collected here were the most typical of any of my collections.

D. fuscéscens Turn. is a smaller plant yet frequently larger than is indicated in the figure, yellowish green, tomentose; leaves narrower, not only secund but plainly crisped when dry; costa forming $\frac{1}{5}$ to $\frac{2}{5}$ width of base, often excurrent into a more or less strongly serrate point; margin usually strongly dentate, but sometimes nearly entire; alar cells very distinct, other basal cells 3 to 8 times as long as broad, porose, the upper almost regularly quadrate or rectangular, and sparingly or not at all porose; capsule striate, sulcate when dry and empty, annulus present; spores maturing in autumn. On decayed wood, more rarely on soil and bases of trees in moist, cool woods. I rarely find it below 1,000 feet altitude. It is like a small form of *scoparium*, but its crispate leaves with quadrate upper cells and its uniformly striate capsules make it easy of recognition. (See Fig. 42.)

D. Mühlenbéckii B. and S. is a fine large species 2^{cm} to 6^{cm} high, growing in dense, radiculose cushions, green above, brownish ferruginous below; leaves usually *equally spreading, crisped when dry*, lanceolate-subulate, concave or subtubulose above, twisted to the left when dry, denticulate above; costa stout; excurrent, slightly roughened on the back by projecting cells; alar cells in two or three layers differing more in color than in size; cells next above rectangular 1:4 to 1:8 somewhat porose; median cells rectangular 1:2; above angular but *irregular*, quadrate, three-cornered, rhomboidal, etc., much as in *pallidum;* capsule arcuate-cylindric, usually lightly striate, scarcely cernuous; annulus present. Spores maturing in late summer and autumn.

The size of this species might cause it to be confused with *D. scoparium*, from which it may be distinguished by the dense tufts, long densely radiculose stems, and crispate not secund leaves. Under the microscope the short angular non-porose upper cells and nearly smooth costa will differentiate it at once.

From *D. fuscescens* it differs in its much greater size, densely radiculose tufts, more erect capsules and equally spreading leaves. The upper leaf-cells, while resembling those of *fuscescens*, differ in being irregular in shape.

The costa is much stouter than in either *D. scoparium* or *D. fuscescens.* In rocky places, usually in elevated regions, rather rare, more abundant westward.

D. spùrium (Hedw). Robust, 2^{cm} to 4^{cm} in height, sometimes more, yellow-green, loosely tufted; leaves loosely and equally spreading, *very strongly rugose*, subtubulose above, bent inward with crispate points when dry, *broader than in any of our other species, broadly ovate at base*, narrowly lanceolate above, serrate above on the margin and back of costa, *strongly papillose* at back above; lower leaf-cells elongated and very thick-walled, porose; upper cells as broad as long,

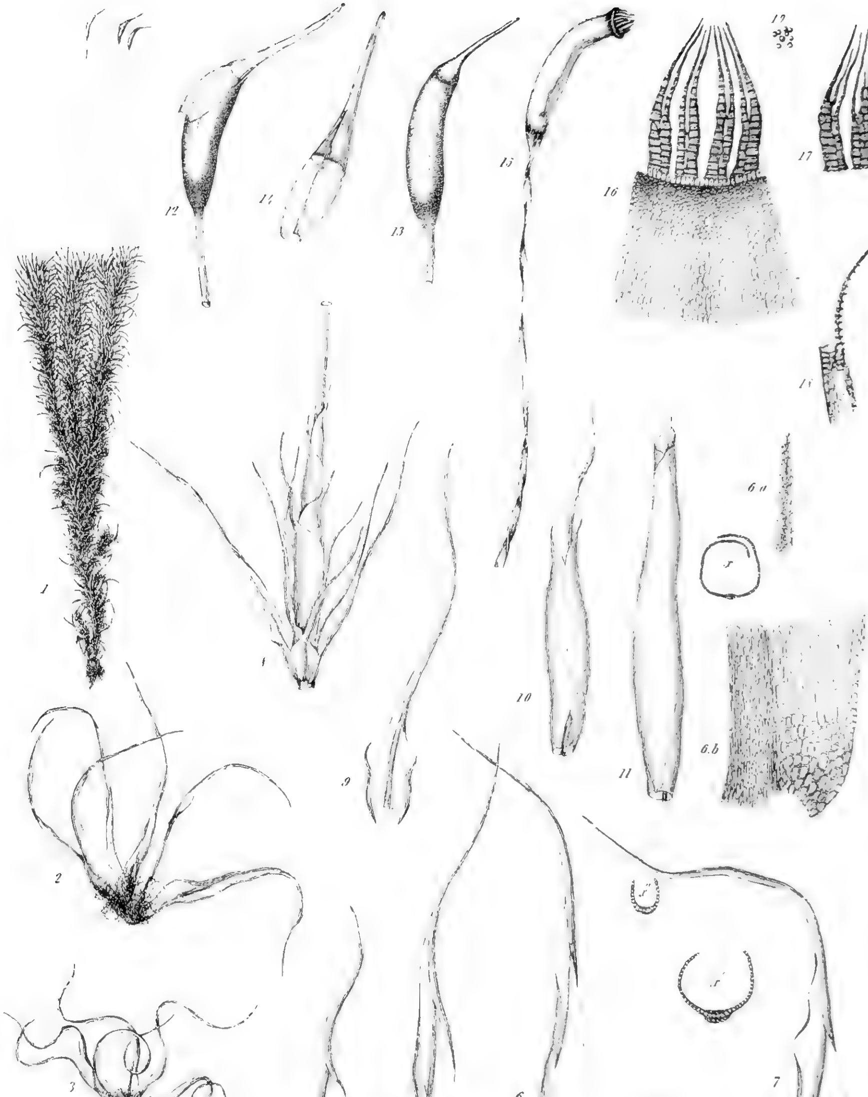


PLATE XVI. *Dicranum Mühlenbeckii* (From Bry. Eur.)

angular, irregular, of various shapes; alar cells very strongly differentiated, inflated and colored, in two or three layers; *seta yellow*, rather slender; capsule arcuate, cernuous, irregularly sulcate when dry and empty; annulus present; spores maturing in spring.

In rather dry rocky places on sandstone or limestone, apparently infrequent. Easily recognized by the very broad, strongly rugose leaves which give the plant, when dry, the appearance of a light yellow *Mnium*. The small-sized yellow sporophyte is also very characteristic; under the microscope the marked leaf characters make it one of the easiest species to recognize.

FIGURE 45

a. Dicranum spurium, slightly magnified. *d*. Leaf of same × 10; leaf cells × 200; costa not shown at apex. *e*. Portion of leaf of same showing papillæ at back × 100. *b*. *D. pallidum*. *c* and *c'*. Broad and narrow leaves of same; leaf-cells × 200.

The habitat, as well as the time of maturing spores, seems to differ in Britain from that in continental Europe or America. Braithwaite and Dixon say August; Limpricht says May, which seems to agree better with my observations.

Our American plant seems to have broader leaves than is represented in the works on European mosses.

D. pallidum B. and S. (*D. spurium condensatum* of L. and J. Manual) is like a reduced form of *D. spurium*, 2^{cm} to 3^{cm} high, *growing in dense radiculose tufts in sandy places, especially in the pine barrens of the Atlantic coast.* It has been collected in Wisconsin by True, and in Massachusetts by Miss Cora H. Clarke. The leaves are *elongated lanceolate, long and narrowly acuminate*, smooth or slightly papillose on the back above; costa slightly roughened at back, capsule slightly strumose; spores maturing in spring.

The difference between this and the last is hard to indicate in a description. The smaller size, more compact tufts, ferruginous below, narrower leaves smoother at back, are the most evident distinctions. Specimens and descriptions lead me to believe that the European *spurium* is intermediate between our *spurium* and *pallidum*. The compact tufts may lead the beginner to confuse this species with *D. Mühlenbeckii*, but the difference in size and the more strongly porose cell-walls in this species will usually be sufficient to identify it.

D. undulàtum Ehrh. Very robust, 7^{cm} to 25^{cm} high, often decumbent at base; growing in loose wide tufts, densely radiculose, bright glossy yellow-green; *leaves undulate, with a silky luster*, very long, lanceolate, gradually narrowed, scarcely secund, margin recurved below for $\frac{1}{3}$ to $\frac{1}{2}$ the length of the leaf, above this strongly serrate to apex; costa comparatively narrow, with *two strongly serrate lamellæ on the back above;* alar cells distinctly marked, other cells elongated and porose throughout; *capsules clustered* (several setæ from the same perichætium); setæ long, reddish; capsule cernuous and arcuate, striate when empty; spores maturing in late summer.

FIGURE 46

a. Dicranum undulatum × 1. *a′.* Leaf × 8. *b. D. Drummondii* × 1. *b′.* Leaf × 8. *c. D. flagellare* × 2. *c′.* Leaf × 10. *d. Flagella* × 10. *e. D. fulvum* × 2. *e′.* Leaf and capsule × 10.

Our largest and most beautiful species, common in shaded places on soil and stones covered with humus, but not fruiting freely. The only species with which it could possibly be confused is the next.

D. Drummóndii Muell. is most likely to be mistaken for *D. undulatum*, but it is rather smaller and less glossy; its leaves are less undulate and are secund and *strongly crisped*, not recurved at base below; *leaf-cells not porose;* the upper quadrate; capsules clustered; spores maturing in summer. Growing on decayed wood in forests in elevated regions, not common.

D. flagellàre Hedw. In dense tufts 2^{cm} to 5^{cm} high, green or yellowish green, radiculose, frequently producing numerous *axillary erect straight flagella* with *minute ecostate* leaves. Leaves gradually narrowed from an oblong base to the linear tubular upper portion; subsecund, crisped when dry, denticulate near the apex; costa narrow, $\frac{1}{5}$ to $\frac{1}{8}$ width of base, not excurrent, entire or slightly denticulate on the back near the apex; angular cells very distinct, reaching almost to the costa; cells next above these loosely rectangular, becoming nearly quadrate above, not porose or papillose; *capsule erect, cylindric*, sometimes slightly curved, striate when dry and empty; spores maturing in summer.

On decaying wood and peaty banks in moist shady places everywhere.

This moss is one of our most common species and by reason of its crisped leaves and narrow costa is not likely to be confused with any but the next. The flagella are very characteristic when present. (See Fig. 46.)

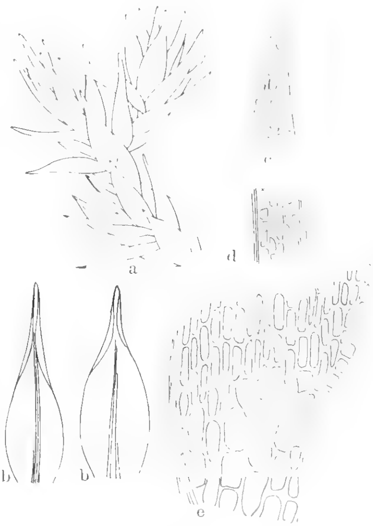


FIGURE 47

a. Dicranum flagellare minutissimum × 10. *b.* Leaves × 30. *c, d, e.* Leaf-cells from apex, middle and base respectively × 200.

D. flagellare var. minutissimum n. var. On rather dry peaty banks and on stems of bushes in the edges of swamps on Long Island, I find a *Dicranum* with short ovate-lanceolate broad-pointed leaves, which I think must be a derivative of *D. flagellare*, but so distinct as to deserve a name. The forms on stems of bushes are nearly always sterile and are seldom over 5^{mm} in height, forming a dense fur-like covering near the base of the stems of bushes. For this form I propose the above name.

D. montànum Hedw. This species is exceedingly like *D. flagellare* in appearance and shape of leaves, but the leaves are much more strongly crisped when dry, rather shorter and smaller, less tubular, more strongly serrate above and *plainly papillose* on the back above; spores maturing in summer.

On decaying wood in forests of the northern part of our range. In the field I have had my attention called to it because it was lighter colored than *D. flagellare*, but I cannot say whether or not this distinction always holds good.

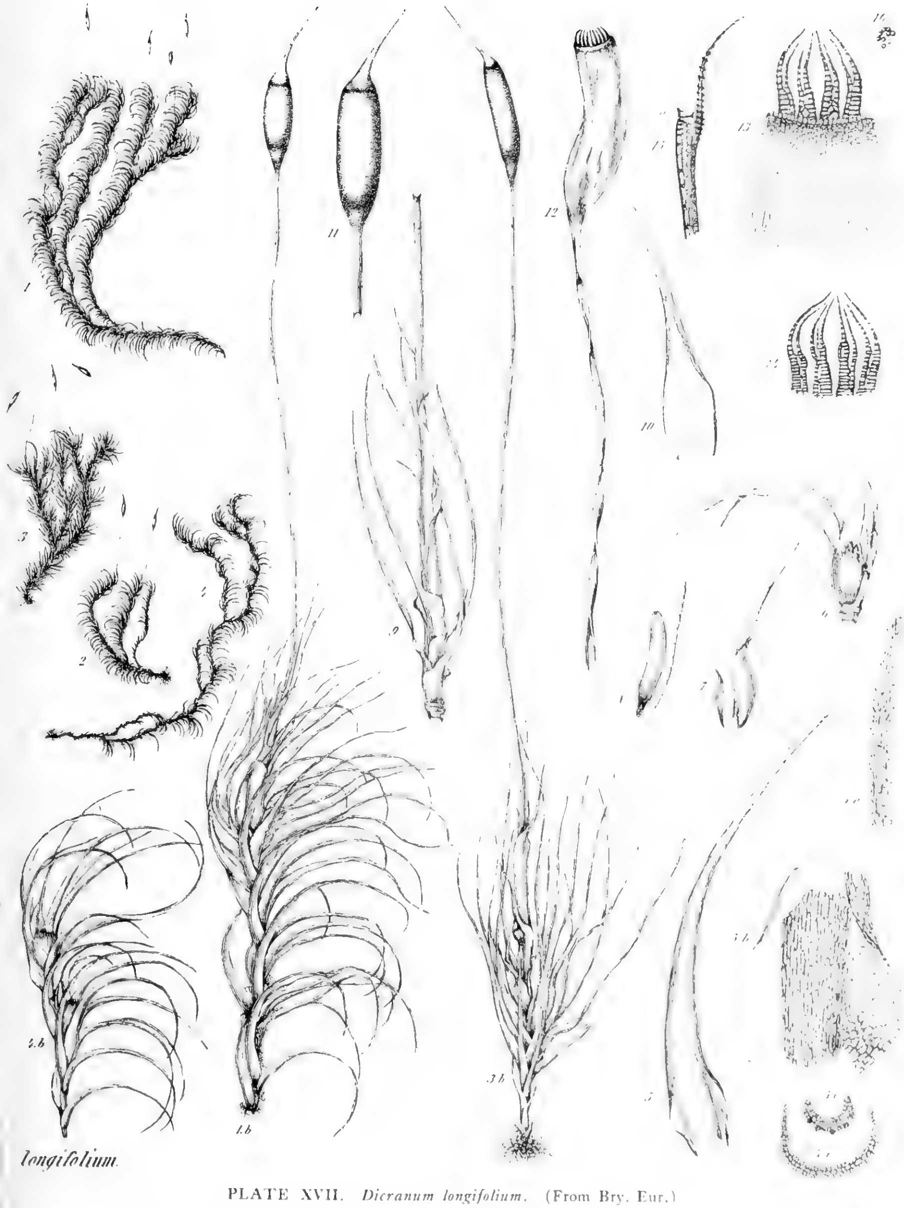
D. fúlvum Hook. This is the only other common *Dicranum* with erect capsules. It is *fulvous brown* in color, *always growing on rocks;* leaves secund, somewhat crisped when dry, gradually narrowed from a lanceolate base to an almost linear apex; margin serrate in the upper $\frac{1}{5}$ to $\frac{1}{4}$, *costa at least* $\frac{1}{3}$ *the width of the leaves at base*, somewhat excurrent, toothed at back; the apices much more slenderly tubulose than in *D. flagellare;* leaf-cells rectangular (1:2) or quadrate above, even on the surface of the costa a few basal cells elongated; not at all porose; capsules cylindric, sulcate when dry and empty; annulus present; spores maturing in late summer and autumn. (See Fig. 46.)

D. longifòlium Ehrh. Growing only in rocky elevated regions, sometimes found on the base of trees as well as the surrounding rocks. Leaves very long and narrowly acuminate so that the *leaf apices look somewhat like hairs*, giving the plant a silky appearance, secund but scarcely crisped when dry; costa more than $\frac{1}{2}$ *the width of the leaf at base*, toothed on the back and sides above, leaf-cells above all elongated linear-oblong. A little above the base *the leaves are suddenly narrowed and in the upper part of the leaf nothing but costa is left for the rest of the length of the leaf;* capsule cylindric, smooth; annulus lacking; spores maturing in summer.

This species and *D. albicans*, in which there is scarcely any lamina, furnish a connecting link with *Leucobryum*.

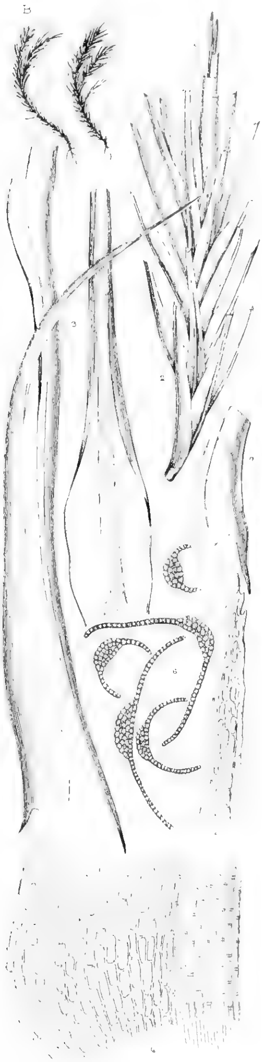
Dicranum longifolium and *Dicranodontium longirostre* have many points of resemblance and when sterile are likely to be confused, although the latter is so infrequent in most parts of our range that doubtful specimens can safely be referred to the *Dicranum*. A cross-section of the costa will settle the matter definitely, for in the *Dicranum* the costa is made up of three layers of cells of almost the same size and structure, while in *Dicranodontium* there is a single layer of larger cells in the middle with numerous small cells on either surface. The figures do not properly show the differences in the cross-section of the costa in these two species. In many cases this difference in the costa is evident in the leaves mounted flat and studied with a low power when the costa of *Dicranum longifolium* appears uniform in density for its whole breadth, while in *Dicranodontium* the costa seems to have a darker central portion near the base. The hair-like apex of *Dicranodontium* is much more slender, being hardly more than a cell or two wide at the apex and the costa is not toothed on the back until very near the extreme apex. In *Dicranum longifolium* the costa is strongly toothed on its back for nearly or quite $\frac{1}{2}$ the length of the leaf. These differences are well shown in the plates.

D. víride (S. and L.) Lindb. This species also has a very broad excurrent costa, $\frac{1}{4}$ to $\frac{1}{3}$ leaf-base. It rarely fruits and hence is not often collected, although it is apparently not rare on decaying wood and bases of trees in moist woods. Plants rather small, green or light green, in gross ap-



longifolium.

PLATE XVII. *Dicranum longifolium.* (From Bry. Eur.)



pearance reminding one of the very large *D. montanum;* leaves crisped when dry; leaf-cells rectangular below, regularly and evenly quadrate above, not porose. The most characteristic things about the species are its smooth leaves (occasionally very minutely dentate at extreme apex as shown in the figure), from which the apices are nearly always broken and sometimes tufts of protonema may be seen growing from the broken ends of leaves before they are detached.

These broken ends undoubtedly serve to reproduce the species and thus the spores are less needed for this purpose.

The plants are usually small in size (1^{cm} to 2^{cm}), but Limpricht gives them as 1^{cm} to 4^{cm}.

SUBFAMILY 8. LEUCOBRYEÆ

Mosses growing in dense, spongy, whitish or glaucous cushion-like tufts which under favorable conditions may become several feet in circumference, becoming brittle when dry; leaves lanceolate, concave, composed almost entirely of the highly developed costa. The chief difference between this subfamily and the Dicraneæ is that the leaves consist of costa only, a condition that is approached very closely in *Dicranum albicans*, a species found in western North America and in Europe. To make the resemblance more striking *D. albicans* becomes whitish when dry. Like the costa of *Dicranum* the leaves of *Leucobryum* consist of two kinds of cells, the outer large and empty, and the inner small and chlorophyllose.

FIGURE 48

Dicranum viride (From Sulliv. "Icones"). The upper right-hand figure was drawn by Miss Thayer from a specimen from Newfane, Vt. It shows the protonemal filaments growing from the end of the costa of a leaf which was still attached to the stem.

LEUCOBRỲUM

Our only genus; characters as above.

KEY

Plants large; 2^{cm} to 10^{cm} high; leaves 3^{mm} to 9^{mm} long; capsules arcuate, strumose . . . . *glaucum*.
Plants smaller; 1^{cm} to 2^{cm} high; leaves 1^{mm} to 4^{mm} long; capsules almost erect, not strumose. *albidum*.

L. glaùcum (L.) Schimp. The White Moss. Any one accustomed to walk in the woods must have noticed the grayish-white tufts of the White Moss, looking like gigantic pincushions.

This moss does not fruit freely, but by searching in moist woods the sporophyte can usually be found without a great deal of trouble. It matures from September to June.

Fig. 49 *Leucobryum glaucum* × 1.

The White Moss prefers moist or even swampy woods, but is often found in drier situations. The plants grow densely packed together, those in the center continually elongating and new plants being added around the edges of the tuft. The White Moss resembles the Peat Mosses in color, and the cushion-like tufts take up and retain water in the same sponge-like way.

Braithwaite states that this species often produces on the upper leaves of the female plants, minute tufts of "radicular tomentum" with young plants which fall off and serve to reproduce the plant, which produces spores rather infrequently. The amount of rainfall has apparently some influence on the spore production of this species, for I have noticed that it produces spores with unusual abundance after an especially wet summer.

L. albídum (Brid.) Lindb. (*L. minus* Hampe). This species (or subspecies according to Dixon) seems to be rare, as I have never met with it and Mrs. Britton in her article in the "Observer," for October, 1894, states that there were very few authentic American specimens in the Columbia herbarium. Small size alone is hardly enough for a specific distinction. Sterile specimens should not be referred to this species except by experts.

Family 8. Grimmiaceae

Plants growing upon *rocks*, rarely on soil (at least in our species), blackish-green when dry, almost black below. The young freshly moistened tips of the stems and branches are the only portions that are chlorophyll green. The plants grow in thin mats or more frequently in dense tufts or cushions.

The stems of fruiting plants commonly branch by innovations below the apex. The leaves are often hyaline tipped, giving the plants a hoary appearance, but the hyaline tip consists of the whole apex of the leaf. Leaves usually lanceolate to ovate-lanceolate, with small thick-walled cells, often in several layers in the upper portion. In *Rhacomitrium* the lower leaf-cells are longer, being usually linear, with strongly sinuose walls. The costa is present and is well developed in all the species except *Hedwigia*. The capsules are usually symmetric, ovoid to cylindric, frequently immersed or emergent. The seta is short even in species with exserted capsules, sometimes arcuate, though rarely so in our species. Calyptra mitriform or cucullate, sometimes papillose, smooth or plicate. Peristome single, often papillose, entirely lacking in *Hedwigia;* teeth entire, cribrose or cleft, often resembling those of *Dicranum*, but entirely lacking the vertical striæ characteristic of that genus.

The *Orthotrichaceæ* are usually included in this family, but I entirely agree with Mr. Dixon that the differences in peristome are fully sufficient to warrant the separation into two families. *Andreæa* is the only genus likely to be misplaced in this family and when sterile one might easily have difficulty in distinguishing it from the *Grimmiaceæ*, but the plants are black even at the top and much more slender than the great majority of the *Grimmiaceæ*.

KEY TO THE GENERA

1.	Leaves ecostate	*Hedwigia.*
	Leaves costate	2.
2.	Calyptra plicate ; leaves crispate as in *Ulota*	*Ptychomitrium.*
	Calyptra not plicate ; leaves not crispate	3.
3.	Basal leaf-cells linear, with incrassate sinuose walls ; capsules all exserted.	*Rhacomitrium.*
	Basal leaf-cells but little longer than broad, walls not sinuose	*Grimmia.*
	Basal leaf-cells but little longer than broad, upper basal somewhat sinuose ; capsules immersed or emergent, not exserted	*Grimmia Pennsylvanica* and forms of *G. apocarpa.*

HEDWÍGIA

is named for Hedwig, one of the best bryologists of the eighteenth century.

H. álbicans (Web.) Lindb. (*H. ciliata* Ehrh.) is our only species. It is very common on boulders, ledges, stone walls and dry exposed places. Indeed, one can hardly find ten feet of old stone wall in some parts of New England that does not bear one or more patches of this moss. The plants vary a great deal in size, but in general have much longer stems and branches than their relatives, besides being much the most common of all the family.

The lower part of the plant is brown or black, the upper green, with a tinge of gray due to the colorless tips of the leaves. The capsules are entirely concealed in the longer more slender perichætial leaves, and the only indication of their presence is a slight enlargement of the ends of some of the branches. The capsules are almost spherical, with a clear-cut lid and no peristome; they mature in spring.

An attempt has been made to illustrate the remarkable transformation that these plants undergo when moistened, but no drawing can do justice to the magic of the change.

It is easily distinguished from all our other *Grimmiaceæ* and from the *Orthotrichaceæ* by its ecostate leaves; its large size, hyaline leaf-apices and ciliate perichætial leaves prevent any confusion with the ecostate species of *Andreæa*. Var. *viridis* is a form with the leaves green to the apex or nearly so.

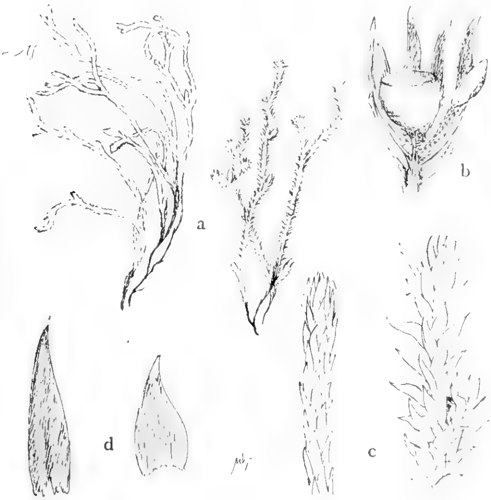


FIGURE 50

Hedwigia albicans. *a.* Dry and wet × 1. *b.* Capsule with a portion of the perichætial leaves removed × 10. *c.* Branches, dry and wet, × 5. *d.* Leaves × 10.

FIGURE 51

4a and *4á*. Apices of leaves of *Hedwigia albicans*. *4b*. Base of same. *10a*. Apex of perichætial leaf. (From Bry. Eur.)

FIGURE 52
Ptychomitrium incurvum. (From Sulliv. "Icones"

PTYCHOMÍTRIUM

The genus *Ptychomitrium* contains several American species, with a considerable range of variation in peristome characters and in general so closely allied to *Grimmia* as to make a satisfactory separation in a key extremely difficult. The plicate calyptra and crispate leaves are general characters tending to indicate this genus.

P. incúrvum (Schwaegr.) Sulliv. is the only species common enough in our range to warrant description here. It is found in the southern part of our range from southern Connecticut and vicinity of New York city south to Texas. The plants are about 5^{mm} high; seta and capsules a little less. The crispate leaves remind one very strongly of *Ulota* and indeed it is most likely to be mistaken for a member of that genus so far as general appearance goes, but its habitat on granitic rocks and its long beaked operculum, scarcely striate capsule and single peristome of slender teeth will easily differentiate it. The spores mature in late winter or early spring.

GRÍMMIA Ehrh.

Plants dark green to almost black, short-stemmed, growing (in our species) almost exclusively on rocks, in more or less compact cushions. Leaves crowded, more or less appressed and somewhat contorted when dry, but not crispate, spreading to squarrose when moist, lanceolate in general outline, margins usually recurved and entire, except at the apex, which is often hyaline, but is composed of the upper lamina instead of the costa alone giving the plants a hoary appearance in many species; costa well developed; leaf-cells short and rounded above, almost opaque in most species, sometimes papillose; the lower cells elongated, often rectangular and nearly hyaline. Calyptra smooth; capsule ovoid to oblong, symmetric; immersed or exserted; peristome single, of 16 teeth, which are entire, perforate or even cleft in some species.

The genus is usually easily recognizable, but the species are difficult and are often almost impossible to determine in sterile specimens, as some of the critical leaf characters are variable. The position of the margin (recurved or plane) seems to be a fairly constant and useful character. Mature leaves from the middle and upper portions of stems must be chosen for examination. The hyaline apex is often confined to the mature upper leaves.

KEY

1. Leaves, at least the upper, ending in a whitish hyaline hair-point . . . . 4.
   Leaves not as above . . . . 2.
2. Leaf-margin strongly revolute . . . . 7.
   Leaf-margin plane, incurved above, rarely slightly revolute below . . . . 3.
3. Leaf of a single layer above, capsule immersed; monoicous; seacoast plants exclusively . . . . *maritima.*
   Leaf of 2 to 3 layers above, margins incurved, cucullate at apex; capsule long exserted; dioicous . . . . *unicolor.*
4. Capsule longer than the seta, immersed, or if shorter than the seta the upper basal leaf-cells are sinuose . . . . 5.
   Capsule shorter than the seta, emergent or exserted; no leaf-cells sinuose . . . . 8.
5. Upper leaves with long hair points; leaf-cells not sinuose; capsule oblong . . . *ambigua.*
   Upper leaves with long hair points; leaf-cells somewhat sinuose . . . . *Pennsylvanica.*
   Upper leaves with short hair points . . . . 6.
6. Lower leaf-cells sinuose, but shorter than in *Rhacomitrium* . . . . *Pennsylvanica.*
   Lower leaf-cells not sinuose (sometimes slightly so in *apocarpa*) . . . . 7.
7. Plants small and slender, in dense cushions, soft dull green; peristome teeth strongly cribrose; central strand present in stem . . . . *conferta.*
   Plants larger, loosely tufted; central strand lacking; peristome less cribrose . . . *apocarpa.*
8. Leaf-margins erect, of one layer of cells; seta curved . . . . *Olneyi.*
   Leaf-margins slightly recurved on one side at least, of one layer of cells; seta straight . . . . *ovata.*
   Leaf-margins erect, upper margins of more than one layer; seta straight . . . . . 9.
9. Leaves oblong-lanceolate, contracted to a long rough hair; basal cells rectangular, slightly or not at all longer than broad . . . . *leucophea.*
   Leaves lanceolate, tapering, basal cells thin-walled and elongated-rectangular, 1:4 to 1:8; strictly alpine . . . . *Doniana.*

SUBGENUS SCHISTIDIUM

Capsule immersed on a short seta, wide-mouthed; columella remaining attached to the operculum and falling with it.

G. apocárpa (L.) Hedw. By far the most common species in New Eng-

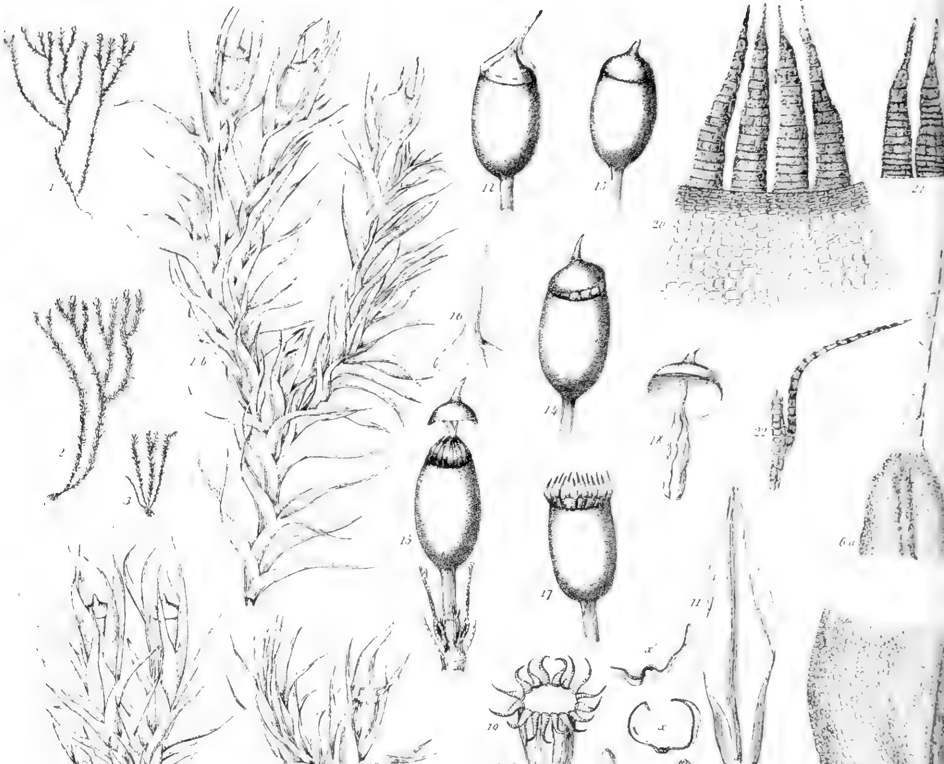


PLATE XVIII

land and northern New York. Growing on shaded rocks everywhere, almost as common as *Hedwigia*. Variable in habit, but usually growing *in loose tufts;* stems suberect, 2^{cm} or *more* high; leaves broadly lanceolate, strongly keeled above, margin narrowly revolute, entire or with a few teeth above, costa vanishing at the apex or below; hyaline point *variable, rarely reaching* ¼ *the length of the leaf*, often wanting. Monoicous; calyptra mitrate, not reaching below the lid; capsule ovoid; teeth of peristome entire or somewhat cribrose, *dark red-brown*. Authorities usually give early spring as the time of maturing spores, but I believe autumn and winter are the seasons with us. I have found the var. *rivularis* with spores maturing in August in southern Vermont. Variable; in some forms the leaf-cells are as sinuose as those figured for *G. Pennsylvanica*, in others this character is scarcely discernible.

Var. **rivulàris** (Brid.) W. and M. Stems *5^{cm} to 10^{cm} long*, denuded of leaves at the base, leaf-apex often serrate and frequently *without hyaline point;* capsule shorter, wide-mouthed and turbinate when dry and empty. Common on rocks in damp places.

Var. **grácilis** (Schleich.) W. and M. is a slender decumbent form with perichætial leaves somewhat secund; leaves serrulate at apex and rough on the back, hair point usually present. Not uncommon.

G. conférta Funck is regarded by many authors as a variety of, or at most, only a subspecies of the preceding. Typically it is much *more slender*, *lighter colored*, and growing in *very dense rounded cushions;* the *teeth are much lighter colored*, tending to orange, and are *more strongly cribrose*, capsules subspherical. Limpricht gives the following differences, which I have been unable to verify. *Apo-*

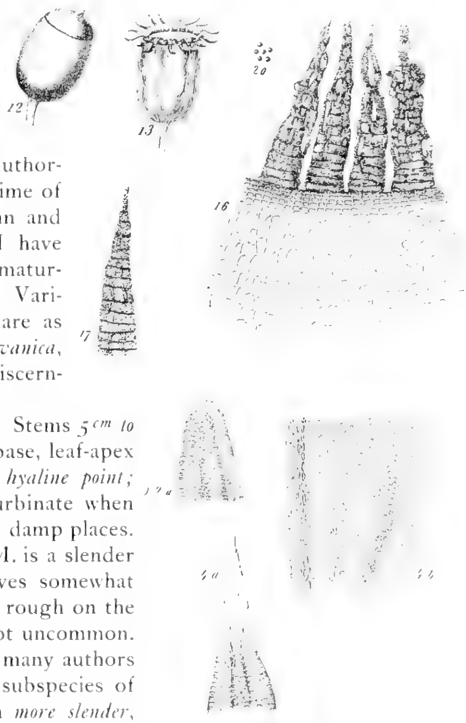


FIGURE 53

Grimmia conferta (From Bry. Eur.) Fig. 13. Deoperculate capsule. Fig. 16. Peristome. Figs. 4*a* and 4*b*. Apex and base of leaf respectively. Fig. *y*. 2*a*. Apex of leaf of var. *obtusifolium*.

EXPLANATION OF PLATE XVIII. *Grimmia apocarpa* (From Bry. Eur.

Figs. 1, 2, 3 and 4. Plants natural size. Figs. 5 and 5*a*, leaf and leaf-apex respectively from the lower part of the plant. Figs. 6 and 7. Upper leaves. Figs. 6*a* and 6*b*. Apex and base of 6. Fig. 11. Perichætial leaf. Fig. 18. Operculum with the attached columella (characteristic of the subgenus *Schistidium*). The other figures are self-explanatory.

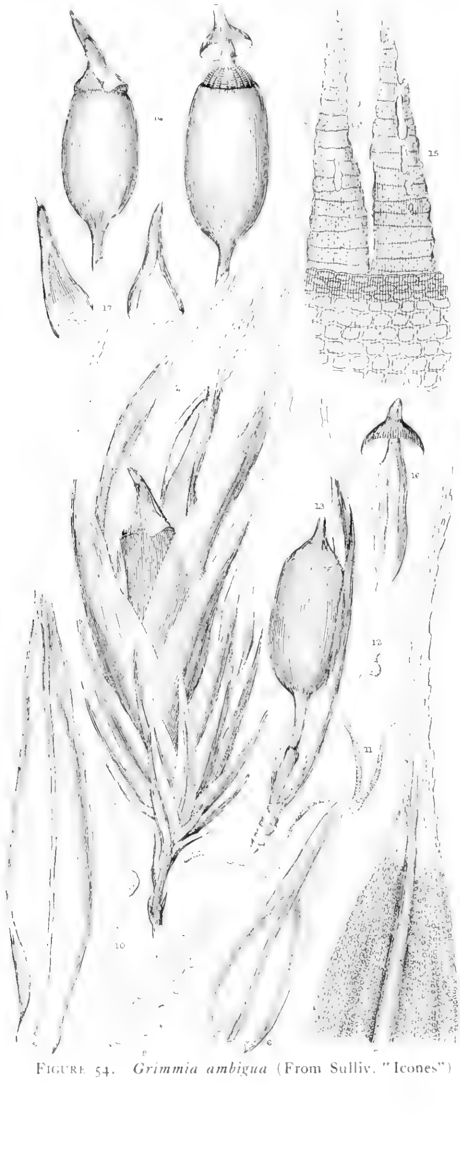


FIGURE 54. *Grimmia ambigua* (From Sulliv. "Icones")

carpa has no central strand, or at most it is rudimentary, annulus present of 3 to 4 rows of cells, 4 to 5 rows of differentiated cells about the mouth of the capsule. *Conferta* has a *well-developed central strand* in the stem, has no annulus, or at most indistinct and of only one row of differentiated cells about the mouth of the capsule. I doubt if all of these distinctions will hold, and certainly the types must be examined to definitely settle the matter.

G. ambígua Sulliv. is a rather rare and exclusively American species related to *conferta*, from which it differs in its larger size, *larger perichætial leaves* with often *a rough hyaline point* reaching nearly ½ the length of the leaf, capsule more elongated and calpytra cucullate. The last character I doubt, for I have compared Austin's Musci Appalachiani No. 142 and do not find the calyptra materially different from that in *apocarpa* and *conferta*, which often splits more on one side. The peristome teeth in *ambigua* are like those of *apocarpa* rather than *conferta*. The basal leaf-cells of these three species are not materially different, but Sullivant seems to have figured them more accurately.

G. marítima Turn. is truly maritime, being found only near the coast, sometimes growing within the reach of the salt spray. It is *darker* below and *more rigid* than any of the preceding; the leaves are *entirely without hyaline apex with margin plane above and only slightly reflexed below*, costa very strong, percurrent or excurrent; capsule ovoid-globose, wide-mouthed and turbinate when dry and empty; peristome much as in *apocarpa*, but with broader, slightly perforate teeth. Spores larger than in any of the preceding, *20µ to 24µ*, rough, maturing in winter.

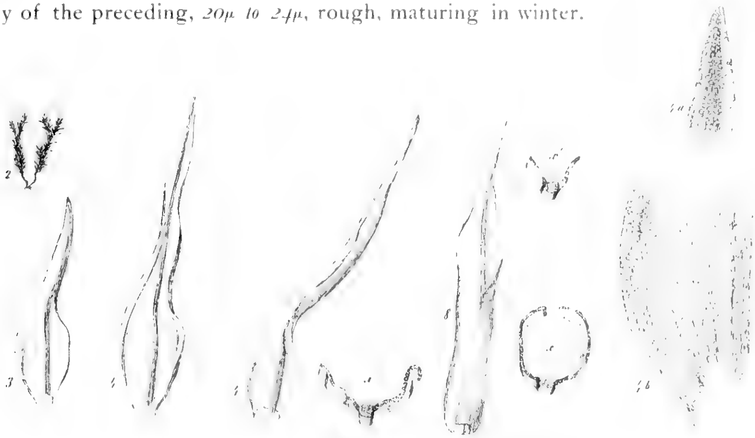


FIGURE 55. *Grimmia maritima* (From Bry. Eur.)
2. Plant natural size. 3, 4 and 8. Leaves. 4*a* and 4*b*. Apex and base of 4

SUBGENUS EU-GRIMMIA

Capsule emergent or exserted, with seta longer than capsule (*G. Pennsylvanica* seems to be an exception).

G. Olneyi Sulliv. Growing in dark green tufts, blackish below, more compact and *finer grained* than *apocarpa;* stems often nearly denuded of leaves below, about 2^{cm} high; leaves lanceolate from an ovate base, the upper ending *in a long rough hyaline hair, margins of a single layer throughout, not at all reflexed;* basal cells rectangular, 2–3:1, a few near the costa longer than this. Dioicous; capsule exserted on a *curved seta;* operculum beaked; spores maturing in April. On rocks, not rare in the lowlands of the central portion of our range especially along rivers, extending north to southern Vermont. This is our only species with curved seta, and even in this a portion of the setæ seem almost erect. In the dried specimens the capsule appears more fully exserted than is indicated in the figure. This is one of our three species with plane leaf-margins, the other two being *Doniana* and *leucophea*.

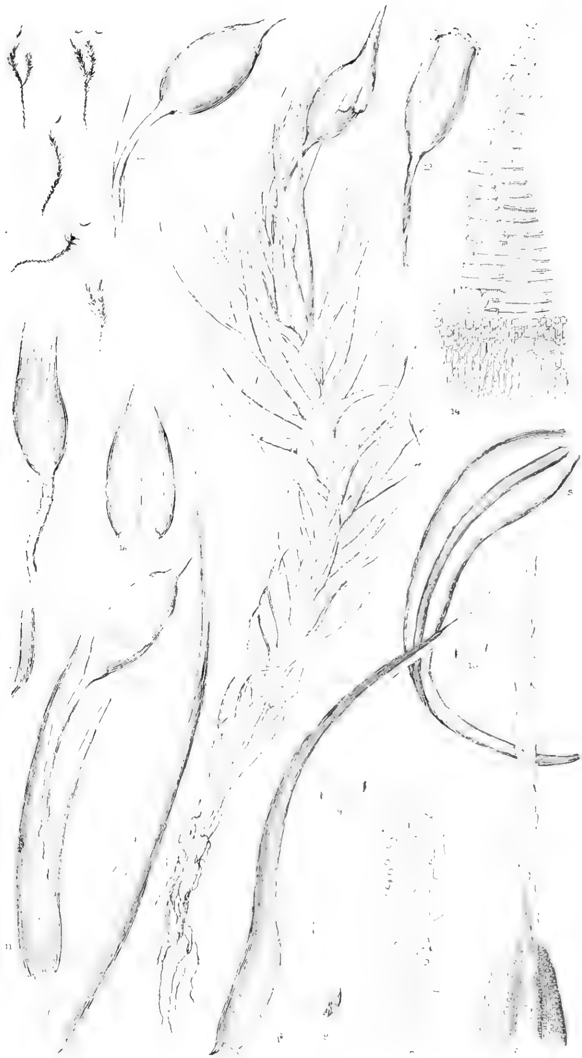


PLATE XIX. *Grimmia Olneyi* (From Sulliv. "Icones")

G. Doniàna Smith (spelled *Donii* by Braithwaite) is an alpine species apparently confined to the northern portion of our range, very rare except in the White Mountain region. Usually *much darker and shorter* than *Olneyi*, and

FIGURE 56. *Grimmia Doniana* (From Bry. Eur. in which it is called *G. obtusa*.) The figures are all self-explanatory.

in more compact cushions; upper leaves with a rough hair-point sometimes as long as the rest of the leaf, but usually shorter, leaves opaque and two-layered on the margins above; costa narrow, obscure at apex; basal cells *hyaline, 4 to 8:1.* Monoicous; capsule emergent or exserted (usually more exserted than is indicated in the figure, especially when dry); operculum not beaked; spores maturing in autumn.

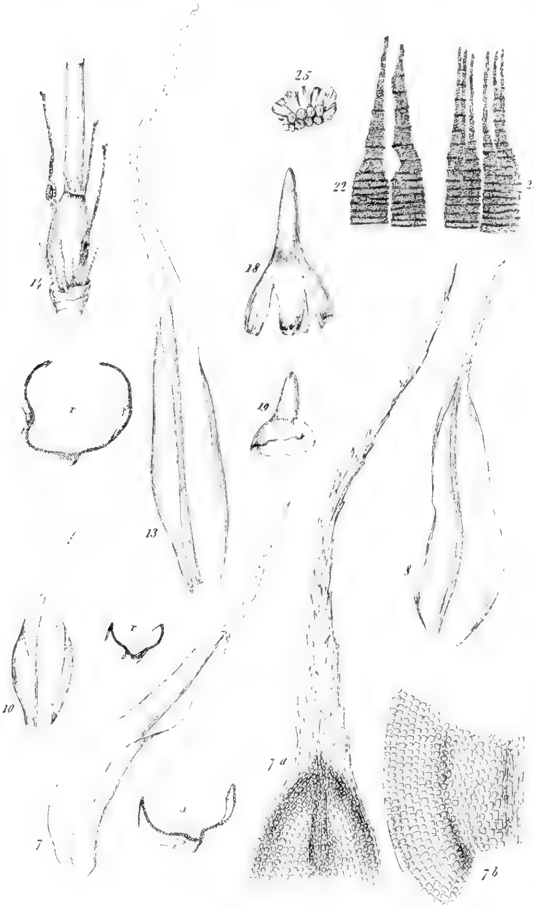


FIGURE 57. *Grimmia leucophea* (From Bry. Eur.)
25. Portion of annulus.

G. ovàta W. and M. is another rare alpine species most resembling *Doniana*, but more robust and laxer in habit; leaves with one margin somewhat reflexed and basal cells somewhat sinuose; capsules more exserted, with a beaked operculum.

G. leucophèa Grev. Rather coarse and stout, in loose wide *boary* tufts; leaves gradually larger towards the top of the stems, *almost regularly appressed-imbricate when dry, very much broader than in the three preceding species, triangular-ovate or oval-oblong, very concave*, with a broad apex terminated by a very long rough hyaline hair which is *decurrent on the leaf-apex* and is often longer than the rest of the leaf; margins plane; basal cells rectangular, a few near the costa longer than broad, *the rest quadrate;* capsule emergent; operculum short-beaked; spores maturing in spring.

Frequent in the lowlands of the southern and middle sections of our range and common on the Pacific slope. Not reported from New England, but collected by Austin on the "New Jersey Palisades south of Steep Rock about two miles east by north of Closter station."

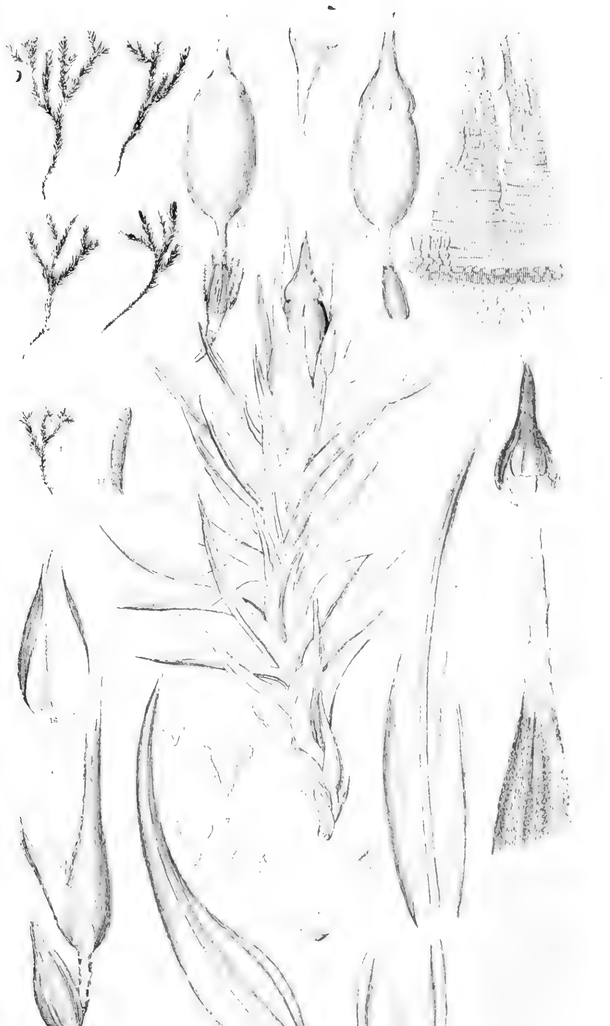


PLATE XX. *Grimmia Pennsylvanica* (From Sulliv. "Icones")

Fig. 1. Plants natural size. Figs. 15, 16 and 17. Antheridial buds, perigonial leaf, and antheridium respectively. The other figures are self-explanatory.

G. Pennsylvánica Schwaegr. seems to be our most common species next to *apocarpa*, but in the northern portion of our range it seems seldom to fruit and is apparently little collected. It is a *large coarse* dark green moss from $1\frac{1}{2}^{\mathrm{cm}}$ to 3^{cm} high, slightly hoary at the ends of the stems; leaves lanceolate, of two layers above, *appearing very dark and opaque in the upper part, margin strongly recurved*, hair-point short and rough, cells at extreme *base elongated-rectangular 3 to 6:1* and hyaline or yellowish with *thin walls;* next above these the cells are short rectangular, thick-walled and sinuose as shown in the figure. Spores maturing in late autumn, but operculate capsules may be found in April.

G. Pennsylvánica Bestii Grout Bryologist, Jan. 1904, p. 6. Growing in short, wide, loose tufts on stone in walls and on ledges in open fields. The stems are less than 5^{mm} high; *the leaves are shorter, with shorter hair-points* and frequently with lamina of a single layer throughout. The lower leaf-cells are characteristically sinuose as in the species. *The leaves bear on the back numerous bodies which look like propagula*, but which Mrs. Britton and Dr. Howe believe to be a species of Alga. This form is very common in Newfane, Vermont, and the surrounding towns, and for several years I have been attempting to locate it. Very likely it will prove to be a good species, and if so it should be called *G. Bestii*.

G. ùnicolor Hook. Dioicous; very dark green to almost black; stems 2^{cm} to 5^{cm} long; leaves without hyaline points, narrowly linear from an oblong concave base, of two or three layers above, margin plane or incurved; capsule exserted; lid beaked; spores maturing in winter (Dixon), July (Limpr.).

FIGURE 58. *Grimmia unicolor* (From Bry. Eur.)
7. Leaves of the flagelliform branches. The other figures are of stem leaves.

From forms of *G. apocarpa* with non-hyaline leaf apices it is readily distinguished when sterile by its much darker color and cucullate leaf apices (a character not well shown in the illustration). From *conferta* it is readily distinguished by its darker color. This is essentially a northern species occurring on rocks near water. I have collected it on boulders along Lake Champlain.

RHACOMÍTRIUM Brid.

Plants with much the habit and appearance of *Grimmia*, *but usually larger*, and in many species *bearing numerous short lateral branchlets*, giving the plants a *peculiar nodose appearance*. The leaves are hyaline-pointed in most of our species and the lower leaf-cells, at least, *are much elongated with thickened sinuose-nodose cell-walls*, which character is the principal distinction from *Grimmia*: the leaf-margins are recurved in almost all cases. The species are all dioicous. Seta straight; calyptra mitrate, *usually long-beaked*, *often papillose*, not plicate; capsule ovoid to cylindrical, smooth, *long-exserted*; operculum beaked, *beak usually long*; annulus large; peristome as in *Grimmia*, but the teeth in the majority of the species divided almost to the base into two filiform divisions. All our species are rock-growing, although one or two may occasionally be found on soil. Difficult to distinguish from *Grimmia* with a hand-lens, though the genus can usually be recognized by the italicized characters. Alpine or subalpine except *R. aciculare*.

KEY

1. Some or all of the leaves with a hyaline point at apex . . . . 3.
   Leaves without hyaline point . . . . 2.
2. Stems without short lateral branchlets; leaves lingulate, broadly obtuse; calyptra smooth . . . . *aciculare*.
   Stems with numerous conspicuous short lateral branchlets (see Plate XXII); leaves lanceolate, narrowly obtuse to obtusely acute; calyptra strongly papillose . . *fasciculare*.
   (Occasionally forms of *canescens* are found without hair-points, but the strongly papillose cells will serve to distinguish it beyond doubt.)
3. Leaves with hyaline points simply toothed . . . . 4.
   Hyaline points irregularly notched and very rough with papillæ . . . . 5.
4. Short lateral branchlets absent; upper leaf-cells rounded-quadrate . . . . *sudeticum*.
   Plants with many short lateral branchlets; upper cells at least three times as long as broad, sinuose . . . . *microcarpum*.
5. Leaves very papillose throughout; seta smooth . . . . *canescens*.
   Leaves smooth, except the hyaline point; seta rough . . . . *lanuginosum*.

R. aciculàre (L.) Brid. is one of our common mosses occurring around waterfalls and on wet rocks in cool and in elevated situations. Plants large, 3^{cm} to 8^{cm} long, and very stout; the broad leaves broadly obtuse, entire or denticulate at apex with small distant teeth, characterize this species so distinctly that no further description is needed, except that given by the plate. The leaf-characters are so distinct that this species is easily recognized with a hand-lens. The spores mature in spring, but well-developed capsules are found in autumn. In this species as well as in most others of the genus

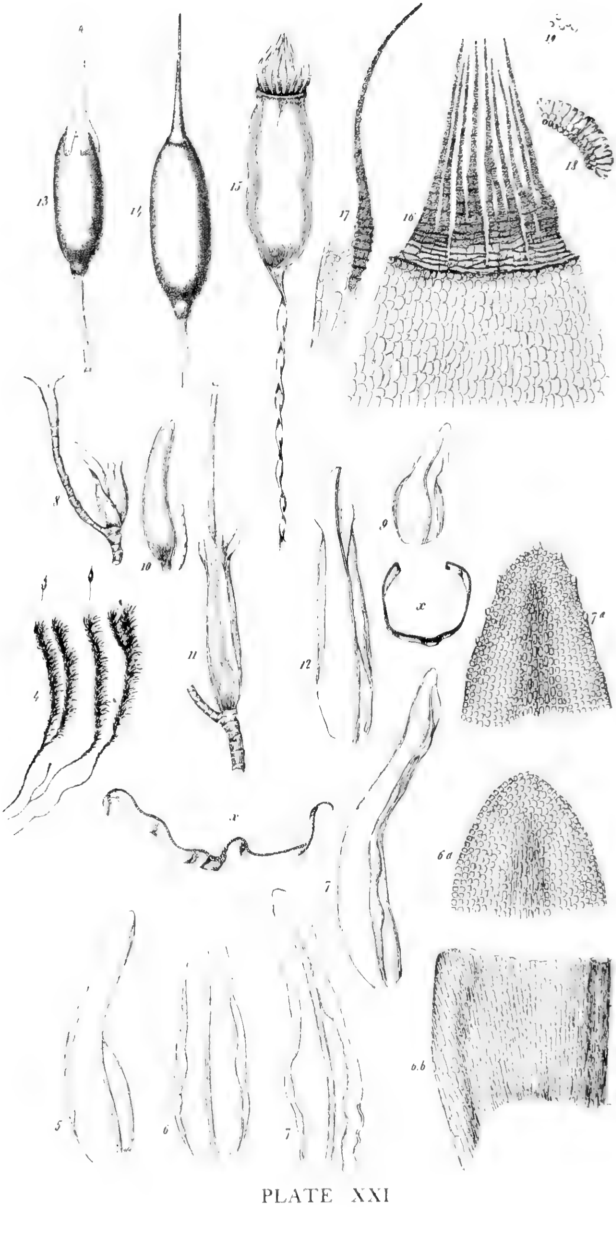


PLATE XXI

nearly an entire year seems to be needed for the complete development of the sporophyte.

R. fasciculàre (Schrad.) Brid. In rather close flat patches, yellowish green above, black or brownish below, bearing *very numerous short obtuse lateral branchlets* (see Plate XXII); leaves *lanceolate, nearly or quite obtuse, without hyaline point;* costa faint, vanishing below the apex; all the leaf-cells long, narrow and sinuose, the upper *2 to 3:1, finely papillose above; calyptra papillose over the whole beak;* peristome teeth divided to the base; spores maturing in spring. Most likely to be confused with *microcarpum*, but easily distinguished by the total absence of hair-points. Common in alpine or subalpine regions, but not likely to be met with elsewhere.

R. microcárpum (Schrad.) Brid. Resembling the last in general appearance, but with leaves shorter and having a *stronger percurrent costa* and *hyaline-tipped leaves* (in the perichætial leaves the costa ceases below the apex and the apex is sometimes obtuse without hyaline tips, making a puzzling combination), hyaline apex of leaves denticulate, leaf-cells much as in the last, but larger above; calyptra somewhat papillose above; capsule smaller and lighter-colored than in the last; spores maturing in spring. Our most common species after *aciculare*, growing on exposed rocks on hills throughout our range, but apparently somewhat local. The form with obtuse perichætial leaves which seems common in the Franconia Mountains is likely to be mistaken for *fasciculare*, unless the lower leaves be examined. Distinguished from *sudeticum* as noted under that species. The European and western forms are frequently hoary, but our eastern material is darker below and rarely noticeably whitened in the mass.

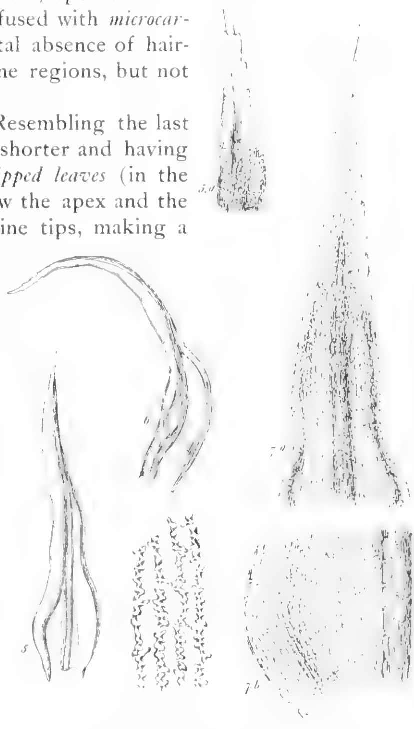


FIGURE 59
Rhacomitrium microcarpum (From Bry. Eur.)
Leaves and leaf-structure.

R. sudéticum (Funk) B. and S. Stems slender, *without short lateral branches;*

EXPLANATION OF PLATE XXI. *Rhacomitrium aciculare* (From Bry. Eur.)

9. Perigonial leaf. 12. Perichætial leaf. In the plants figured at 4 the leaves are secund, a rather unusual condition. The other figures are self-explanatory.

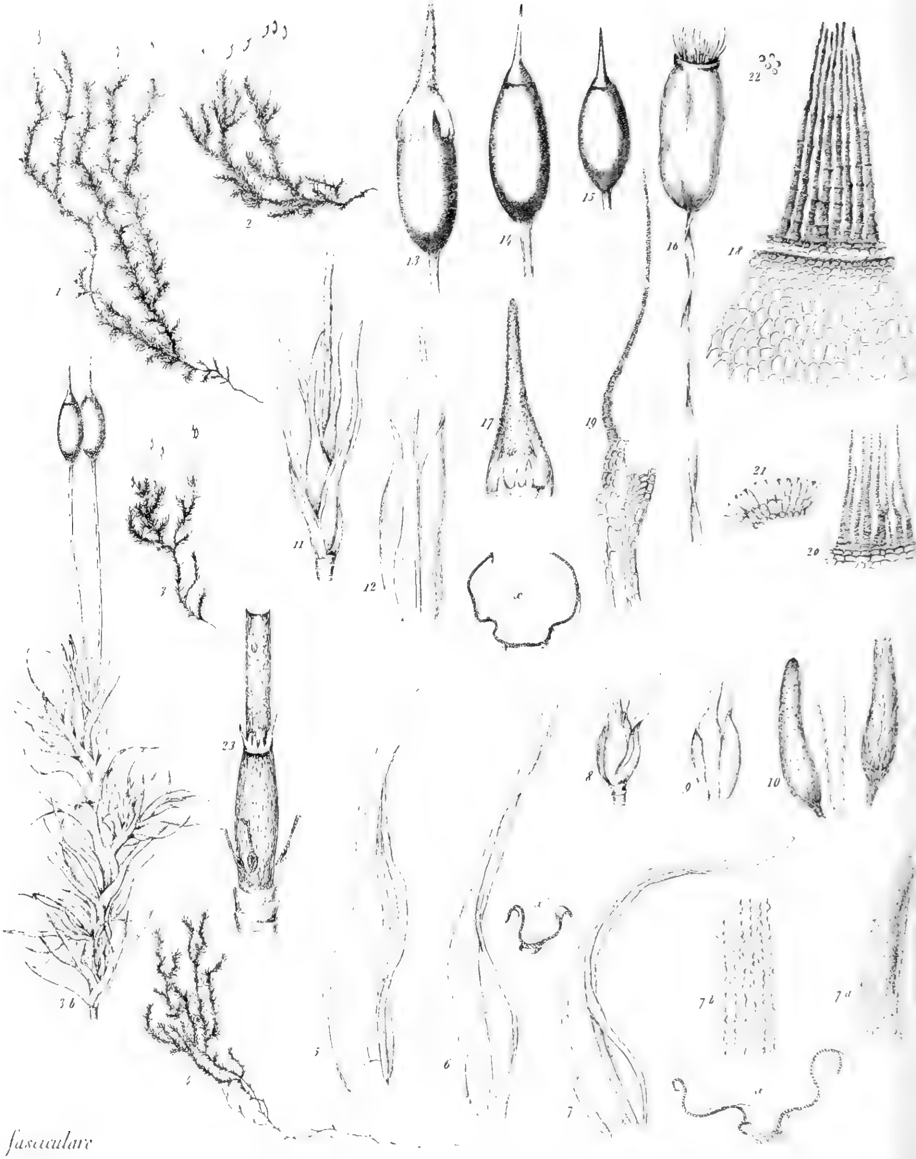


PLATE XXII. *Rhacomitrium fasciculare.* (From Bry. Eur.)

1. Plant natural size, showing characteristic method of branching. 7*b*. Basal leaf-cells. 19. Peristome and capsule wall in section. 21. Cells from annulus. The other figures are self-explanatory.

upper *leaf-cells roundish-quadrate*, hyaline leaf-apices present, denticulate; *costa stout;* peristome teeth *irregularly divided;* spores maturing in spring. Frequently confused with *microcarpum* (Austin's Musci Appalachiani No. 148 of my collection is not this species but *R. microcarpum*), but is readily sepa-

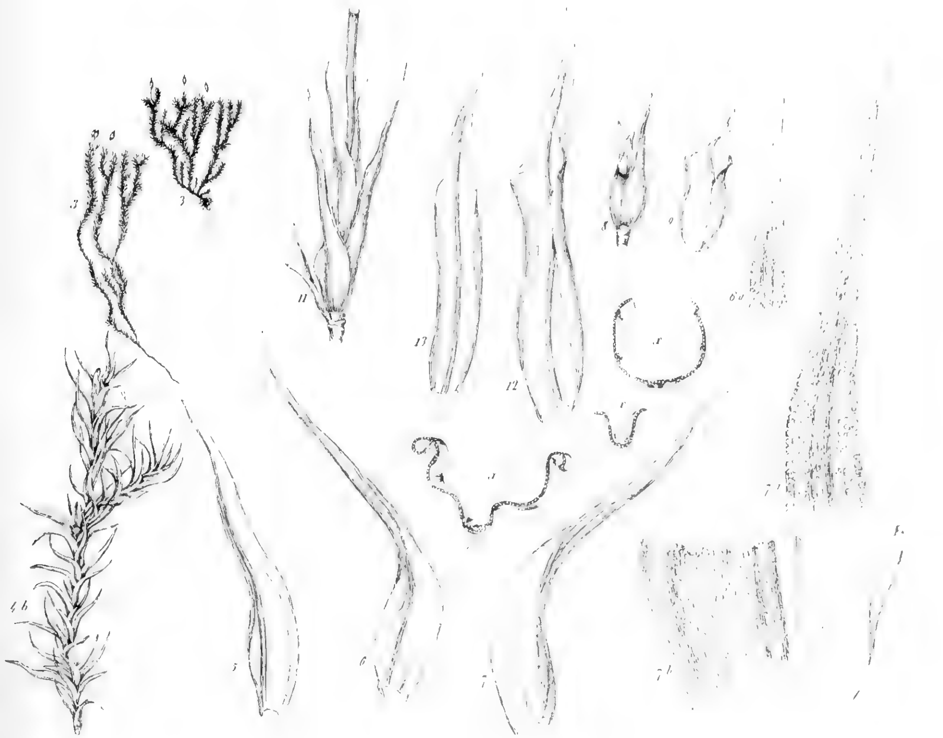


FIGURE 60. *Rhacomitrium sudeticum* (From Bry. Eur.)
9. Perigonial leaf. 12 and 13. Perichætial leaves. The other figures are self-explanatory.

rated even with a hand-lens by the lack of short lateral branchlets. Under the microscope the shorter upper leaf-cells furnish an entirely reliable distinction. This is a rather infrequent alpine species.

R. canéscens (Timm.) Brid. Rare and apparently local in mountainous districts. In loose or dense wide yellowish green tufts, usually hoary above;

lateral branchlets usually numerous, but sometimes few. Known from all other species by having the cells of the leaf strongly papillose on both surfaces, the papillæ being high and over the cavity of the cell. There are a few thin-walled hyaline cells at the basal angles as shown in the figure; seta smooth; spores maturing winter to spring.

R. lanuginòsum (Hedw.) Brid. is a rare alpine species of New England summits and northward, readily known by the characters indicated in the figure. Plants very hoary in appearance; short lateral branchlets present; hyaline leaf-apex papillose, but not the green portion of the leaf; *seta rough;* spores maturing in early summer. Visitors to the summit of Mt. Washington may collect this species on the ledges near the summit-house. I have collected it just in front of the stables.

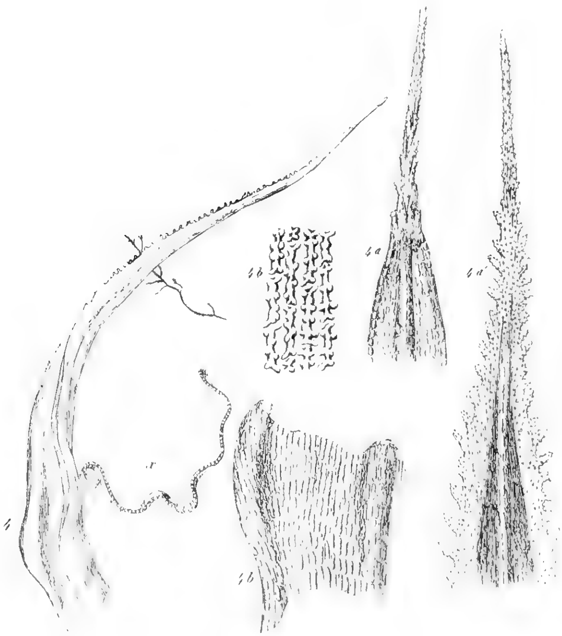


FIGURE 61. *Rhacomitrium lanuginosum* (From Bry. Eur.) Leaf and leaf structure. 4*b*. Cells of base of leaf.

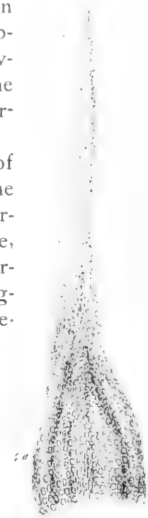


FIGURE 62. *R. canescens* (From Bry. Eur.) Leaf structure. 4*b*'. Cells of base of leaf.

Family 9. Ephemeraceae

Exceedingly minute plants about 1^{mm} to 2^{mm} high, stemless, except in the case of *Physcomitrella*, with persistent protonema, except *Physcomitrella* and *Acaulon*, usually scarcely visible except as a green film over the soil, composed merely of a bud-like cluster of leaves enclosing the subglobose cleistocarpous capsule. Leaves minute, leaf-cells rhomboid-hexagonal, longer below, shorter above, smooth, or slightly papillose in one or two species of *Ephemerum*; costa present, except in *Nanomitrium* and some species of *Ephemerum*.

Growing on bare, moist earth. Through *Ephemerum* and *Physcomitrella* these plants are plainly related to the *Funariaceæ*, but through *Acaulon* they are just as clearly related to *Phascum* and the *Tortulaceæ*. Consequently it has seemed better and more convenient to treat this as a separate family.

KEY TO THE GENERA

1. Green protonema persistent, leaves lanceolate . . . . 3.
   Green protonema not persistent, leaves ovate . . . . 2.
2. Plants with an evident stem . . . . *Physcomitrella.*
   Plants without an evident stem . . . . *Acaulon.*
3. Capsule-wall colorless, of a single layer of cells, without stomata; rudimentary operculum well differentiated and easily separating when mature capsules are pressed . . . . *Nanomitrium.*
   Capsule-wall colored, of more than one layer of cells, with stomata; operculum not differentiated, capsules dehiscing irregularly . . . . *Ephemerum.*

NANOMÍTRIUM Lindb. (*Micromitrium* Aust.)

Resembling *Ephemerum*, but differing in the characters mentioned in the key and in the usually smaller capsule almost without apiculus and the minute persistent calyptra. The leaves are ecostate and the columella lacking in mature capsule. Salmon's figures show a single row of transversely elongated cells extending around the capsule between lid and urn. These cells are almost linear in shape and break upon pressure, thus causing the lid to separate and open the capsule. The plants of this genus are said to be rather rare, but this probably is because of their small size, which renders them so inconspicuous that they are rarely collected. Apparently the spores mature in late autumn to early spring.

The relations between this genus and the next have not been at all well understood, but Mr. E. S. Salmon, in the Journal of the Linnæan Society for 1899, published some very interesting notes on these genera, and as his results have been incorporated by Brotherus into "Naturlichen Pflanzenfamilien" of Engler and Prantl, I have incorporated them into my treatment, except that I have not put the plants into the *Funariaceæ*. It will be noted that Salmon's observations do not agree with Sullivant's figures of *Nanomitrium synoicum* or *Ephemerum megalosporum*.

KEY

Spores 25μ in diameter, very smooth; leaves serrulate, calyptra central . . *Austinii* (Sulliv.) Lindb.
Spores rough, a little less than 25μ, leaves entire, calyptra a little to one side . . . . *synòicum* (James) Lindb.

FIGURE 63. *Nanomitrium Austinii* (Sulliv. "Icones") reduced ½.

1. Shows height of plants. 7. Longitudinal section through the capsule. 8. Calyptra. The other figures are self-explanatory.

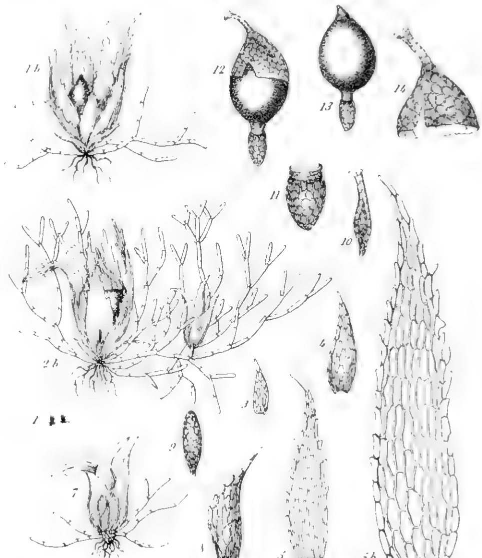


FIGURE 64. *Ephemerum serratum* (From Bry. Eur.)

1. Plants natural size.

These two mosses appear to be rare and collected by scarcely anybody except Austin and scarcely anywhere except New Jersey, but it is hardly probable that a careful search will not reveal these forms in many other places. Moist clay banks not covered with any other vegetation are the proper places to search. The L. and J. Manual gives *N. megalosporum* as a synonym of the European *N. tenerum*, but it has been found by recent students to have stomata in the upper part of the capsule-walls, so that it is a distinct species which should be referred to *Ephemerum*.

EPHÉMERUM Hampe

Minute plants developed on a persistent much-branched green protonema. Leaves lanceolate to narrowly ovate-lanceolate, costate except in *E. serratum* and *E. megalosporum*, capsules immersed, cleistocarpous, subglobose, minutely apiculate, colored; possessing spore-sac and a columella which may be partially absorbed at maturity, stomata present; capsules dehiscing irregularly; calyptra small, campanulate, torn at base but sometimes on one side only. Spores maturing in late autumn to early spring.

This genus stands related to the *Funariaceæ* through *Physcomitrella* and *Physcomitrium* in much the same way that *Acaulon* is related to the *Tortulaceæ* through *Phascum* and *Pottia*.

The very abundant protonema in this and in *Nanomitrium* is a striking feature, as it often almost obscures the plant when mounted under the microscope. Spores naturally maturing in late autumn to early spring.

KEY

1.	Leaves ecostate	2.
	Leaves costate	3.
2.	Leaves strongly serrate; stomata at base of capsule only	*serratum*.
	Leaves very slightly serrulate above; stomata on the upper part of capsule	*megalosporum*.
3.	Costa ending at apex or below, leaves serrate; stomata scattered over the whole capsule	*cohaerens*.
	Costa excurrent	4.
4.	Calyptra papillose, leaves papillose both sides	*papillosum*.
	Calyptra smooth	5.
5.	Costa excurrent into a long spinulose awn-like acumination which constitutes the greater portion of the leaf above the capsule	*spinulosum*.
	Leaves gradually long-acuminate, scarcely serrate at apex	*sessile*.
	Leaves gradually long-acuminate, strongly serrate at apex	*crassinervium*.

E. serràtum (Schreb.) Hampe first catches the eye by reason of its dark green protonema and shining chestnut-brown capsules; said to be common; easily known by its ecostate leaves. It is likely to be mistaken for some species of *Nanomitrium*, but its leaves are strongly serrate, while those of *Nanomitrium* are only serrulate.

E. megalospòrum (Aust.) Salm. (*Micromitrium megalosporum* Aust.) is a very rare species of especial interest because it is intermediate between *Nanomitrium* and *Ephemerum*. The capsule is light-colored and the calyptra small, but the capsule is irregularly dehiscent with its wall of more than one layer of cells, and Mr. Salmon finds well-developed stomata in the upper part of the capsule.

E. cohaerens (Hedw.) Hampe has oblong-lanceolate or ovate-lanceolate leaves which are very different from the leaves of *E. crassinervium* and its allies *E. papillosum* Austin and *E. spinulosum* Schimp., with their very long and very slenderly acuminate strongly serrate leaves. This portion of the leaf is papillose in all three of the latter, after the manner of the teeth on the back of a *Dicranum* leaf rather than after the manner of *Barbula* or *Pottia*.

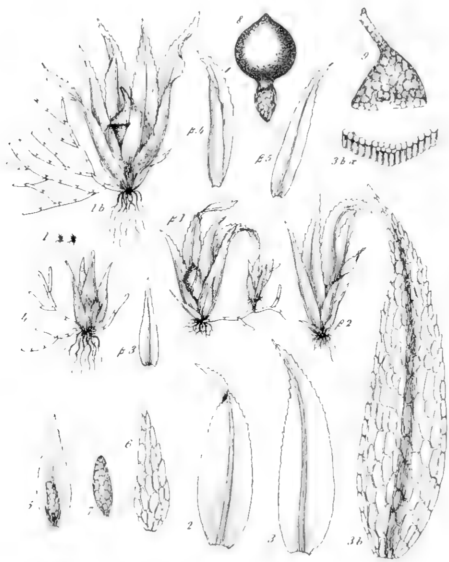


FIGURE 65. *Ephemerum cohærens* (From Bry. Eur.)

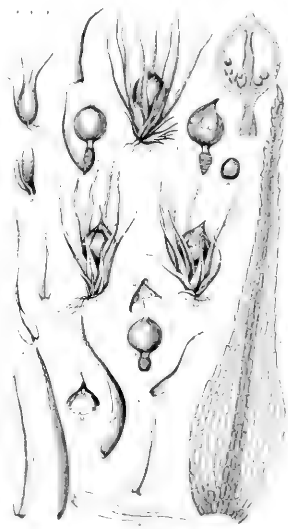


FIGURE 66

Ephemerum crassinervium (From Sulliv. "Icones" × ½, so that the plants in 1 are ½ natural size.)

E. crassinérvium is rather the largest species with less pronounced teeth on the surface, while in *E. spinulosum* that portion of the leaves above the capsule is little but a strongly toothed costa, reminding one of the excurrent costa in *Dicranum scoparium*, only on a much smaller scale. This species is apparently more addicted to swamps than the others, which grow on moist soil in various situations.

E. séssile (B. and S.) C. Müll. has leaves tapering more uniformly than those of the *crassinervium* group and almost entire, so that there is little danger of confusing it with them.

ACAÙLON C. Müll.

The species of this genus are distinguished by their broadly ovate loosely areolate smooth costate leaves, spherical capsule almost without apiculus; with leaf-cells (as well as leaves) broader and proportionately shorter than in *Ephemerum*, but growing in the same situations. The time of fruiting is in early spring.

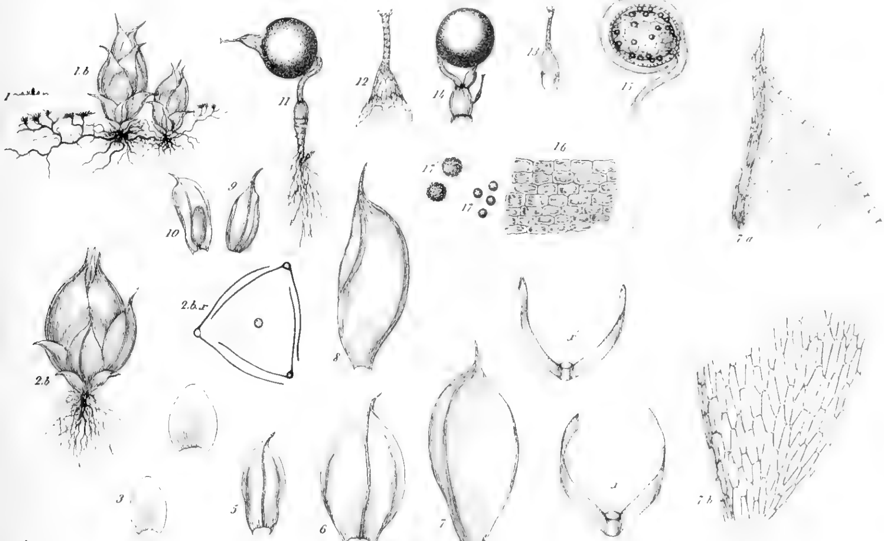


FIGURE 67. *Acaulon triquetrum* (From Bry. Eur.)

A. triquètrum (Spruce) C. Müll. has the margins of the upper leaves reflexed and the characters indicated above and is otherwise well described by the illustrations. It is widely distributed, but is rather less common than the next.

A. ruféscens Jaeg. is distinguished by its rounder less conspicuously three-cornered form and the terminal leaves with plane margins.

Both the above species are distinguished from *A. muticum*, a European and west-coast species, by the squarrose leaf-apiculus of most of their leaves, as shown in the figure.

Phascum Floerkianum W. and M., a very rare plant, closely resembles the species of *Acaulon*, but has the leaves papillose above on both sides, and an apiculate capsule.

Physcomitrella patens (Hedw.) B. and S. differs from *Acaulon* chiefly in having a distinct stem and an apiculate capsule. It is not rare in Ohio, but will probably not be found in the eastern part of our range.

I have had very little field experience with the *Ephemeraceæ* and the text is largely compiled, but has been tested on herbarium specimens. It is inserted with the hope that students may be led to search for these tiny plants and enlarge our knowledge of them.

Family 10. Tortulaceae

With few exceptions short-stemmed mosses radiculose at base only, often cæspitose, growing mainly on soil, rarely on stones and roots of trees. Leaves of various shapes, margin usually entire and of only one layer of cells, costa strong; basal cells usually thin-walled, hyaline and rectangular; upper cells usually thick-walled, quadrate to subcircular, papillose. Seta straight; calyptra cucullate, smooth; capsule erect and symmetric or nearly so; cleistocarpous, gymnostomous, or, usually, peristomate; peristome when present of 16 straight or spirally twisted teeth which are often divided into two filiform papillose divisions, appearing as if there were 32 teeth.

A family difficult to define satisfactorily by reason of the degenerate sporophytes of many species whose leaf characters show undoubted relationship to more fully developed and typical members of the family. For this reason the leaf characters play a more important part in the classification of the species in this family than in almost any other. To increase the difficulty this family is very closely related to several other families through different species belonging to it: To the *Dicranaceæ* through *Ceratodon* of the latter family; to the *Ephemeraceæ* through *Phascum;* to the *Grimmiaceæ* through *Trichostomum*. The *Encalyptaceæ* are by many authors included in this family.

Brotherus in Engler and Prantl, "Naturlichen Pflanzenfamilien" groups the subfamilies of the *Tortulaceæ* mainly upon leaf characters, putting all the genera here included, except those in the *Cinclidoteæ*, into two sub-families: the *Trichostomeæ*, with leaves lanceolate, never broader above than below, and the *Pottiæ* with leaves widest above with the costa of a somewhat different construction.

While it is evident that cleistocarpous and gymnostomous forms may belong in the same family with peristomate mosses, it would seem that the presence or absence of operculum or peristome would be worthy of as much weight in arranging subfamilies as the shape of leaves and structure of the costa.

KEY TO THE GENERA

1.	Costa producing conspicuous outgrowth of lamellæ or filaments from its upper surface (*Tortula papillosa* may be sought here)	2.
	Costa without outgrowths	3.
2.	Costa producing lamellæ; no peristome	*Pterygoneurum.*
	Costa producing threads; peristome present	*Aloina.*
3.	Leaves widest at or near base, usually tapering to an acute apex . . .	6.
	Leaves increasing in width from the base upwards, usually broad in outline and rounded at the apex except for the excurrent costa (some forms of *Barbula unguiculata* may be sought here)	4
4.	Peristome lacking (in our species)	*Pottia.*
	Peristome present (very short in some species of *Desmatodon*)	5.
5.	Costa strongly excurrent into a hair-point; peristome of 32 filiform teeth from a high basal membrane, twisted to the left	*Tortula.*
	Costa not excurrent (except in *D. plinthobius*); peristome teeth 16 . .	*Desmatodon.*
6.	Plants minute, cleistocarpous	7.
	Plants larger; capsule opening by a lid; peristome lacking or present .	8.
7.	Areolation dense and strongly papillose above; upper leaf-margin strongly involute	*Astomum.*
	Leaves more loosely areolate, margin slightly revolute above	*Phascum.*
8.	Peristome lacking; leaf-margins plane or revolute	*Gymnostomum.*
	Peristome lacking; leaf-margins involute (forms of)	*Weisia viridula.*
	Peristome present	9.
9.	Leaves with margin more or less revolute (scarcely so in *Barbula convoluta*), curled or occasionally crisped when dry; basal cells rarely hyaline, usually yellowish or reddish	10.
	Leaves with margin plane or involute; basal cells mostly hyaline; costa often excurrent; leaves usually crisped when dry	11.
10.	Peristome teeth 16, more or less divided or perforate along the median line, erect or twisted to the right	*Didymodon.*
	Peristome teeth 32, filiform, strongly twisted to the left	*Barbula.*
11.	Leaf-margin strongly involute	*Weisia viridula.*
	Leaf-margin plane or leaves concave	12.
12.	Basal leaf-cells hyaline, elongated-rectangular and extending obliquely up the margin; peristome of 32 long twisted teeth	*Tortella.*
	Basal cells not as above, or, if so, not extending up the margin; peristome of 16 untwisted teeth (in our species)	13.
13.	Leaves as in *Tortella*, except that the hyaline cells do not extend up the margin	*Trichostomum cylindricum.*
	Leaves with a lighter margin as in some species of *Fissidens*	*Desmatodon Porteri.*

PHÁSCUM (L.) Schreb.

Is a genus clearly intermediate between the *Ephemeraceæ* and the *Tortulaceæ*, but more closely allied to the latter. Plants very small, growing close together, with short erect stem clearly marked, thus differentiating the genus from most

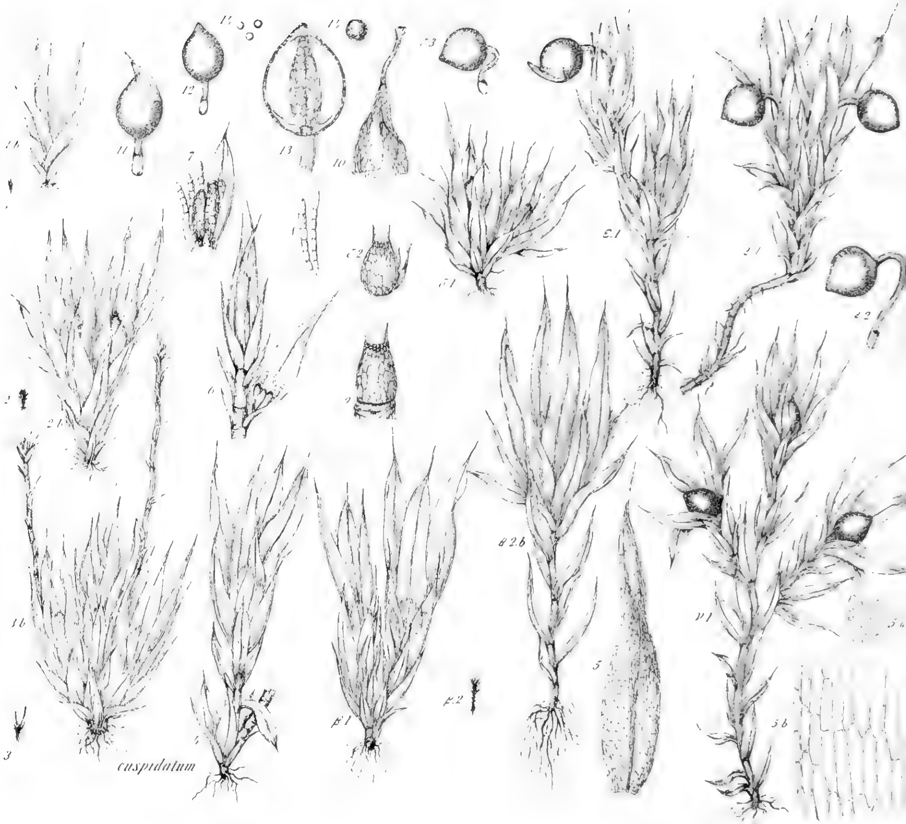


FIGURE 68. *Phascum cuspidatum* (From Bry. Eur.)
δ. Var. *piliferum*. β. ε. ν. Other varieties. 5*a* and 5*b*. Cells from apex and base of leaf respectively.

of the *Ephemeraceæ*. Leaves ovate to lanceolate and entire (in our species), papillose above. Capsule immersed or somewhat emergent, subglobose.

P. cuspidàtum Schreb. Stems often branching and sometimes producing flagella; upper leaves ovate to oblong-lanceolate, margin subrevolute in the upper part: leaf-cells rectangular and hyaline at base, hexagonal to subquadrate above and finely papillose; costa excurrent; capsules often more than one on the same plant; spores maturing in early spring. On soil in fields, waste places, banks, etc. Said to be common in some sections, but apparently not frequent in New England.

Var. **piliferum** (Schreb.) Hook. & Taylor is a form with the costa long excurrent.

This species and its variety may be known from *Pleuridium* by its broader leaves and papillose leaf-cells and from the *Weisiæ* by the looser areolation.

SUBFAMILY WEISIÆ

Small persistent plants with stems usually short and rarely radiculose, and not glossy. Leaves lanceolate or linear-lanceolate, equally spreading, usually keeled, seldom obtuse, twisted when dry, basal leaf-cells hyaline and rectangular, upper almost always isodiametric and papillose; costa usually strong. Capsules mostly exserted (except in *Astomum*), small, symmetric, oblong or ovoid, seldom cylindric, with stomata normally phaneropore, capsules cleistocarpous (in *Astomum*), gymnostomous, or peristomate. Peristome when present of 16 short, more or less imperfect, entire or somewhat divided, erect teeth.

While there can be no doubt of the close relationship of this subfamily with the rest of the *Tortulaceæ*, I cannot see the utility or reasonableness of lumping these forms and many others of a higher development in a single genus, as is done by Lindberg and Braithwaite. Nor, on the other hand, can I see the helpfulness of making such a large number of families as is done by Limpricht. It seems to me that Mr. Dixon's excellent judgment has, in this matter, been somewhat biased by Braithwaite's work.

ÁSTOMUM Hampe

Small gregarious mosses growing on soil. Leaves crisped when dry, not narrow, keeled; upper leaf-cells small, round-quadrate, papillose on both sides. Capsules immersed (in our species) subglobose, apiculate, oftentimes with a distinctly formed lid which can be removed but which does not fall of itself; calyptra cucullate.

Easily distinguished from *Bruchia* by its deeply immersed capsules, and from both *Bruchia* and *Pleuridium* by the leaves crisped when dry and strongly papillose on both sides; very strongly resembling sterile *Weisia viridula*.

KEY

Capsules brown; spores 14–17, rarely 20, maturing in spring . . . . *crispum*.
Capsules brown to orange; spores 21–27, maturing from autumn to early spring . . . *Sullivantii*.

A. Sullivantii Schimp. is a fairly common species which has not previously been clearly differentiated from *A. crispum* in the manuals. The orange color of the capsules appears not to be present in even the majority of fresh specimens. The plants in *Sullivantii* are less branched than in *crispum*, and the spores are larger. This species grows under the same conditions as *Pleuridium subulatum* and *Bruchia Sullivantii* but is distinguished at once, even when sterile,

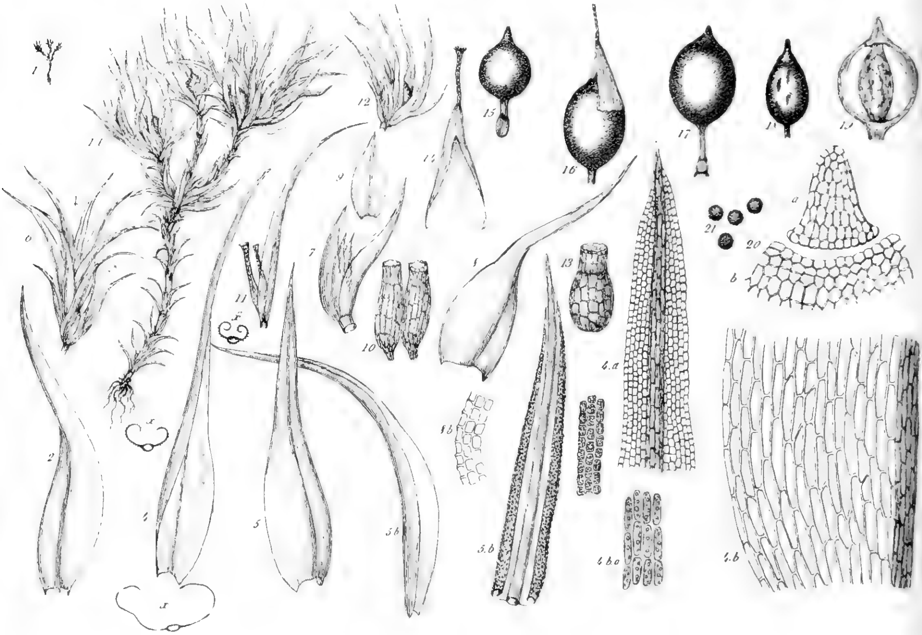


FIGURE 69. *Astomum crispum* (From Bry. Eur.)
1. Plants natural size. 4*a*. Shows the areolation of the upper portion of the leaf.
20. Shows the separation of the operculum.

by the spirally twisted crispate leaves which are seldom moist enough to be entirely straight. Fig. 19 of the glossary well illustrates the field appearance of this species except that the lower portion of the stem is omitted and the capsule is not so much hidden by the leaves as in *A. Sullivantii*. For all practical purposes the cut of *A. crispum* illustrates this species.

A. crispum (Hedw.) Hampe. (*Weisia crispa* Mitt.). Subcæspitose, pale to dark green, 4–10^{mm} high, branched at the top, monoicous leaves erect-open, crispate when dry, lower small increasing in size upwards and somewhat tufted at the summit. The comal leaves 2–3^{mm} long, linear-lanceolate, margins narrowly incurved above, costa strongly excurrent into a smooth point, basal leaf-cells hyaline, rectangular; spores maturing in spring (April–May). On bare soil.

In the collections of the New York Botanical Gardens and Columbia University, I could find but one specimen of *A. crispum* from within our range, and this was thought to be *A. Sullivantii* by excellent authority. There were several specimens from the southern states.

A. nitídulum Schimp. is a rare species, so small as not to be confused with *crispum*, but very hard to distinguish from *Sullivantii*. In my opinion it is but a variety of the latter at most. In all the specimens I have seen, including specimens named by Austin and Sullivant, the twisting and coiling of the leaves is not enough different to be worthy of note. Drawings made from Schimper's specimens at Kew show the stem-leaves to be narrowly linear-lanceolate and less than half the length of the broadly ovate-lanceolate long acuminate perichætial leaves; the calyptra is about two-thirds as long for the same width at base, and the seta is about two-thirds the length of the operculate capsule.

I am unable to see that Austin's Musci Appalachiani, No. 57, differs in any essential particulars from *A. Sullivantii*.

WEÍSIA Hedw.

Small mosses growing in tufts or mats on soil, especially rather dry sandy soil in our species, freely branching; upper leaves usually much larger than the lower, erect-spreading, strongly crispate when dry, elongated-lanceolate with the costa usually excurrent into a short point; basal cells rectangular and hyaline, the upper small roundish and thickly papillose with small papillæ; capsule well exserted on a seta of moderate length, usually erect and symmetric, ovoid, plicate when dry and empty; peristome rudimentary, teeth short, sometimes perforate or somewhat divided, rarely almost lacking.

W. virídula (L.) Hedw. is a species common in rather dry soil and occasionally growing in more moist situations. It is exceedingly variable in its peristome and its size. Our plants are mainly of the smaller size figured in the plate, but the capsules are nearly always erect. It may usually be distinguished from *Astomum* when sterile by its larger size and longer leaves. The capsules do not apparently become wrinkled as shown in the plate until they have reached a considerable age. The generic characters and the figures will serve for the ready identification of our only species. The spores mature in spring. In Californian forms the peristome is almost entirely lacking.

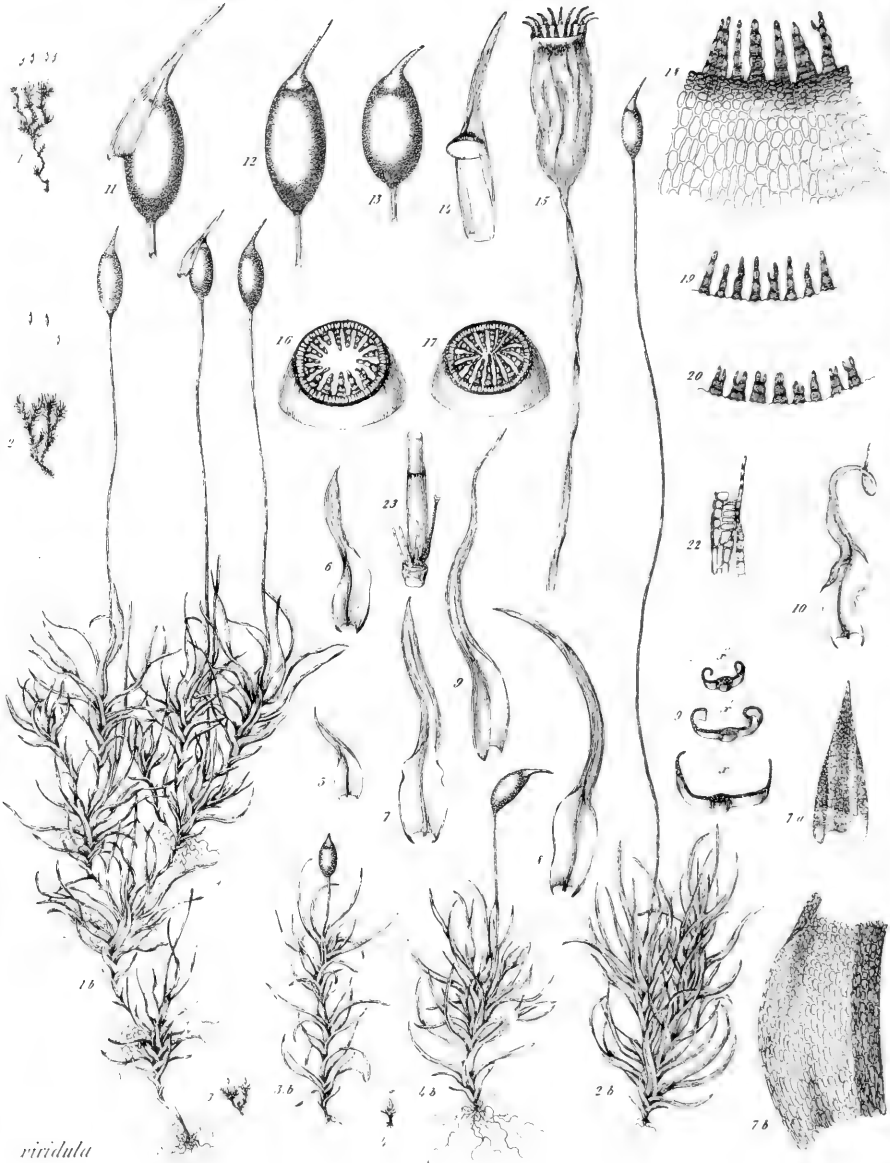


PLATE XXIII. *Weisia viridula* (From Bry. Eur.). The figures are all self-explanatory.

GYMNÓSTOMUM Hedw.

Plants dioicous, densely cæspitose, ferruginous below, growing mostly in limestone regions. Leaves small, gradually increasing in size upwards, tufted at apex, scarcely crisped when dry, but somewhat twisted and appressed, linear-lanceolate to narrowly linear, costa and lamina papillose on both sides with rather low papillæ; lower cells rectangular, upper roundish quadrate; capsule long-exserted, erect, symmetric, ovoid to oblong-ovoid, smooth and glossy when first ripe; peristome lacking, lid falling easily or remaining attached to the columella, calyptra cucullate, extending half way down the capsule.

KEY

1. Stem very short, 1–3^{cm}, leaves lingulate-obtuse . . . . *calcareum.*
   Stem usually larger, leaves acute or subacute . . . . 2.
2. Upper leaf-cells minute, opaque, margin of leaves plane; operculum falling at maturity . . . . *rupestre.*
   Upper leaf-cells clear and pellucid, margin of leaf revolute on one side at least; operculum remaining attached to the columella . . . . *curvirostre.*

All our species of *Gymnostomum* grow on wet ledges and cliffs in dense mats or cushions from 1–10^{cm} thick. Some one of these species can be found on wet cliffs in almost any region fortunate enough to have the cliffs.

G. curviróstre (Ehrh.) Hedw. This species is placed in the genus *Hymenostylium* by recent authors, but will be most readily studied and classified in this genus by all except the experts. It is apparently our most common species as well as our largest. The plants sometimes reach a length of 10^{cm}. Leaves scarcely twisted when dry, more narrowly lanceolate than in the other two species, acute, *one margin*, at least, *recurved; upper leaf-cells distinct, with papillæ low and often comparatively few;* seta usually longer than in the other species; *capsule dark red-brown*, *glossy*, *thick-walled*, widest at mouth when dry and empty, *operculum remaining attached to the columella after separating from the urn* and remaining thus attached for some time; spores maturing in late summer or autumn, 15–22μ in diameter.

Var. **scàbrum** Lindb. Leaves almost as densely papillose as in the next but with the *stems also strongly papillose.*

This species and the next are very closely related and are often confused. The variety in particular is usually referred to *rupestre*. If collected in autumn or winter this species is readily distinguished by reason of the fact that the operculum remains attached to the columella after dehiscence. I have found opercula attached as late as May or June when the young sporophytes were beginning to appear. When moistened the capsule-walls and the operculum

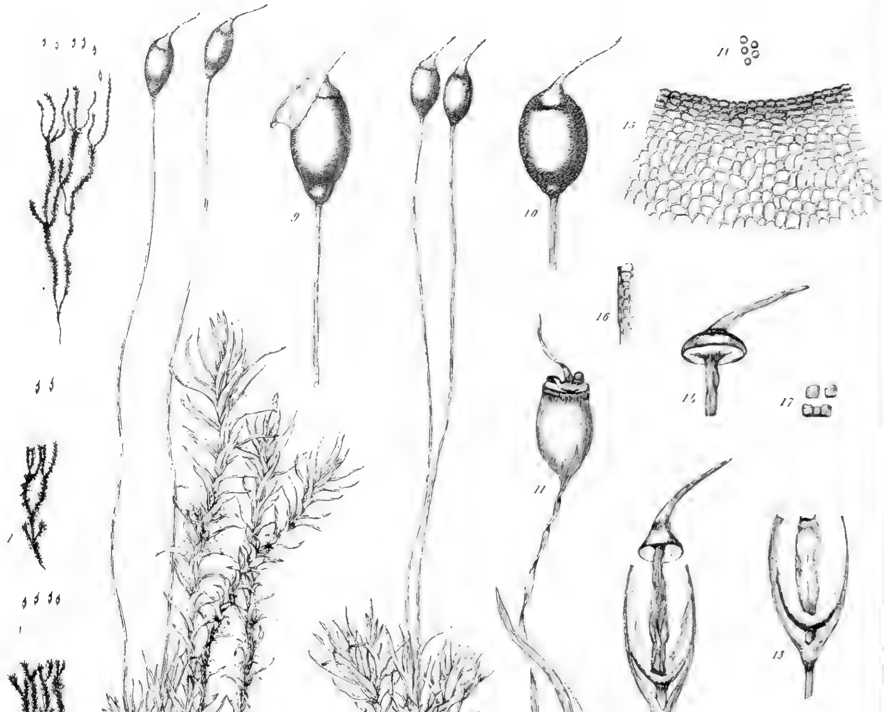


PLATE XXIV. *Gymnostomum curvirostre* (From Bry. Eur.)

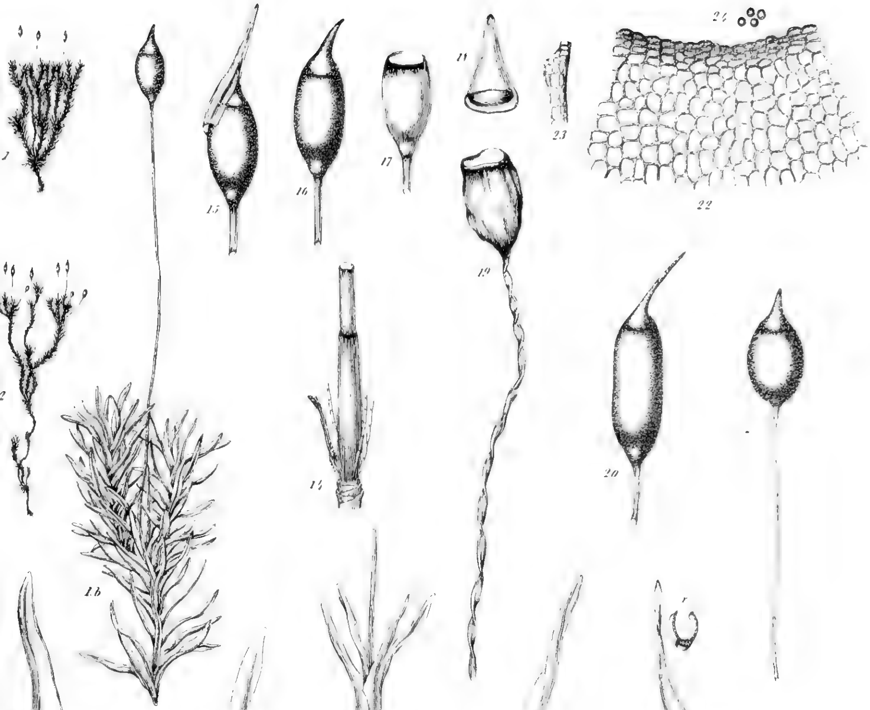


PLATE XXV. *Gymnostomum rupestre* (From Bry. Eur.)

swell so as to again close the capsule and thus do the work ordinarily done by the peristome.

G. rupéstre Schleich. is distinguished from the preceding by the *broader-pointed, plane-margined leaves with upper cells smaller* (7–12μ) *and so densely papillose above as to be indistinguishable*, by the shorter seta, and capsule *thin-walled, yellowish brown*, and by the *completely dehiscent operculum.* The spores are 10–12μ, slightly roughened, ripening at about the same time as in the last. Very much less frequent than *G. curvirostre.*

G. calcàreum Nees and Hornsch. is a much smaller plant than either of the above; leaves plane-margined, some or all rounded at apex, upper cells obscure, densely papillose; capsule oblong, somewhat narrowed below the mouth when dry and empty, thin-walled; spores 8–10μ, smooth, ripe in summer.

The apices of the leaves are not so distinct from those of *G. rupestre* as some books would lead one to believe, but the smaller size combined with the constantly more lingulate-obtuse leaves with a much more slender costa will usually serve to distinguish this species. Limpricht states that *rupestre* has 4–6 median guide cells (*Deuter*) in the costa, while *calcareum* has but 2. (See Fig. 43.)

SUBFAMILY BARBULÆ

Plants usually with a reddish brown tinge, leaves gradually narrowed to the acute apex (except *Barbula unguiculata* and *Tortella cæspitosa*). Costa usually vanishing into apex or slightly excurrent. Peristome as in the *Tortulæ* except that the basal membrane is always narrow.

DIDÝMODON Hedw.

Leaves mostly lanceolate from a broader base, somewhat contorted when dry but scarcely crispate, *margins revolute;* upper cells small, roundish quadrate, nearly smooth to strongly papillose, sometimes elongated and transparent at base. Capsule oblong to cylindric, not altering when dry; operculum conic and beaked; *peristome of 16 teeth, undivided, perforate, or divided nearly to the base as in Ceratodon, short, not twisted.*

KEY

1. Lower portion of plant reddish; cells of the lower portion of leaf elongated and thin-walled . . . . *rubellus.*
   Lower portion of plants brown; only the extreme row of basal leaf-cells elongated . . 2.
2. Leaves widely ovate-lanceolate; costa ending in the obtusely acute apex . . . . . . *luridus.*
   Leaves lanceolate, the upper lingulate and rounded-obtuse; costa ending below apex . *tophaceus.*

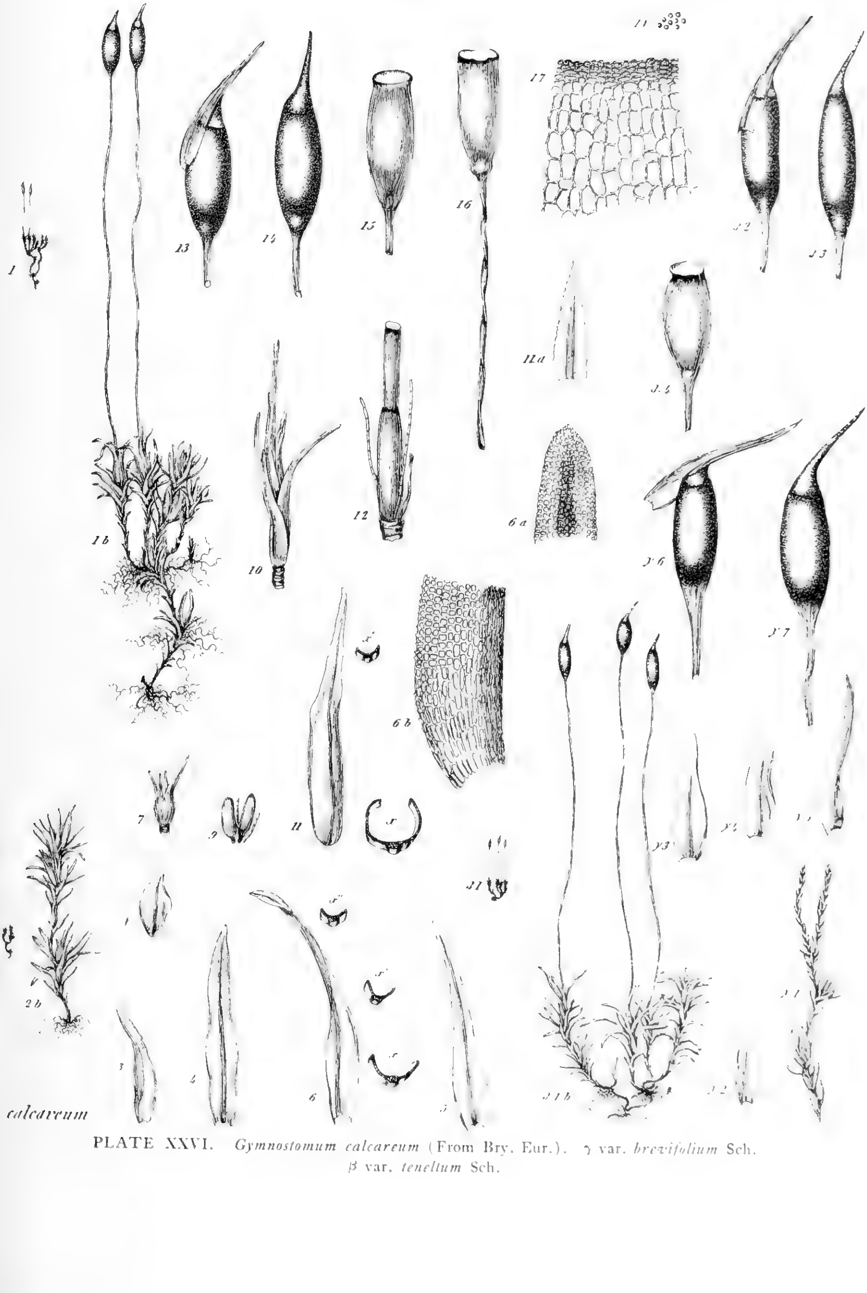


PLATE XXVI. *Gymnostomum calcareum* (From Bry. Eur.). γ var. *brevifolium* Sch.
β var. *tenellum* Sch.

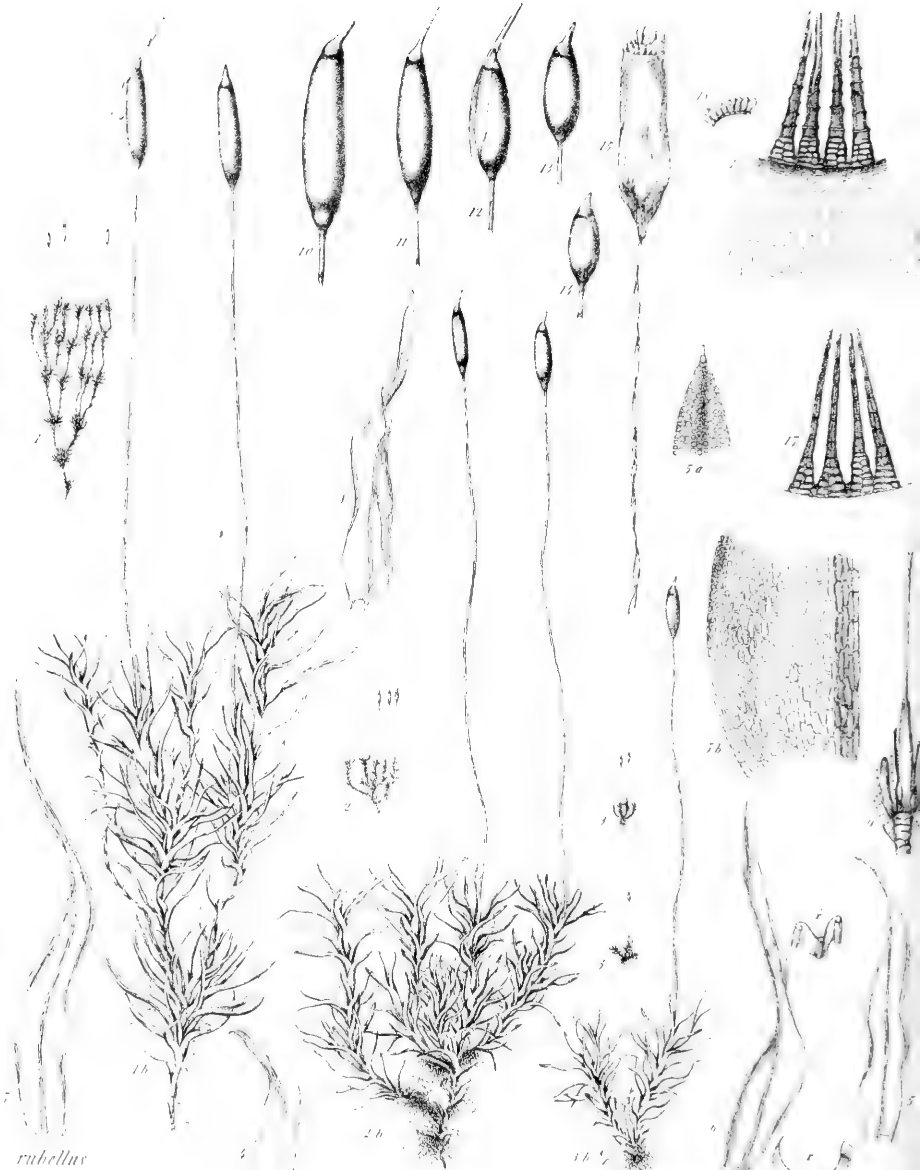


PLATE XXVII. *Didymodon rubellus* (From Bry. Eur.). Fig. 8. Perichætial leaf. The other figures are self-explanatory.

D. rubéllus (Hoffm.) B. & S. Plants monoicous, 2–5^{cm} high, rusty red below, often branched, leaves spreading when moist, somewhat curled when dry, often more or less denticulate at extreme apex, margin revolute to near apex; costa vanishing in the apex or *excurrent into a minute apiculus*; upper leaf-cells subopaque, quadrate, *papillose*; *lower elongated-rectangular*, nearly transparent; peristome *teeth regular, united at base, with a distinct median line* but rarely divided, pale red, minutely roughened; spores maturing summer to autumn. On rocks, walls, stony soil, etc., in rather moist places. Frequent, often associated with *Myurella Careyana*. The minute, almost pellucid apiculus is usually present on some of the leaves, and this, together with the italicized characters, makes the species readily determinable. Our plants seem smaller than the European, usually being under an inch in height.

D. lùridus Hornsch. Plants dioicous, in dense tufts, 1–2^{cm} high, somewhat branched; leaves closely imbricate when dry and scarcely twisted, concave, ovate-lanceolate; margins entire, recurved nearly to apex; costa strong, ending in the obtusely acute apex; cells hexagonal or roundish quadrate, *not papillose; scarcely different except at extreme base; peristome irregular*, simple or with teeth divided above; spores maturing in winter. On rocks, especially limestone. Infrequent, at least in the eastern portion of our range.

FIGURE 70.
Didymodon luridus (From Bry. Eur.)

D. tophaceus (Brid.) Jur. (*Trichostomum tophaceum* Brid.) is a species rare in the East, growing on moist limestone soil, and readily distinguished by the short lingulate obtuse upper leaves with the costa ending below the apex.

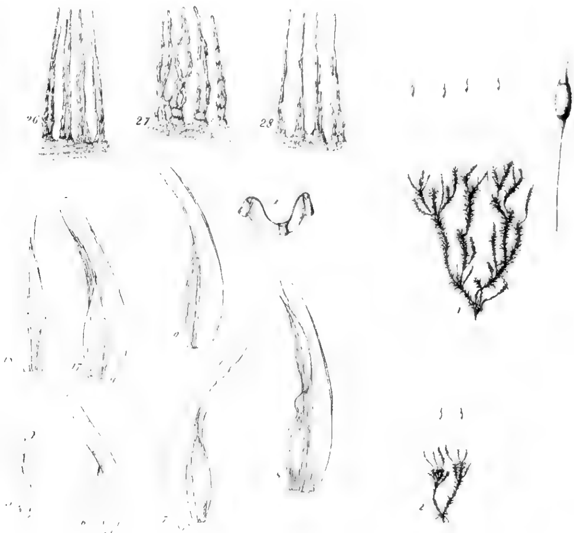


FIGURE 71. Leaves and peristome of *Didymodon tophaceus* (From Bry. Eur.)

BÁRBULA Hedw.

In habit and size much like *Didymodon* and distinguished from it chiefly by the better developed twisted peristome of 32 filiform teeth, and the leaves more strongly papillose as a rule. The basal cells are enlarged, quadrate to rectangular, hyaline to somewhat colored.

KEY

1. Perichætial leaves long sheathing, convolute; leaves crisped	*convoluta.*
Perichætial leaves not convolute-sheathing, or conspicuously different from the others	2.
2. Leaves smooth or nearly so, tapering to a long acute point; costa distinctly excurrent	*gracilis.*
Leaves strongly papillose; costa scarcely excurrent (except *unguiculata*)	3.
3. Leaves obtuse, mucronate with the excurrent costa; the perichætial sometimes acute	*unguiculata.*
Leaves acute	*fallax.*

B. unguiculàta (Huds.) Hedw. Our most common and most variable *Barbula*. Plants dioicous, green to dirty green, 5–30^{mm} high; leaves erect-spreading or slightly recurved when moist, spirally twisted when dry, lingulate to oblong-lanceolate, obtuse; costa excurrent into a short round mucro; margin recurved below, plane above; upper cells small, subquadrate, obscure, densely papillose, the lower elongated-rectangular, yellowish transparent to hyaline; perichætial leaves longer and more acute; seta 1–1½^{cm} long, red-brown; capsule oblong or cylindric, usually symmetric, with beaked lid; annulus lacking; peristome teeth long and slender, spirally twisted in two turns, from a very short basal membrane; spores maturing from late autumn to early spring. On damp earth, walls and stones. Exceedingly variable, especially in leaf forms, which may become lance-linear, and even acute in the case of the perichætial leaves. It might be confused with *Tortella cæspitosa*, but the

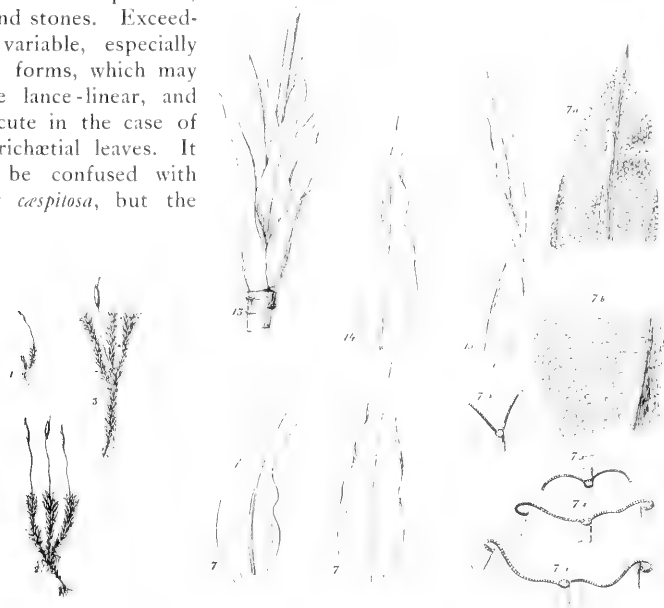


FIGURE 72. *Barbula unguiculata* (From Bry. Eur.). 1, 2, 3, plants natural size.

leaves are shorter than in that species; the margins are recurved and the hyaline basal cells do not run up the margin. In general the plants are much darker colored.

A form from Meadville, Pa. (Miss Cora H. Clarke), has the leaves abruptly acute above, and in some plants the costa is hardly percurrent.

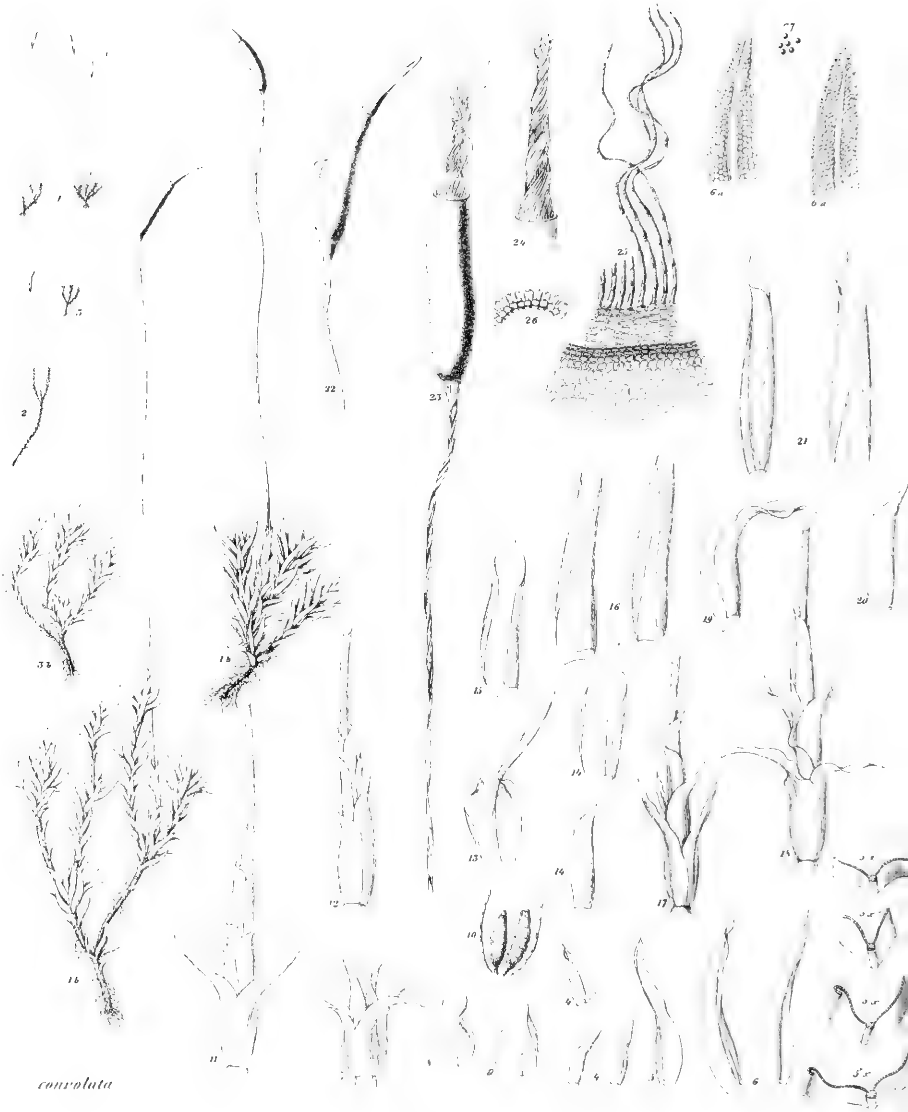


PLATE XXVIII. *Barbula convoluta* (From Bry. Eur.)

Var. **obtusifòlia** (Schultz) B. & S. In this variety the costa is often merely percurrent, and the apex sometimes without point.

B. convolùta Hedw. Next to the preceding our most common *Barbula*. Plants dioicous, slender, 5–10^{mm} high, densely cæspitose, yellowish green; leaves erect-spreading when moist, crisped when dry, oblong-lanceolate to lingulate, obtuse to obtusely acute; costa ending in or below the apex, very rarely excurrent into a minute point; margin said to be slightly recurved at base, *but this character is very hard to demonstrate;* leaf-cells subquadrate, small and densely papillose above, elongated-rectangular and nearly hyaline below; *perichætial leaves long-sheathing, convolute, inner without costa;* seta 5–25^{mm} long, slender, *straw-colored or becoming reddish with age;* peristome several times twisted; spores maturing in spring. On soil, especially in limestone regions, in rather dry places.

At first sight this species reminds one of *Ceratodon*, but the longer operculum, yellowish seta, and convolute perichætial leaves easily distinguish it, even with a hand-lens.

B. fállax Hedw. Plants dioicous, in wide loose tufts, brownish green, sometimes reddish when dry, slender, 1–4^{cm} high, branching; leaves rather distant, spreading to recurved, appressed and often somewhat twisted when dry; lanceolate from an ovate base, gradually tapering to a slender acute or subacute apex; *margin entire, strongly revolute to above the middle; costa strong, thickest at base and tapering somewhat upwards*, usually ending in the apex; *leaf-cells small and thick-walled, strongly papillose, basal gradually enlarged and elongated, the very lowest elongated-rectangular;* perichætial leaves with subsheathing base and elongated-rectangular hyaline basal cells; seta red; capsule elongated-ovoid to subcylindric, nearly symmetrical, lid long-beaked; peristome long and much twisted; spores maturing in late autumn and winter. On stones and soil, especially that recently disturbed and not fully occupied by other plants.

Easily distinguished from the last by the larger size, more slender pointed leaves with recurved margins, slightly different basal cells, and when in fruit by the slightly differing perichætial leaves. Apparently not rare but sparingly collected.

B. refléxa Brid. (*B. recurvifolia* Sch.) is a variety or subspecies of the last, distinguished by its reddish brown colors, strongly squarrose-recurved lower leaves, broader, shorter and abruptly pointed. Not common.

B. grácilis (Schleich.) Schwaegr. is a *very rare species* somewhat resembling small forms of *B. fallax* but the leaves are shorter, straighter and more erect. Plants dioicous, densely tufted, 1–2^{cm} high, olive-green; leaves ovate-lanceolate; costa excurrent in the upper leaves, forming the greater part of the leaf apex; leaf-cells rounded, nearly or quite smooth.

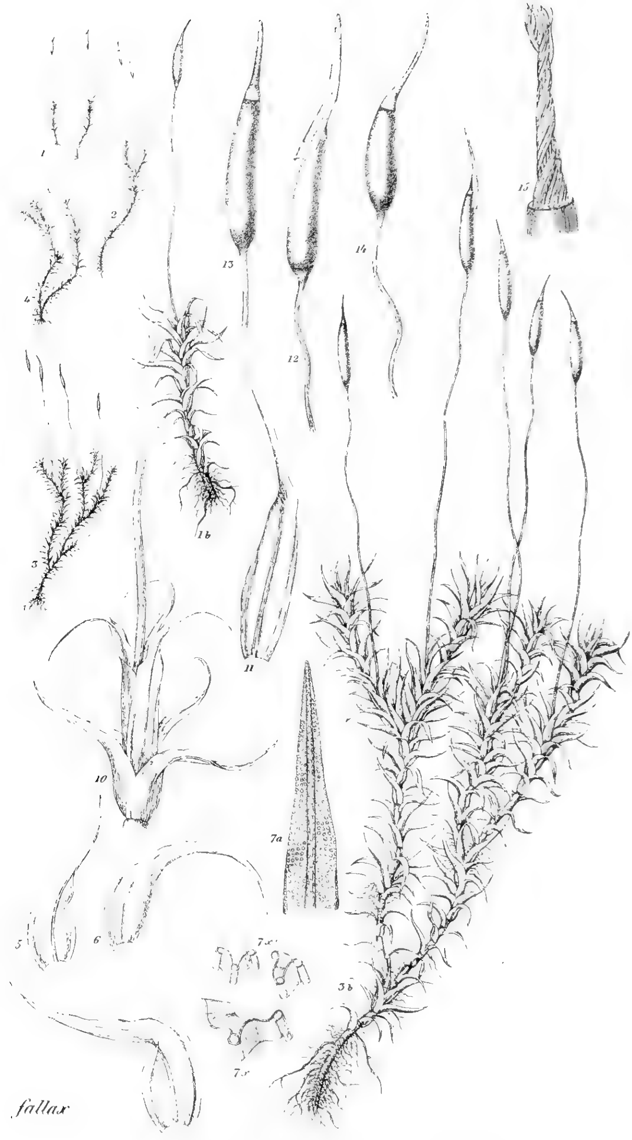


PLATE XXIX. *Barbula fallax* (From Bry. Eur.)

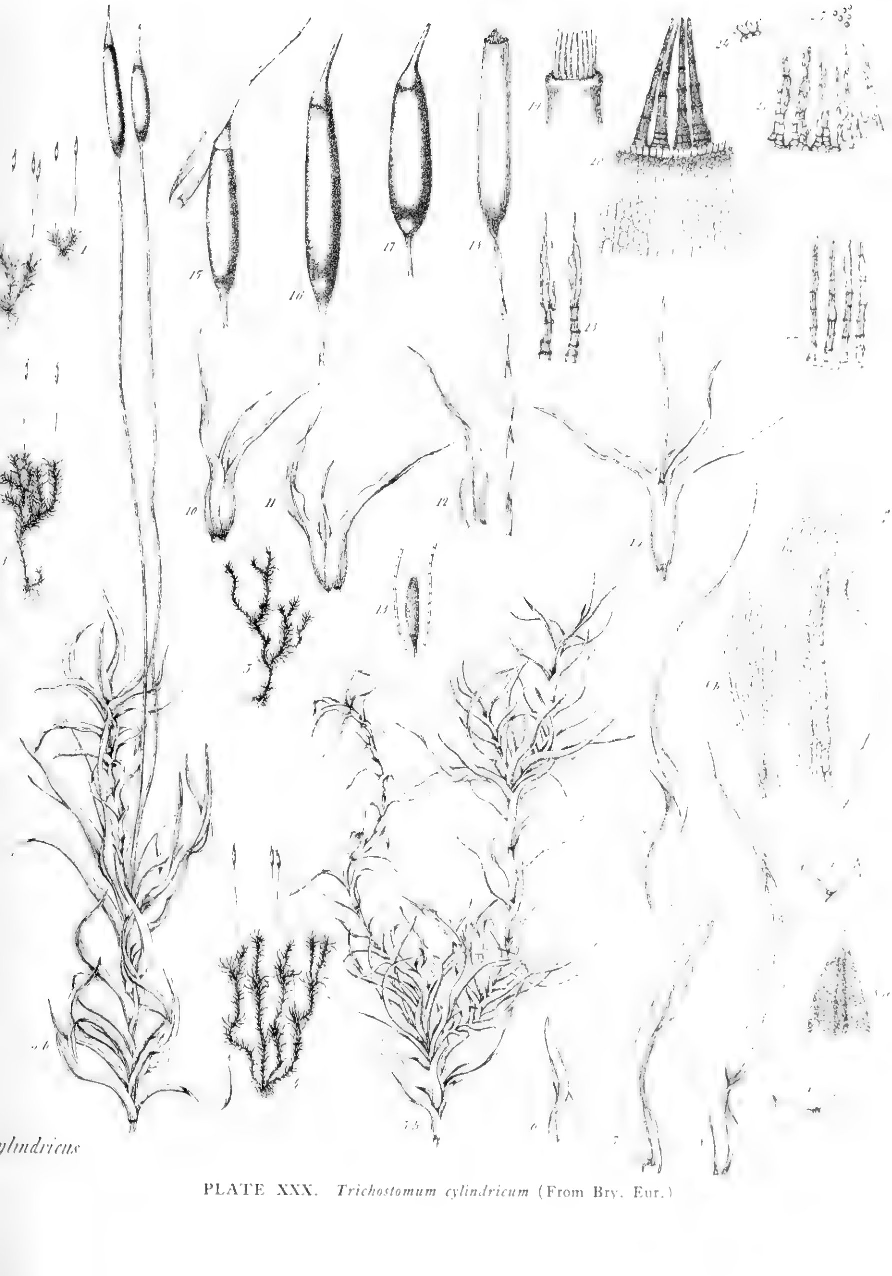


PLATE XXX. *Trichostomum cylindricum* (From Bry. Eur.)

TRICHÓSTOMUM Hedw.

This genus differs from *Didymodon* in having the leaf-margins plane or incurved, and in the elongated-rectangular or linear basal cells. Distinguished from *Tortella* by the short untwisted peristome and the fact that the basal cells do not extend up the margin.

T. cylíndricum (Bruch) C. Müll. (*Didymodon cylindricus* Wahl.). This species is common in the Alleghany region and is apparently widely scattered in subalpine localities. It has been collected in the White Mountains in New Hampshire. It very rarely fruits and when collected is usually confused with the species with which it is contrasted below. Although it is much more slender than *Tortella cæspitosa* or *T. tortuosa*, it resembles small plants of the former more than any other species; its leaves, however, are more slenderly pointed, usually acute, tapering more or less gradually to the apex formed of the slightly excurrent costa. The hyaline basal cells do not extend up the margin to any marked extent. The leaves are much less slenderly acuminate than in *T. tortuosa*, and the plants are very much shorter.

The plants of this species are dioicous, yellow-green above, often brown below. The leaves sometimes reach 4^{mm} in length and are very strongly papillose above.

TORTÉLLA (C. Müll.) Limpr.

Usually growing in dense rather deep tufts, densely leaved. Much like *Barbula*, but the leaves are *cirrhate-crispate* (except *T. fragilis*) when dry, spreading to recurved, longer, *elongated-oblong to linear-lanceolate with margins plane or involute;* costa strong, ending in the apex or excurrent; upper leaf-cells papillose with large papillæ; *basal cells sharply differentiated from the upper, hyaline, elongated and extending up the margins to a noticeable extent* (see Plate XXXI, Fig. 9.*ab*), rectangular, linear near the margins; peristome well developed and twisted.

All our plants of this genus have previously been included in *Barbula* by American authors.

KEY

1.	Leaves long lance-linear, obtusely acute, abruptly mucronate by the excurrent costa; monoicous	*cæspitosa.*
	Leaves long-acuminate; dioicous	2.
2.	Leaves twisted crispate when dry, of one layer of cells throughout	*tortuosa.*
	Leaves erect, rigid, much less contorted when dry, of two layers of cells above . . .	*fragilis.*

Sterile *Trichostomum cylindricum* may be sought here, but in that species the hyaline cells do not extend up the margin farther than in the middle of the leaf.

FIGURE 73. *Tortella tortuosa* (From Bry. Eur.)

T. tortuòsa (L.) Limpr. Plants 2–6^{cm} or more in height, densely radiculose with red-brown filaments, stout, *growing in dense rounded tufts*, pale or yellowish green above, light brown below; leaves crowded, very long (5–6^{mm}), *linear-lanceolate*, tapering gradually to the *slenderly acute apex*, spreading and flexuose when moist, very strongly crisped and often spirally contorted when dry, *margin flat and crenulate-papillose* above; *costa excurrent into a short acute point* which is sometimes faintly denticulate above; upper leaf-cells strongly papillose, hyaline area at base large and extending obliquely far up the margin; seta 1–3^{mm} long, *red*

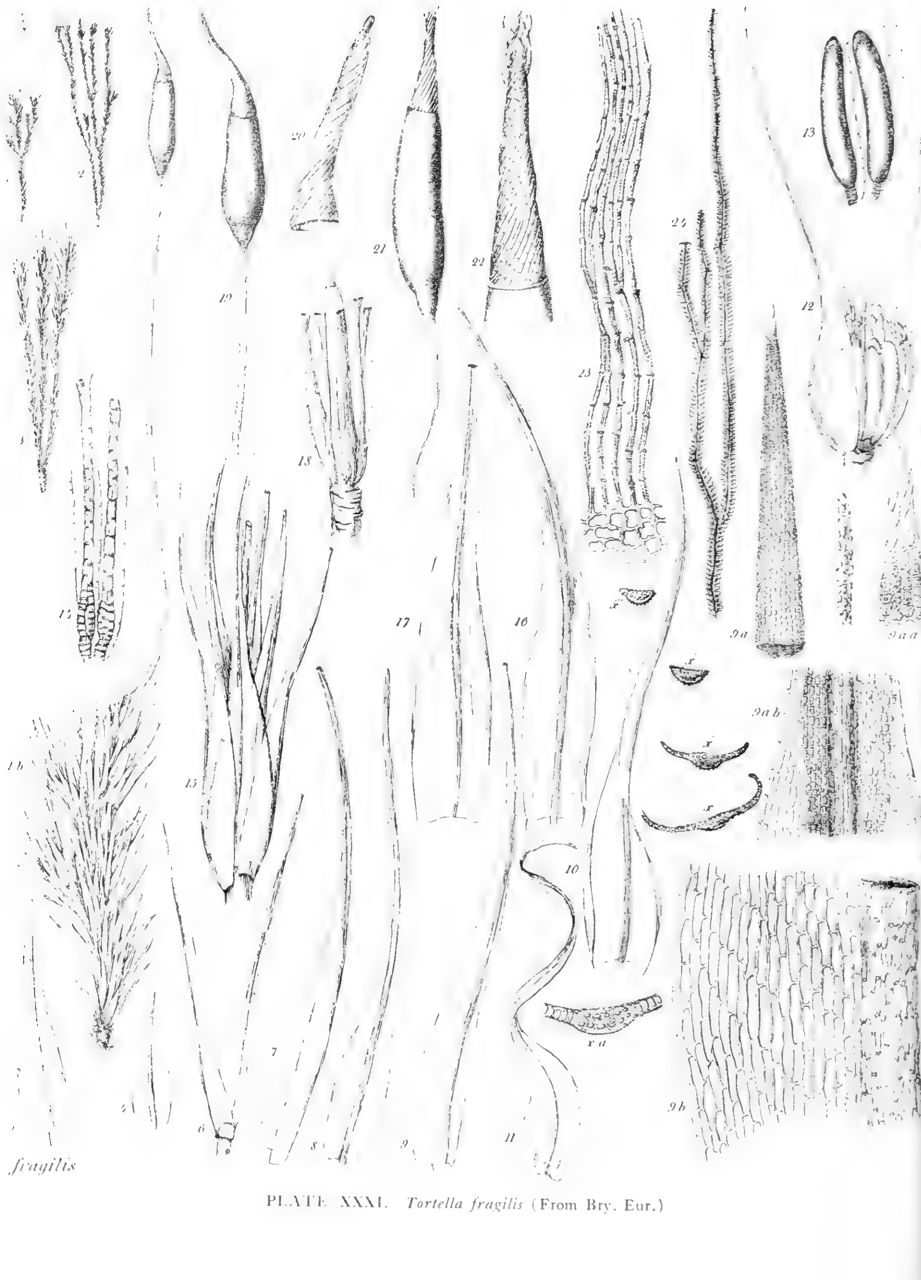


PLATE XXXI. *Tortella fragilis* (From Bry. Eur.)

below, paler above; capsule cylindric, 2.5–3.5^{mm} long; teeth from a narrow basal membrane, long, and several times twisted; spores maturing in late spring. Common on rocks, especially limestone, perhaps the most common species of the family except *Weisia viridula*, but fruiting rather infrequently. This species is of almost world-wide distribution.

The large size of the plants and the *long-linear* or *lance-linear* slenderly acuminate leaves, much crisped when dry, make the species easy of recognition.

T. frágilis (Drumm.) Limpr. Plants shorter and more slender than in the last; leaves somewhat curled when dry *but rarely crisped to any great extent*, when moist becoming rather *rigidly straight and suberect, glossy and shining at back when dry, not undulate*, rather quickly tapering from an ovate lanceolate base into a *very long slender apex, composed of the stout excurrent costa;* apex very fragile, broken off in all except the young leaves; basal hyaline cells extending up the margin as shown in the plate; spores maturing in summer. Growing on soil and rocks; infrequent and rarely fruiting. Reported from east of the Rockies chiefly in the regions of the Great Lakes and the drainage area of the Hudson River.

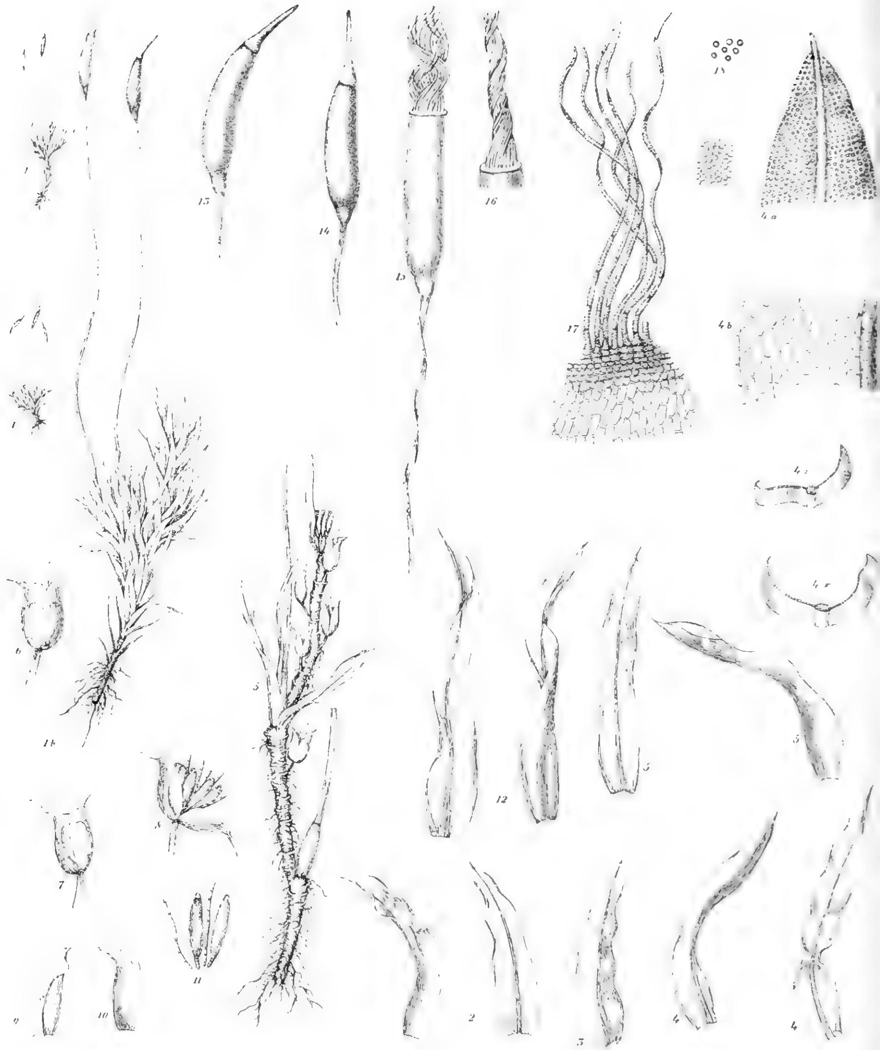
T. cæspitòsa (Schwaegr.) Limpr. Plants in rather loose tufts, green to yellowish green, scarcely 1^{cm} high, leaves erect-open when moist, crisped when dry, *oblong-lanceolate*, very long, acutish to obtuse *and mucronate by the strong, yellowish excurrent costa*, concave; margins entire, sometimes slightly incurved; basal hyaline cells occupying $\frac{1}{4}$–$\frac{1}{3}$ the length of the leaf, V-shaped in area next the chlorophyllose cells, upper cells obscure, strongly papillose; seta yellow, changing to reddish yellow with age; capsule nearly or quite symmetric, ovoid-cylindric, thin-walled, greenish yellow; peristome from a low basal membrane, strongly twisted, papillose; spores maturing in spring. On roots of trees and soil in woods. Common and variable.

The apex of leaf figured in the plate is about the average, some being more acute and others more obtuse. This species may possibly be mistaken for *Barbula unguiculata;* for distinctions see under that species.

SUBFAMILY POTTIÆ

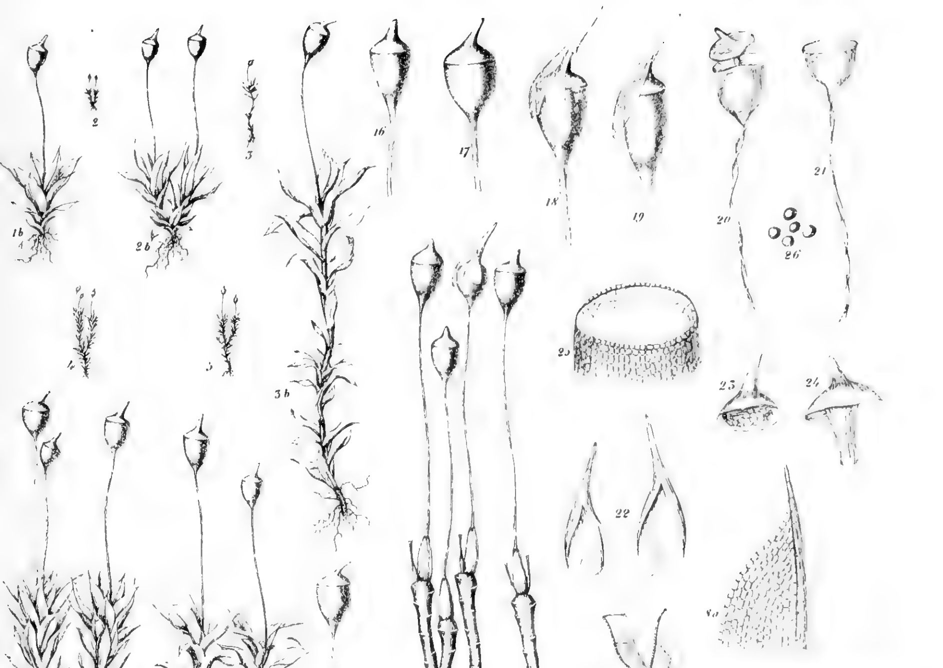
Leaves broad in outline and narrowed toward the base. Costa excurrent in most species. Calyptra cucullate; capsules gymnostomous (in our species).

Phascum is usually included in this subfamily, but it is an intermediate form, difficult to classify and hardly homogeneus with the rest of the subfamily. Brotherus makes the *Pottiæ* include the *Tortulæ*, while Limpricht makes the family name *Pottiaceæ* instead of *Tortulaceæ*.



cirrhata

PLATE XXXII. *Tortella cæspitosa* (From Bry. Eur.)



truncata

PLATE XXXIII. *Pottia truncatula* (From Bry. Eur.)

PÓTTIA Ehrh.

Plants short, sometimes branched, scattered or in tufts. Leaves soft, broad in outline, enlarging upwards, ovate to oblong, usually papillose (but not so in our most common species), costa reaching apex or beyond (except *P. riparia*); areolation rather lax for the family. Capsule erect and exserted on a straight seta, ovoid to cylindric; peristome lacking in our species.

P. truncátula (L.) Lindb. (*P. truncata* Fuern.) is our only common species, and will be readily recognized from the generic description and the plate. The leaves are not papillose. It is most likely to be confused with *Physcomitrium*, as its habitat and general appearance are somewhat similar. It is distinguished from *Physcomitrium* by the smaller size, being only about half as large, and by its excurrent costa, which can be made out with a strong lens. The spores mature from late autumn to early spring.

P. ripária Aust. is a rare and local species found on moist rocks along streams in New Jersey, northern New York and through the central portion of our range; but little collected either because it is rare and local or so small as to escape notice unless fruiting. The leaves are subspatulate, more or less denticulate, with costa ending below apex; capsule narrowly cylindrical-oblong. It is not now included in *Pottia* by the best of recent authorities, but will probably be most easily referred to this genus by most students.

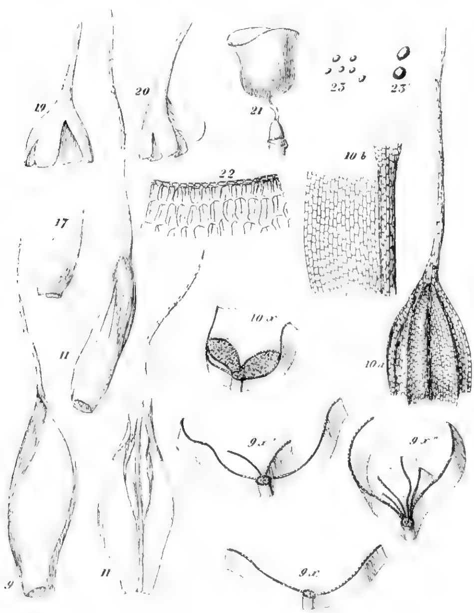


FIGURE 74. *Pterygoneurum subsessile* (From Bry. Eur.) 10*a* and 10*b*. Apex and base of leaf respectively. 17. Perigonial leaf. The other figures are self-explanatory.

PTERYGONEÙRUM Jur.

P. subséssile (Brid.) Jur. (*Pharomitrium subsessile* (Brid.) Schimp., is a plant of southern and western range, of Pottioid habit, readily known by the lamellæ on the upper surface of the leaves. These lamellæ toward the apex of the leaf form follicles, which are filled with a granulose mucilaginous mass. Plants variable in size, 2–4^{mm} high, simple or branched; leaves ending in a long rough hair-point; capsules immersed; spores maturing in early spring. On soil and earth-covered stones, etc.

The western *P. cavifolium* (Ehrh.) Jur. (*Pottia cavifolia* Ehrh.) is a very similar plant, but with a long-exserted capsule and leaves with a smooth hair-point.

SUBFAMILY TORTULÆ

Leaves broad, oblong to spatulate or lingulate. Peristome of thirty-two long filiform spirally twisted teeth or of sixteen shorter scarcely twisted teeth. Costa nearly always excurrent.

Encalypta species are likely to be sought here, especially if sterile, but the papillæ in *Encalypta* are very large and verrucose and the costa not excurrent or very shortly so. In *E. streptocarpa*, our most common species, the leaf-margins are incurved above and the apex almost cucullate.

ALOÌNA (C. Müll.) Kindb.

A. ericæfòlia (Neck.) Kindb. (*Barbula ambigua* B. & S.) is a rare species of the central states closely related to the last. The costa is broad and is covered above toward the apex of the leaf with a large number of filaments composed of cylindrical cells placed end to end. The upper leaf-margin is inflexed so as to make the leaf cucullate. The peristome is well developed and in spite of its evident relationship to the preceding it belongs in the *Tortulæ*.

FIGURE 75.
Aloina ericæfolia (From Bry. Eur.)

DESMÁTODON Brid.

This genus as a whole is scarcely distinct from *Tortula*, except that the basal membrane is very narrow or lacking, and the peristome is short and scarcely twisted, sometimes so short as to be scarcely visible with a hand-lens. In some species the teeth are scarcely separated into sixteen definite divisions. All our species appear to be comparatively rare.

The three species here treated are put in *Tortula* by Brotherus in the "Naturlichen Pflanzenfamilien," but while our American species may not belong in the same genus with the European and perhaps might be put in a new genus, I cannot regard them as belonging in *Tortula*.

D. plinthòbius Sulliv. & Lesq. is about the size of the next and has the leaves of a *Tortula* with the characteristic excurrent costa, and if found sterile would undoubtedly be referred to that genus. The leaves are oblong, obtuse and occasionally almost notched at apex, strongly papillose above, margins recurved, costa very stout, hair-point smooth; dioicous; annulus very large; peristome teeth short, without basal membrane, split little if any below the middle, much like that figured for *D. arenaceus*. Walls, pavements and limestone rocks. Common in the southern part of the United States, northward to Pennsylvania. It might easily be mistaken for *Tortula muralis* when sterile by one unfamiliar with both species, but it is shorter and much more slender, being not more than half the size of that species. The hair-point is much longer, frequently as long as the leaf proper, while the upper leaf-cells are very small (4–5μ) and very opaque.

FIGURE 78.
Leaves of *Desmatodon plinthobius* (From Sulliv. "Icones.")

D. arenàceus S. & L. has the leaves of a *Tortula* except that the mucro, or point, of the leaves is not made by the costa, which is not excurrent; the perichætial leaves often lack this mucro and are often lingulate in outline. The leaf-margins are revolute above and crenulate by reason of the papillæ; peristome very short, often much shorter than the figure indicates. Said to be common on sandstone rocks in the north central states. Sterile *D. arenaceus* might be mistaken for *Barbula unguiculata* by one not familiar with both, but the costa in the latter is plainly excurrent in all but the lowest leaves. This species is called by Brotherus "*Tortula obtusifolia* Schleich. *Forma peristomio imperfecto* (Hag.)."

D. Pórteri James is a rare and minute species, *1–3mm high;* leaves with plane margins, *bordered with a band of lighter colored cells as in some species of Fissidens;*

PLATE XXXIV. *Desmatodon arenaceus* (From Sulliv. "Icones") costa very stout, vanishing below the apex; *seta bright orange-yellow* when young, darker with age; teeth divided nearly to base; spores maturing in spring. Growing on rocks. Type from Easton, Pa. It has been collected as far west as Wyoming. Rather infrequent and local.

TÓRTULA Hedw.

Plants robust, with large oblong or subspatulate leaves which are rounded at apex and usually have the costa long-excurrent, not crispate when dry but somewhat twisted and contorted, mostly entire; upper leaf-cells opaque and papillose (except *T. mucronifolia*), basal rectangular and hyaline or colored. Peristome teeth thirty-two, from a high basal membrane (except *T. muralis*), papillose and twisted to the left.

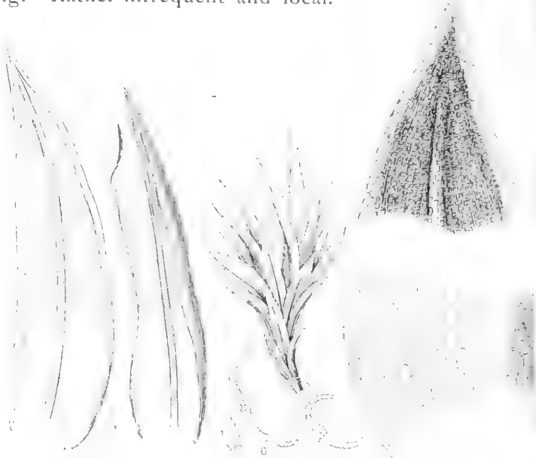


FIGURE 79. *Desmatodon Porteri* (From Sulliv. "Icones")

T. papillosa grows on tree trunks, the rest of our species on soil and stones. Distinguished from our species of *Desmatodon* by the high basal membrane and thirty-two spirally twisted teeth. Only one of our species of the latter, *D. plinthobius*, has an excurrent costa.

KEY

1. Growing on trunks of trees; leaves very concave, with costa very short-excurrent and bearing propagula; never fruiting . . . . . *papillosa.*
   Growing on soil and stones . . . . . 2.
2. Leaf-cells smooth . . . . . *mucronifolia.*
   Leaf-cells papillose . . . . . 3.
3. Leaves with a short hair-point, bordered with 2–4 rows of yellowish linear cells in two layers . . . . . *marginata.*
   Leaves with a long hair-point, not bordered . . . . . 4.
4. Hair-point rough; basal membrane nearly equaling the teeth in length . . . . . *ruralis.*
   Hair-point smooth or nearly so; basal membrane narrow . . . . . *muralis.*

T. muralis (L.) Hedw. Typically growing in small dense cushions, short, averaging about 1^{cm} high, dull or bright green, hoary; leaves twisted and curled when dry, oblong-lanceolate below to elongated-lingulate above; margin closely revolute, causing the leaves to appear margined; costa excurrent into a very long smooth hyàline hair which is usually one-half the length of the leaf; upper cells very opaque, roundish-quadrate, 9–12μ, strongly papillose; monoicous; capsule broadly cylindric on a red-brown seta which is orange when young; lid beaked, basal membrane almost as narrow as in *Barbula;* spores maturing in spring. Infrequent and local on our range. On stones and walls. Distinct in fruiting forms by the narrow basal membrane. The combination of papillose leaf-cells, smooth hair-point and revolute margin will serve to distinguish from everything except possibly *Desmatodon plinthobius.*

T. ruràlis (L.) Ehrh. Larger than the preceding, *2–6cm high*, branched, bright green above, reddish-brown below; leaves *recurved-squarrose above* when moist, when dry appressed and somewhat twisted, oblong to oblong-spatulate, *rounded or notched at apex;* perichætial leaves acute; *costa excurrent into a very long and very rough hair which is hyaline above and often colored at base;* margin reflexed almost to apex; upper leaf-cells rounded-hexagonal (13μ or more) and strongly papillose; *dioicous; capsule cylindric, long,* lid half as long as capsule, basal membrane constituting one-half the long peristome;

FIGURE 76.
Tortula muralis (From Bry. Eur.)

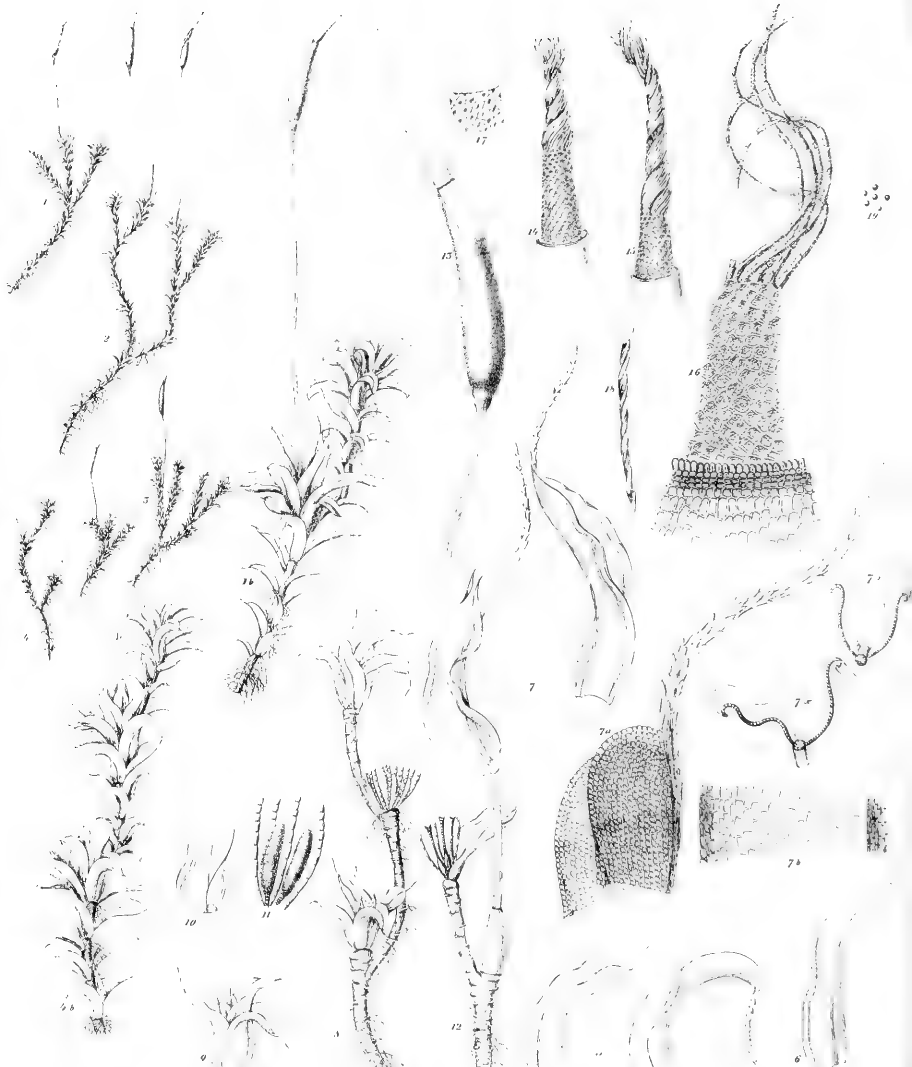


PLATE XXXV. *Tortula ruralis* (From Bry. Eur.)

spores in spring. Common on the Pacific coast but infrequent eastward. Very variable, but distinct from all our other species by the italicized characters.

T. ruralifórmis (Besch.) Dixon is a more robust plant of the Rockies and westward, having its leaves acuminate and the whitish lamina of the apex running up the base of the hair-point.

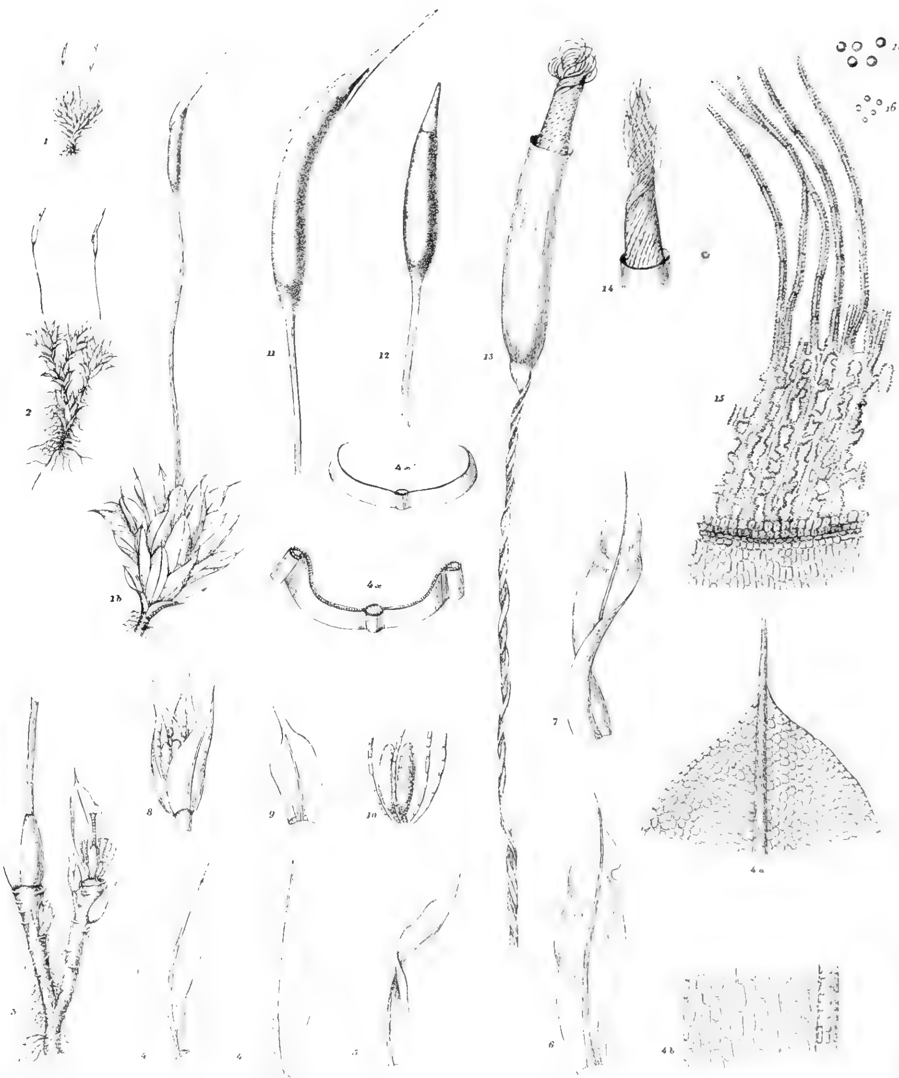
T. mucronifòlia Schwaegr. Loosely tufted, monoicous; leaves oblong-spatulate, margins reflexed below; costa excurrent into *a smooth hair-point*, upper leaf-cells hexagonal, *smooth both sides;* capsule ovoid-cylindric, lid elongated-conical; basal membrane $\frac{1}{3}$–$\frac{1}{2}$ the height of the entire peristome; spores in summer. On soil and stones, rather infrequent in our region.

T. papillòsa (Muell.) Wils. is not often collected, but is probably as common as any of our species. It never has been found fruiting except in Australia and

FIGURE 79. *b*. Cross-section through the costa of *Tortula papillosa*, showing papillæ at back and brood bodies on the inner surface. (After Limpricht.) 1, 1*a*, etc. Leaves and leaf-cells of the same. (After Dixon.)

New Zealand and must be often overlooked. The plants are small, less than 12^{mm} in height, and are readily known by the concave papillose leaves with the margins strongly involute, bearing on the upper surface of the costa numerous multicellular propagula as shown in Fig. 79. The papillæ on the leaves are simple except at the back of the costa. This species, unlike its relatives, grows on the bark of trees. *T. pagorum* (Milde) DeNot has been collected on bark of trees in Georgia by Dr. John K. Small. It is similar to *T. papillosa* but has *compound papillæ, costa smooth at back* and without brood bodies; but in the axils of the upper leaves are found tiny leaf-like brood bodies, ecostate with a hyaline apiculus.

T. marginàta (B. & S.) Spruce is a rare species which sometimes grows on the walls of houses. The leaves are narrowly oblong or lingulate, with a short hair-point, papillose, with margins plane and bordered with a distinct band of *2–4 rows of yellowish linear cells*. It is dioicous and matures its spores in spring as a rule.



mucronifolia

PLATE XXXVI. *Tortula mucronifolia* (From Bry. Eur.) 1 and 2. Plants natural size.

Family 11. Encalyptaceae

The mosses of this family grow on soil or stones and are erect and usually cæspitose. The leaves in our species are broad and lingulate or spatulate; lower leaf-cells thin-walled and hyaline; upper cells small, dense and opaque, bearing strong verrucose papillæ. The extinguisher-like calyptra (see Plate XXXVII) is the most characteristic thing about the family, and because of it these mosses are often called Extinguisher Mosses. The members of this family belong in the single genus

ENCALÝPTA Schreb.

which is so much like some species of the *Tortulaceæ* that Brotherus in "*Die Planzenfamilien*" makes it only a subfamily of the *Tortulaceæ*. In many respects our species strongly resemble the species of *Tortula*. The leaves are large and tongue-shaped and are twisted when dry, but the costa is little or not at all excurrent. In fruiting plants the peristome and the characteristic calyptra are enough to render identification easy, in sterile plants the beginner might make a mistake. The plants are much too large to be confused with *Desmatodon*, and the percurrent or barely excurrent costa distinguishes from all of our species of *Tortula* except *T. papillosa*, which has simple papillæ, or *T. mucronifolia*, which has no papillæ at all.

In *Encalypta* we have a curious combination of peristome characters; the striking similarity of the calyptra and leaves in the various species make it certain that no mistake is made in putting them all in one genus; yet within the limits of this one genus we have almost all degrees of completeness of the peristome, from none at all to one highly developed and double. Some of the peristomes show a strong likeness to the nematodont type, while in *E. procera* there is an almost typical arthrodont double peristome. There seem to be good grounds for considering the peristome of *Encalypta* as a primitive form connecting the two types above mentioned, and I now believe that an arrangement of the families in the following order would better represent their relationships than the one decided upon when the book was begun: Georgiaceæ, Polytrichaceæ, Buxbaumiaceæ, Encalyptaceæ, Tortulaceæ, Ephemeraceæ, Grimmiaceæ, Dicranaceæ, Fissidentaceæ. For a more complete discussion of this matter, see the Bryologist **7**: 38. 1904.

E. streptocárpa (Hedw.), the Common Extinguisher Moss, is very common on limestone. The plants are very large, 3–6^{cm} in height, and many of the large (about 6^{mm} in length) coarse leaves are strongly incurved at apex and subcucullate. The costa is rough on the back and does not reach the obtuse and rounded apex. The perichætial leaves are acuminate; the seta long and reddish; calyptra rough at the tip; capsule long-cylindric, with 8 reddish spiral ribs; peristome double, outer teeth long, red, filiform and papillose; inner peristome half the length of the outer, consisting of 16 or 32 filiform seg-

FIGURE 80. *Encalypta streptocarpa.* (From Bry. Eur.). 1. Plant natural size. 1*b*. Plant enlarged. 2 and 3. Leaves. 5. Perichætial leaf. 4*a*. Leaf apex. 4*b*. Cells from base of leaf.

ments from a basal membrane which is adherent to the teeth. The spores mature in late summer, but so far as I know this species has never been found fruiting in America.

E. ciliata (Hedw.) Hoffm. is a less frequent plant, rather smaller and lighter green than the preceding. In fruit the strongly fringed calyptra will render it unmistakable. When sterile the apiculate leaves, plane margined above, but narrowly recurved below with costa excurrent or ending just below the apex, will

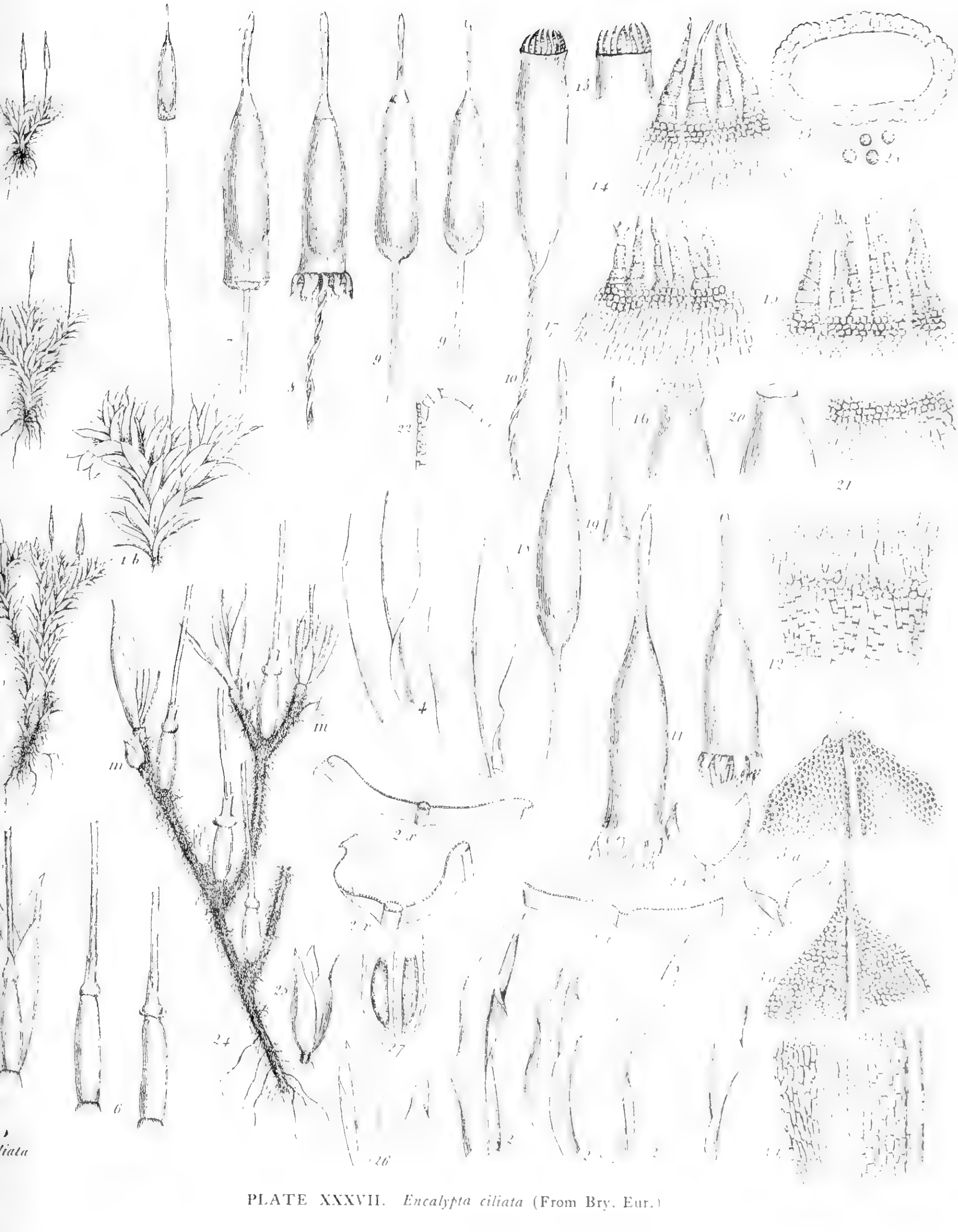


PLATE XXXVII. *Encalypta ciliata* (From Bry. Eur.)

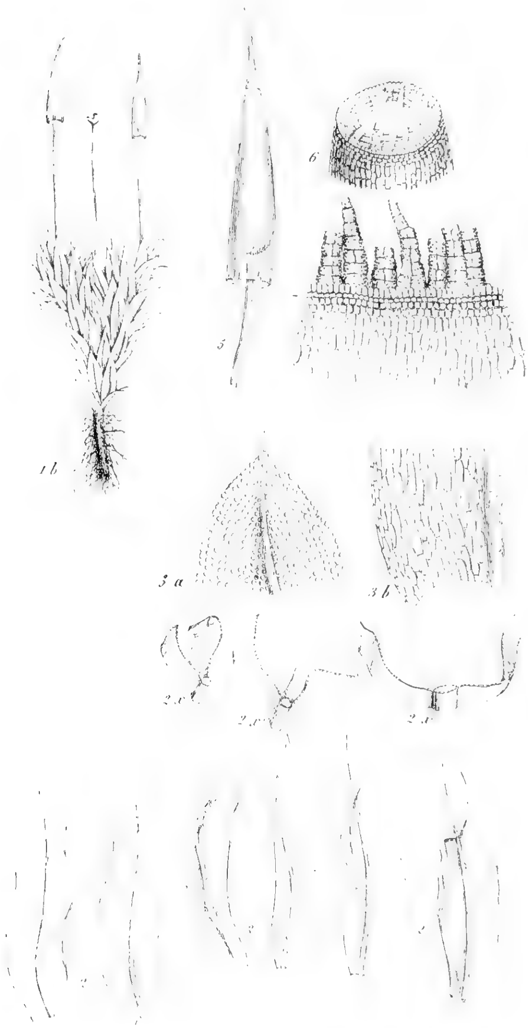


FIGURE 81. *Encalypta vulgaris* (From Bry. Eur.) 1*b*. Plant enlarged.

usually serve to identify it. The capsules are not ridged when dry; the peristome is single, of 16 teeth; spores maturing in late summer.

E. vulgàris (Hedw.) Hoffm. is rare in America. It is alpine or subalpine; small, about 12^{mm} high or less; leaves obtuse-rounded and apiculate, or more or less acute; costa excurrent or merely percurrent; capsule smooth; peristome simple, of very fragile teeth, or sometimes entirely wanting; spores in late spring.

One who had never seen either species might confuse sterile specimens with *Tortella cæspitosa*, from which it is distinguished by its larger lingulate leaves having the hyaline basal area bordered by a few rows of much narrower elongated cells.

The shape and structure of the leaves is similar to that of *Barbula unguiculata*, but the leaves in this species are so much larger that it appears very *much more robust*, and the leaves are also much more spreading when dry.

GROUP 2. DIPLOLEPIDEAE

Peristome double, the plates of the outer side of the teeth (outer peristome) in two rows, separated by a zigzag median line; inner side of teeth of a single row of plates.

Inner peristome thin and membranous, made up of the inner walls of the same cells whose outer walls formed the inside plates of the teeth. (See pages 33 and 34). The teeth of the inner peristome are known as segments, and are usually 16, alternating with the teeth, somewhat keeled, usually arising from a basal membrane $\frac{1}{8}$ to $\frac{1}{2}$ the height of the teeth, and in the highest development separated by 1–3 hair-like cilia of varying lengths. The segments may be opposite the teeth and without basal membrane or cilia as in *Funaria*. The segments themselves may be reduced to a mere filament, as in *Orthotrichum*. The entire inner peristome may be lacking in degenerate types, as in some species of the *Bartramiaceae*, or even the entire peristome may be lacking, as in *Physcomitrium*.

SUBGROUP 1. ACROCARPAE

Sporophyte terminal from erect, or nearly erect stems, sometimes becoming lateral by innovations. In these respects the plants of this subgroup are like most of those of the preceding families.

Family 12. Orthotrichaceae

This family somewhat resembles the Grimmia Family, but nearly always *grows on trees*. The plants are small, rarely reaching an inch in height and usually much shorter, blackish or brownish green below; nearly always growing in tufts or cushions. The leaves are oblong- or linear-lanceolate and usually very hygroscopic; cells of the upper part hexagonal to rounded-hexagonal, thick-walled and often papillose; lower cells oblong to rectangular, rarely papillose, thinner walled in most cases, and often hyaline; costa single, strong. The calyptra is nearly always hairy and the capsules often immersed, *with very distinct longitudinal wrinkles when dry and empty*. The peristome usually consists of 16 *rather short teeth, which are nearly always reflexed when dry and are often united in pairs; the inner peristome is usually represented by 16 slender hairlike processes*, often called cilia, but really homologous with the segments of the type of peristome found in *Mnium* and *Hypnum*. In some cases the peristome may be simple or even wanting, as in *Amphidium*. This family is often united with the *Grimmiaceae*, from which it is distinguished by the italicized characters. Members of these two families may become so dry and brittle as to crumble to dust in the fingers and yet retain their vitality unimpaired, springing into renewed growth with the next rain.

KEY TO THE GENERA

1.	Calyptra smooth, cucullate; peristome none or very short and single; rock-growing except *Drummondia*	2.
	Calyptra mitrate, nearly always hairy; peristome well developed, almost always double; growing almost exclusively on trees	3.
2.	Tree-growing; capsule long-exserted; peristome single, short and truncate. Common	*Drummondia.*
	Rock-growing; capsule barely exserted; peristome lacking. Rare	*Amphidium.*
3.	Capsule exserted; leaves crisped, except *U. Americana*	*Ulota.*
	Capsule immersed or emergent; leaves not crisped when dry	*Orthotrichum.*

AMPHÍDIUM (Nees) Schimp. (*Amphoridium* and *Zygodon* of authors)

Slender-stemmed dichotomously branching plants growing on rocks, usually in dense tufts from 3–8^{cm} in depth, rather densely radiculose. Leaves linear to lance-linear, twisted and contorted to crispate; costa strong, reaching nearly to apex; upper leaf cells small, thick-walled, rounded or angular, said to be papillose but the papillæ are very low and inconspicuous; basal cells becoming gradually elongated-rectangular and thinner walled, also lighter colored or even hyaline. Calyptra cucullate, without hairs. Capsules erect, emergent or exserted, with a distinct neck, becoming urn-shaped and 8-striate when dry; peristome none.

The two species of this genus appear to be mainly alpine or subalpine in our range, and either rare or else sterile and seldom collected and identified. Both mature their spores in summer.

A. Lappónicum (Hedw.) Schimp. Monoicous, olive-green above, blackish or brownish below, seldom above 3^{cm} in height; *leaf margin plane throughout*, basal cells thinner walled than in the next; perichætial leaves sheathing seta; seta 1.5^{mm} long or less; capsule partially immersed, *beak of operculum usually shorter than radius of capsule.*

A. Mougeótii (B. & S.) Schimp. Dioicous, yellowish green, ferrugineous below, reaching 8^{cm} in height; leaves longer and narrower than in the last, with *borders narrowly recurved below, basal cells thicker walled* than in the last and seta twice as long, *sheathed only at base* by the perichætial leaves; capsule usually exserted, beak of operculum *longer than radius of capsule.*

Limpricht remarks truly that this genus reminds one of *Rhabdoweisia* in appearance. Mr. Dixon says that *A. Mougeotii* is most likely to be mistaken for

Gymnostomum curvirostre or *rupestre.* This confusion is not likely to take place with fruiting plants, and the papillæ on the leaves of *Gymnostomum* are so much larger and more conspicuous as to afford a ready means of distinction. Besides, *Gymnostomum* usually grows on calcareous rocks, while Amphidium rarely does so.

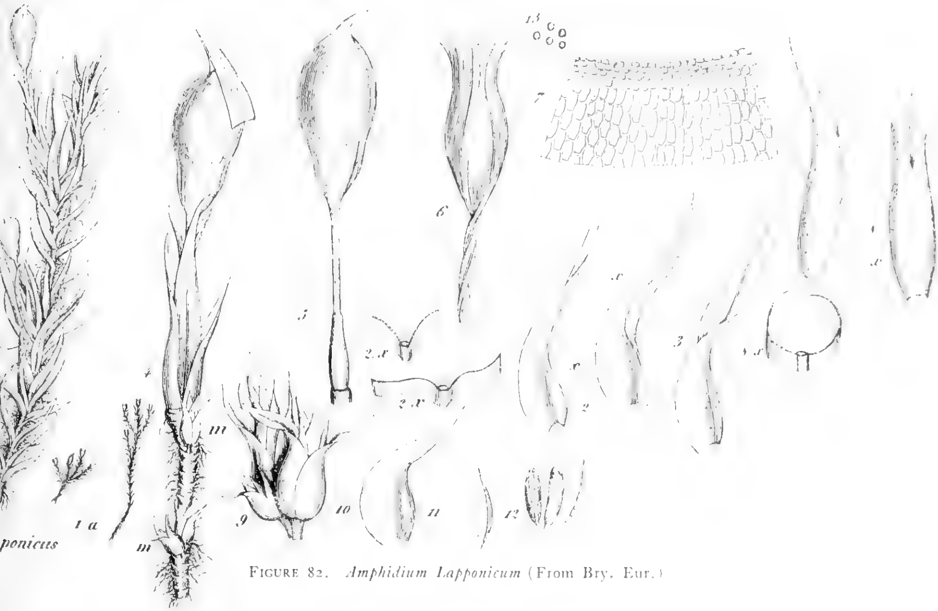


FIGURE 82. *Amphidium Lapponicum* (From Bry. Eur.)

DRUMMÓNDIA Hook.

Drummondia is a common moss of the Orthotrichum Family. It always grows on the bark of trees, but is easily distinguished from its tree-growing allies by three characters. Its stems are long and closely applied to the bark of the tree, sending out short horizontal branchlets so thickly that the stems below become apparent only when the plant is removed. The capsule is on a long seta, the calyptra is cucullate, and the peristome is so small as to be scarcely apparent.

Drummondia is named for Drummond, one of the earliest collectors of American mosses.

FIGURE 83.
Drummondia clavellata. *a*, 1. *b*, × 10. *c*, Calypta × 10. *d*, Empty capsule × 10.

D. clavellàta Hook. is our only species. Its leaves are ovate-lanceolate, acute, entire; leaf-cells rounded and thick-walled, only slightly different at base, not papillose. The peristome is single, of 16 short truncate teeth, which look as if the upper three-fourths had been broken off.

ULÒTA Mohr.

The species of Ulota have the characteristic brownish-green or blackish-green color of the Orthotrichum Family. They are distinguished from all save *Orthotrichum* by the hairy calyptra. Both Orthotrichum and Ulota grow on the bark of trees or more rarely on rocks, in cushions of varying size and thickness. The Ulotas growing on trees usually grow in more rounded tufts, with the leaves more crisped when dry than is usual with Orthotrichum growing in similar situations. The median basal leaf cells are often nearly linear, upper cells slightly papillose to smooth. The books all say that the hairs on the calyptra of Ulota are flexuous, and those on Orthotrichum straight, but this distinction appears to be rather too fine for the amateur to profit by it. The capsules in both genera are erect and symmetric and quite regularly striate when dry, with eight or sixteen ridges and as many alternating furrows. These ridges consist of cells larger, darker, and thicker-walled than the alternating tissue. The peristome may be single or double. The seta in Orthotrichum is so short that the capsule is nearly always partially immersed; in Ulota the seta is long enough to exsert the capsule entirely beyond the perichætial leaves.

The remarks in the discussion of *Orthotrichum* on the condition of capsules suitable for study apply equally to *Ulota*.

U. Ludwígii Brid., the Puckered Ulota, has pear-shaped capsules, abruptly narrowed to the very small mouth; the ridges and furrows extend only a short distance from the mouth of the capsule, giving it the peculiar and characteristic appearance shown in the cut. The peri-

FIGURE 84. *d*, *d'*. *U. Ludwigii* × 4 and 1 respectively. *e*. Capsule × 20. *f*. Calyptra of mature capsule × 21.

PLATE XXXVIII. *Ulota crispa* and var. *crispula* (From Bry. Eur. *Orthotrichum crispum* and *crispulum*.)
3*a*. Dry leaves. 8*x*. Cross section of calyptra. 7. Dry and empty capsules.

stome teeth are erect when dry, united in pairs; inner peristome imperfect or wanting. The marginal cells at the base of the leaves have thin longitudinal walls and form a narrow hyaline marginal band tapering upwards to the top of the leaf-base. Spores in autumn.

U. críspa Brid. The capsules of the Crisped Ulota have a much larger mouth, are striate for the entire length and are contracted under the mouth when dry and empty. The peristome teeth are united in pairs and at first are spreading, later recurved; segments 8 or rarely 16. The seta is shorter, the color is lighter, and the tufts are rather thicker than in the Puckered Ulota. The leaves resemble those of that species, but have a wider marginal band of hyaline cells at base. In the not uncommon variety *crispula* of the Crisped Ulota the capsule is much shorter and is suddenly contracted into a neck, narrow and much twisted when dry. The capsule is scarcely contracted under the mouth except immediately after the fall of the operculum; when very old it may taper uniformly to the seta. The spores are ripe in late spring and early summer.

U. Brùchii Hornsch. is an alpine or subalpine species, rather rare, larger and with leaves less strongly crisped than in the last. The seta is longer, and when the capsules are dry and empty they become distinctly fusiform, gradually narrowed to the mouth but not contracted beneath it.

The cut gives an excellent idea of the progressive changes in the capsules. Sometimes all the forms illustrated may be found in the same tuft. This species is occasionally found on rocks. The spores mature in summer.

U. Americàna (Beauv.) Lindb., the American Ulota, grows exclusively on rocks. Its leaves are rigid when dry like those of *Orthotrichum*, not crisped as in the two tree-growing species; the capsules very closely resemble those of the Crisped Ulota, except that the seta is markedly longer. It is most likely to be confused with *Orthotrichum anomalum*. For distinctions, see under that species. All of these species of *Ulota* except *Bruchii* are common in the hilly portions of our range, and the tree-growing species with *Orthotrichum* furnish good collecting for winter and early spring, when most other plants are buried under snow.

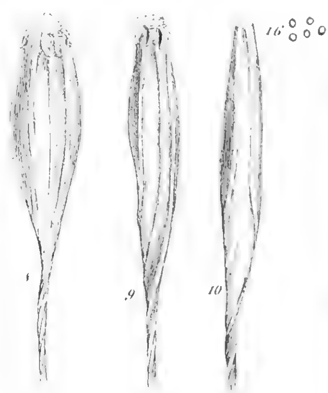


FIGURE 85.
Three capsules of *Ulota Bruchii*, showing progressive changes due to increasing age. (From Bry. Eur.)

ORTHÓTRICHUM Hedw.

Plants comparatively short-stemmed, in close rounded cushions, sometimes looser, on trees everywhere, and more rarely on rocks. Leaves hygroscopic, imbricated when dry and not greatly curled or twisted, which character separates the genus from *Ulota* except *U. Americana*. Upper leaf cells usually papillose, thick-walled, the lower thinner-walled and quadrate to rectangular. Calyptra sparsely hairy or naked. Base of seta enclosed in a minute cup-like sheath, the ochrea. Capsule immersed or emergent, rarely exserted; usually with 8 regular folds, or plicæ, when dry, but sometimes smooth or with 16 plicæ. Peristome usually double, with 16 broadly lanceolate teeth, which are usually united in pairs. Inner peristome of 8–16 narrow segments, often called cilia. The paired (bigemminate) teeth and degenerate inner peristome illustrate well the degeneracy of peristomes on erect capsules.

The Orthotrichums are most frequent on trees about houses, and in orchards and village streets, although they are not lacking in other situations where the trees stand somewhat apart. They can be found abundantly on almost any fruit or shade tree in the country. In the larger cities, for some reason, they do not seem to thrive. They may frequently be found growing with *Ulota*, from which the immersed or emergent capsule and non-crisped leaves distinguish them at once. One common species (*O. anomalum*) grows on rocks. The calyptras are less densely hairy than those of *Ulota*. Two species have a calyptra without hairs. The leaves have revolute margins, except in *O. obtusifolium*, which appear as a darker margin when the leaves are mounted on a slide. *Drummondia* has the general appearance of an *Orthotrichum* with an exserted capsule, but the calyptra is cucullate and without hairs and the capsule is not wrinked when dry.

This is a difficult genus, usually avoided by the amateur, but I believe one can learn to recognize all the common species with a hand-lens when they are well fruited; it will usually serve to determine the number and position of the teeth, markings of the capsules and general outlines of the leaves. Sterile specimens are often indeterminable. The stomata furnish an excellent and definite microscopic character and are easily observed by separating a capsule into two or more divisions with the dissecting needles and mounting outside up; the stomata are nearer the middle of the capsule than in many mosses and are, therefore, easier of observation. The condition of the material is of the utmost importance. The capsule must be thoroughly soaked in hot water for a long time to be fully expanded, and the dry capsule must be thoroughly dry to be characteristic. The capsules of all species shrink progressively with increasing age, and many varieties had their origin in this fact. The plants should be moistened to determine whether the capsules are immersed, emergent, or exserted. The peristomes are often quite brittle and are apt to be broken, especially the segments. For identifying species, especially with a hand-lens, perfect calyptras are of the greatest value and importance.

KEY

1. Rock-inhabiting species; peristome single, teeth 16, erect or erect-spreading on dry capsules; stomata immersed . . . . 2.
Tree-inhabiting species; peristome double, teeth usually united into 8 pairs, recurved or reflexed when dry . . . . 4.
2. Capsule fully exserted, 16-striate . . . . *anomalum.*
Capsule immersed or emergent, 8-striate . . . . 3.
3. Capsule ovate-cylindric, urn half emergent when dry . . . . *Porteri.*
Capsule much shorter, ovate-globose, leaves nearly reaching mouth of urn when dry . . . . *Lescurii.*
4. Stomata superficial (*i. e.*, with both guard-cells on the surface. See plate 39, figure 13) . . . . 5.
Stomata immersed. (See figure 87, 10) . . . . 8.
5. Leaves obtuse (rarely with some leaves acute), broad pointed, margins plane . . *obtusifolium.*
Leaves acute, margins revolute or involute . . . . 6.
6. Capsule almost or quite exserted, smooth, or very slightly plicate around the mouth when dry and empty . . . . *speciosum.*
Capsules immersed or slightly emergent, plicate the whole length when dry . . . 7.
7. Empty capsule strongly contracted below the mouth when dry, neck immersed; common . . . . *sordidum.*
Empty capsule less strongly contracted, exserted; rare . . . . *affine.*
8. Capsules strongly contracted under the mouth when dry, and so strongly plicate that the red-brown folds are in contact on the outside when dry and empty . *strangulatum.*
Capsules very slightly or not at all contracted, much less strongly plicate, pale, whitish or yellowish . . . . 9.
9. Leaves entire, blunt at extreme apex . . . . *Ohioense.*
Leaves (some at least) dentate with projecting cells, often apiculate . . . . . . 10.
10. Leaves mostly acute at apex, not rounded; usually some with an apiculus of a single projecting cell; capsules plainly 8-plicate when dry . . . . *Schimperi.*
Leaves obtuse, rounded and some sharply denticulate at apex with several projecting cells; capsule smooth or faintly 8-plicate when dry . . . . *pusillum.*

O. anómalum Hedw. In rather dense cushions, dark olive-green or brown below; leaves ovate-lanceolate, papillose with small simple papillæ; basal cells rectangular, *thin-walled and hyaline;* calyptra hairy; capsule usually fully exserted, 16-striate, the 8 intermediate folds less distinct, oval-cylindric when moist, cylindric when dry, abruptly narrowed to the neck; stomata immersed; peristome erect when dry, of 16 teeth, usually separate, with preperistome (*i. e.*, with two short lamellæ before each tooth reaching as high as the second or third articulation); segments none or rudimentary. Spores maturing May–June. Not rare.

Mrs. Britton says that we also have the var. *saxatile*, which has narrower 8-striate capsules with teeth united in pairs, and 8 well-developed segments.

This species will not be confused with any other species of *Orthotrichum*, but may be confused with *Ulota Americana*. The latter has the dry capsule gradually narrowed into the long neck and the teeth *reflexed* when dry and united in pairs, and the basal leaf-cells are thick-walled and colored; besides, it is almost black in color except at the extreme ends of the stems and branches, and grows in loose wide mats. Its spores mature much later, July–September. *Drummondia* has the general appearance of an *Orthotrichum* with an exserted capsule, but it grows on trees only.

O. Pórteri Aust. and **O. Lescùrii** Aust. are our only other rock-inhabiting forms, at least the only ones at all likely to be met with. They have usually been treated as varieties of *O. cupulatum* Hoffm., but both Dr. Venturi and Mrs. Britton consider them distinct, and Mrs. Britton says that we have no *cupulatum* in the Eastern States. These two forms have not been frequently collected or adequately described. Their habitat and immersed or emergent capsules should serve to identify them, and collectors should be on the lookout for them.

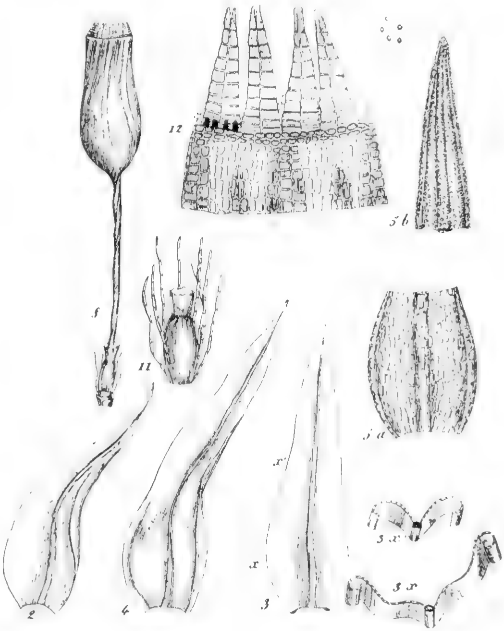


FIGURE 86. *Orthotricum anomalum* (From Bry. Eur.).

2, 3, 4 and 5. Leaves; *x* and *x'* indicate where the sections 3*x* and 3*x'* were made. 11. Vaginula. 8. Deoperculate capsule and seta. 12. Peristome highly magnified; the tooth at the left has been redrawn to show the lamellae of the preperistome.

Dr. Venturi stated in a letter to Mrs. Britton that *O. Porteri* had a distinct preperistome as in *O. anomalum*, but he is the only one who has noted it, and other observers have failed in their attempts to verify his observations.

O. Ohioénse S. & L. In rather dense, small cushions, yellowish green, brown below; stems about 1^{cm} long; leaves oblong-lanceolate, blunt at the apex or obtusely acute, papillose; calyptra hairy; moist capsule immersed, oblong-ovate, when dry slightly 8-plicate, campanulate, becoming more narrowed with age, straw-colored; peristome of 8 double teeth, strongly reflexed when dry; segments shorter than the teeth, of a double row of cells, except at apex;

FIGURE 87. *O. Ohioense* (Sulliv. Icones Musc. Suppl.) 5. Areolation of leaf. 7. Dry and empty capsule. 10. Stoma.

spores maturing in early spring (April). Common on trees. When sterile it is a difficult matter to distinguish this from the next, but the straw-colored lightly plicate capsules are easy of recognition and the entire leaves serve to distinguish it from the other species with light-colored capsules.

FIG. 88. Capsule of *O. strangulatum*.

O. strangulàtum Sulliv. This is one of our most common mosses, abundant on shade trees almost everywhere. It can be recognized with a hand-lens by the characters given in the key if one is familiar with it. The capsules are not so deeply plicate until a month or more after the spores ripen. It is a little smaller than the preceding, the leaves are narrower, and the calyptra naked and strongly plicate; the spores apparently mature about a month later. The first few rows of cells around the mouth of the capsule in this species have nearly quadrate cavities, while in the preceding these cavities are nearly circular.

Dr. Best is of the opinion that the form figured here is at least a good variety and not the true species. The capsule figured by Sullivant (Icones Musc. pl. 36) has a shape intermediate between that shown here and that figured for *O. Ohioense.* The form shown in Fig. 88 is the common one in northern New England.

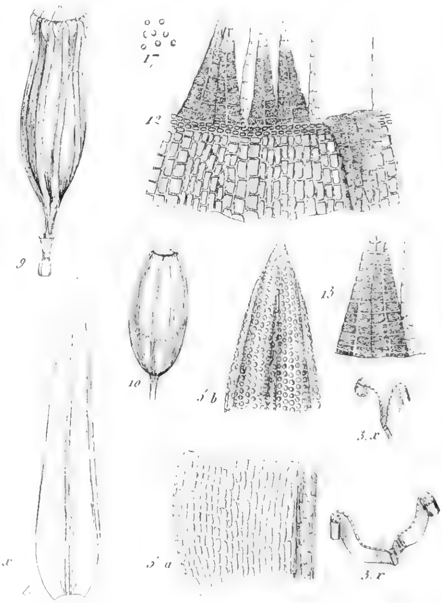


FIGURE 89. *O. Schimperi* (From Bry. Eur.) 3, 4 and 5. Leaves. 9, 10, 12 and 13. Capsules and peristome.

O. Schímperi Hamm. (*O. fallax* Schimp.) In short, close, dark green tufts, only a few mm. high; leaves oblong-lanceolate, obtuse or usually some acute and ending in an apiculus of a single elongated cell, leaf cells rather large and thinner-walled than usual in the genus, papillose; calyptra with a few short hairs; capsule small, immersed, oblong-ovoid, light-colored, when dry narrow and slightly contracted below the mouth, with 8 rather prominent plicæ; teeth 8, reflexed, densely papillose; segments 8|; spores maturing in spring. Frequent.

FIGURE 90.
Leaf structure of *O. pusillum* (Sulliv. Icones Musc. Suppl.)

A specimen with all the leaves obtuse might be mistaken for *O. Ohioense*, but the smaller size, darker color and smoother calyptra are quite pronounced. The form with the leaves narrowly acute and apiculate and narrower capsule has been called var. *truncatulum* by Austin. Rarely the leaves have more than a single projecting cell at the apex. Mrs. Britton and Dr. Best think that *O. brachytrichum* Schimp. is a synonym for the American form of this species, and that we have no true *O. Schimperi.*

O. pùsillum Mitt. (*O. psilocarpum* James.) The plants are as small as those of the preceding and the color is blackish green, but the capsules are ovoid or globose when moist, only faintly ribbed even when old. Spores maturing in May. Apparently not common. The apex of the leaves is very characteristic as figured. It is very like *O. Schimperi* except in the characters mentioned here and in the key.

O. obtusifòlium Schrad. Yellowish green, about an inch high;

FIGURE 91. *O. obtusifolium* (From Bry. Eur

3, 4, 5 and 6. Leaves from below upwards. 7. Shows cellular structure of leaf. 10. Capsule. 13. Peristome highly magnified. 14. Segments of the same. 19. Propagula.

leaves short and very broad, oblong-ovate, *very broad and obtuse at apex, papillose, margin not appreciably revolute or incurved; calyptra naked, not at all plicate*, brownish at the tip, lighter colored below; capsule immersed, with 8 plicæ when dry; peristome double.

Probably a very common species, but so seldom fruiting as to be collected infrequently. The leaves usually bear clavate, septate propagula, which may account for the rarity of the fruit. The broad apex, entire except for papillæ, and erect margins, render sterile specimens easy to determine. All other species have the margins revolute or involute. *O. gymnostomum* Bruch has been found in Newfoundland. It is closely related to this species but has *involute* leaves and no peristome. Collectors should look out for it.

O speciòsum Nees. Perhaps the largest of our species, two to four cm. in height, yellow-green above; leaves tapering, *very acute*, papillose; *leaf cells very thick-walled*, the upper circular or elliptical; calyptra large, hairy, campanulate; capsule oblong-cylindrical, almost exserted, the upper leaves barely reaching the base, smooth or barely marked with irregular ridges when dry; operculum rostellate; peristome of 8 teeth, which when dry are recurved rather than reflexed, as the tip of the tooth sometimes touches the capsule wall in a way to remind one of the handle of a mug; segments 8, papillose. Like *O. obtusifolium*, this species occurs rarely on rocks. The spores mature by October, but I have collected operculate capsules in March.

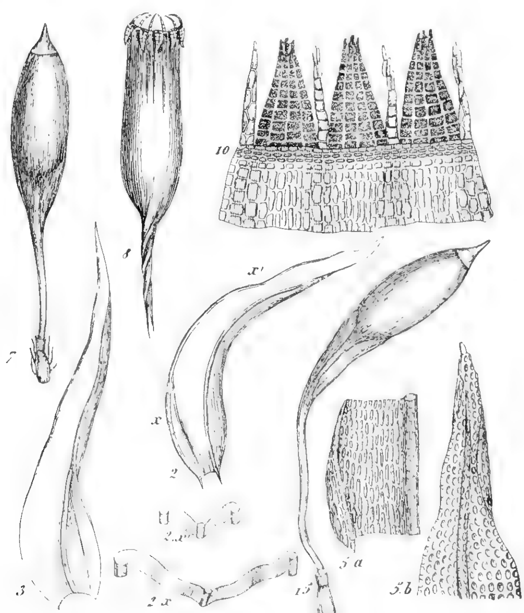


FIGURE 92. *O. speciosum* (From Bry. Eur.)
2, 3 and 5. Leaves. 7, 8, 10 and 15. Capsules and peristome.

O. sórdidum S. & L. Somewhat resembles the preceding in leaf characters, but the leaves, though acute, are broader pointed, with thinner cell-walls. It is at once distinguished by the immersed or emer-

PLATE XXXIX. *O. sordidum* (Sulliv. Icones Musc. Suppl.)

1. Plants natural size. 3. Leaves. 4. Leaf sections. 5. Cellular structure of leaf base and apex. 12. Antheridial branch with antheridium and paraphysis. 11. Segment of peristome highly magnified. 13. Superficial stoma. The other figures are self-explanatory.

gent plicate capsules and smooth segments. The spores mature in late spring or summer.

This species is so close to the var. *fastigiatum* of *O. affine* that it may cause confusion, especially as the teeth of *sordidum* are often as markedly trabeculate at the summit as those of *fastigiatum* figured by Limpricht (Laubmoose 2:82), but both *affine* and its var. are rare. I have not been able clearly to differentiate *sordidum* from *affine*, and incline to the opinion that they are forms of the same species for all except the experts. All our ordinary forms are *sordidum*, however. *O. affine* is certainly treated differently by European authors and is exceedingly variable. The capsule of *sordidum* is often so strongly contracted under the mouth as to resemble *strangulatum*, except for the larger size of the plant and the lighter color of the capsule.

O. striatum (L.) Hedw. (*O. leiocarpum* B. & S.) is a rare species, with capsule almost as smooth as in *O. speciosum*, and it has been confused with it by several good bryologists, but the capsules are *immersed* or only slightly emergent and ovoid; teeth *16*, *separate*, segments 16, comparatively broad.

In August I have found *O. speciosum*, *O. sordidum*, *O. strangulatum* and *O. Ohioense* growing together on fruit trees. *O. strangulatum* is much the most abundant, and is easily recognized by the strangulate, dark red-brown capsules appearing as described in the text. *O. Ohioense* is about the same size, but the straw-colored capsules catch the eye at once. *O. sordidum* stands out at once by reason of its greater size and larger leaves and capsules less plicate than in *O. strangulatum*. *O. speciosum* is somewhat smaller than *sordidum*, and at this time the capsules are immature, with the hairy calyptra still firmly attached. The comparative sizes of *speciosum* and *sordidum* are just the reverse of what my herbarium specimens and the book descriptions led me to expect, as the specimens of *speciosum* I collected were much smaller than those in my collection.

Visiting these same trees in April, I found *O. obtusifolium* abundant and readily distinguished by its naked non-plicate calyptra, while the naked calyptra of *O. strangulatum* was regularly and deeply plicate. At this stage these species were readily distinguished from each other and all the other intermingled species by the naked eye alone.

Family 13. Schistostegaceae

Schistóstega osmundàcea (Dicks.) Mohr., the Luminous Moss, belongs in a family all by itself because of its numerous peculiarities.

The plants are very small and slender. The sterile plants have the leaves distichous and ecostate with their bases confluent. Those of the fertile plants are arranged in a tuft at the top of the stem; the leaf-cells are lax and rhomboidal in shape. The capsules are very small and without peristome; they are sparingly produced and ripen in spring. It is found in caves and dark holes in the woods, sometimes under the roots of overturned trees. It has once been found under the sill of an old shed.


FIGURE 93. *Schistostega osmundacea* (From Bry. Eur.) 1 and 2. Plants natural size. 29. Protonema as it appears under the compound microscope.

On looking into one of these caverns containing the Luminous Moss, the bottom seems covered with a golden-green glow, something like the appearance of a cat's eyes in the dark. In order to see the glow one must look into the cave in the direction from which the light enters, and care must be taken not to shut off all the entering light, as the Luminous Moss, like the moon, shines by reflected light alone. If one attempts to gather the glowing substance he will find nothing but dirt and stones, with possibly a few tiny green plants like those in the figure. The compound microscope will reveal threads like those shown in the plate, but the lens will show only a cobwebby appearance of fine green threads. This beautiful plant is probably the reality upon which are based the fairy tales of goblin gold. The discovery of this rare and curious plant will repay a search in every dark hole one sees. If present, it can always be seen from the outside, as it cannot grow beyond the reach of light. Mrs. Britton's Observer articles give a much fuller account of this moss.

Family 14. Splachnaceae

The mosses of this family are rather short-stemmed with leaves distant and flaccid, with a loose areolation, not papillose. The calyptra is cucullate, or entire and conical. Capsules erect and symmetric, with a very pronounced and characteristic hypophysis, which in some species is so exaggerated as to become a striking natural curiosity. The peristome is single in all our species, but is often constructed of three layers with a cellular cavity between two of them so that it is probable that the inner peristome is merely coincident with the outer and adherent to it. The teeth are often united in pairs or more rarely in fours, much as in *Orthotrichum*, and are sometimes reflexed as in that genus. The hypophysis is well supplied with stomata and is made up of loose tissue well adapted for the assimilation of carbon dioxide.

The mosses of this family nearly all grow upon decaying animal tissue or upon animal excreta, more rarely upon decaying vegetable matter, and this, taken in connection with the peculiar hypophysis, makes fertile plants unmistakable. The flaccid leaves, with their loose areolation, distinguish sterile forms from most mosses except, perhaps, the *Funariaceæ* and *Meeseaceæ*.

KEY TO THE GENERA

Hypophysis not very much broader than the rest of the capsule . . . . *Tetraplodon.*
Hypophysis greatly inflated . . . . *Splachnum.*

SPLÁCHNUM L.

The exceedingly large hypophysis and the obovate or broadly lanceolate leaves widest above the base, considered with the family description, sufficiently characterizes the genus. There are several species of Splachnum, but only one is likely to be found.

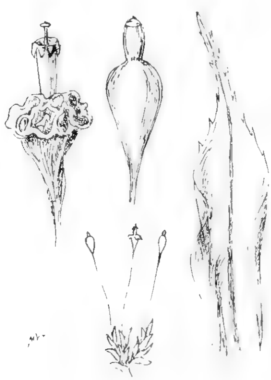
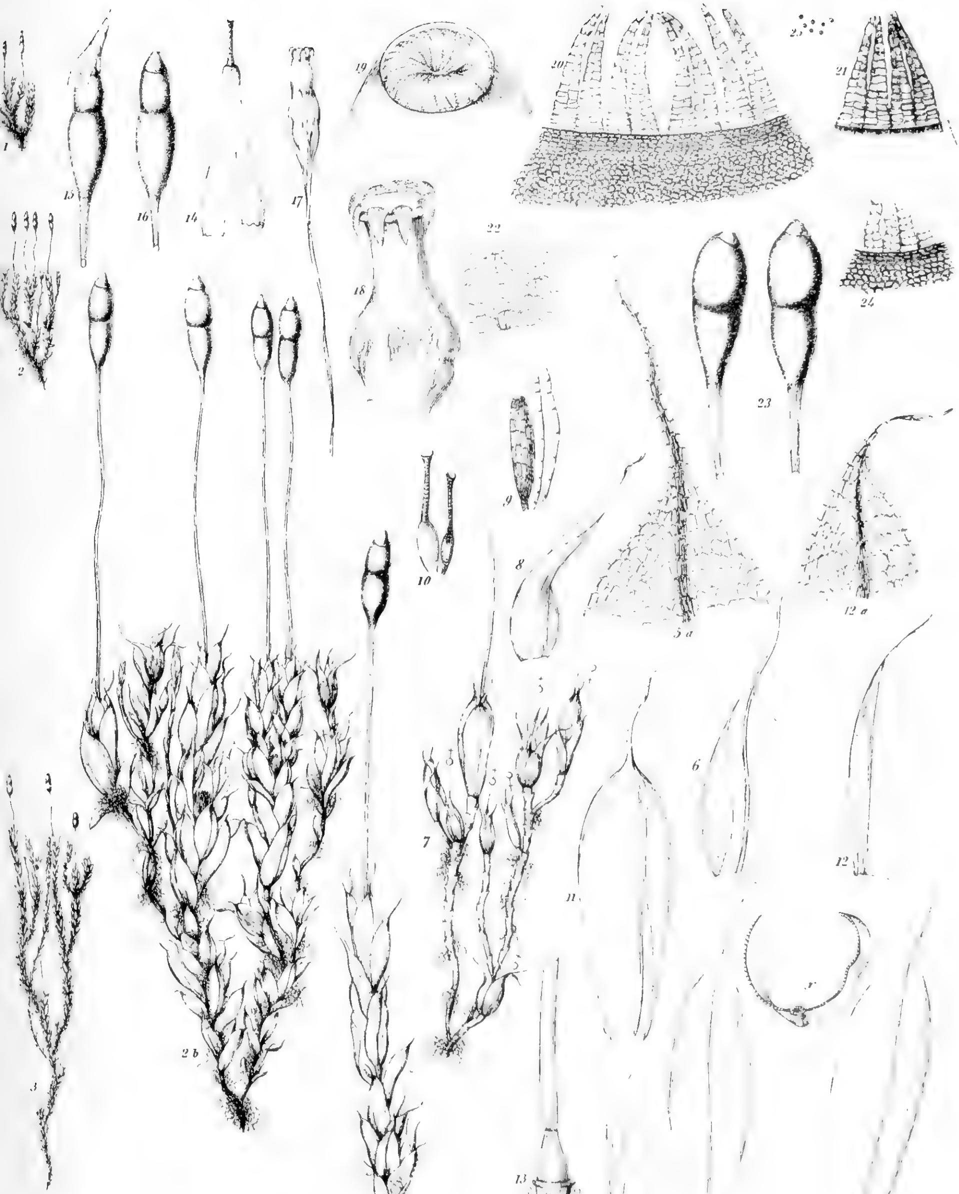


FIGURE 94.

Splachnum ampullaceum; leaf × 10; capsule, ripe and unripe × 5. (The plant and capsules represented are rather small, as they are often found of twice this size.

S. ampullàceum L., the odd-looking moss represented in Fig. 94, is not very common and will not be found readily by most students. It is so striking in appearance that no one can fail to recognize it. The spores are borne in the slender upper portion; the swollen and colored (lilac or purplish) lower portion is the hypophysis of the capsule, which is covered with stomata and filled with loose tissue suitable for the assimilation of carbon dioxide. When dry this portion becomes irregularly shrunken in a manner very difficult to represent in a drawing.

The plants are 1–2^{cm} in height, usually longer than those figured. The leaves are rather distant, the lower lanceolate, the upper narrowly obovate with a slender apex, as shown in the figure; all are serrate, with the costa percurrent or nearly so. The spores mature in summer.



mnioides

PLATE XL. *Tetraplodon bryoides* (From Bry. Eur. *Splachnum mnioides*.
22. Stomata from capsule wall.

This species is widely distributed in swamps throughout our region, but is rather rare. When found, it is often growing on cow dung.

S. luteum Mont. is a very rare species with an enormous yellow umbrella-shaped hypophysis.

S. rubrum Mont. is another very rare species with a similar purple hypophysis.

TETRÁPLODON B. & S.

Resembling Splachnum but with a much smaller hypophysis of the same color as the rest of the capsule and with the leaves narrower as a rule, although *T. bryoides* is an exception to this last.

KEY

1.	Leaves elongated-lanceolate, strongly serrate	2.
	Leaves ovate-lanceolate to obovate, entire	*bryoides.*
2.	Leaves sharply serrate, narrowed to a filiform point	*angustatus.*
	Leaves incised serrate, acuminate with a broader apex	*australis.*

FIGURE 95.
Tetraplodon australis (From Sulliv. "Icones." Reduced $\frac{1}{2}$). 1. Plants $\frac{1}{2}$ natural size. 8. Cross section of seta.

T. bryoìdes (Zoeg.) Lindb. (*T. mnioides* B. & S.). This is probably the most abundant species of the family within our range, although it is confined to the tops of our higher mountains. It is densely tufted, two to eight cm. high; leaves concave, entire, ovate-lanceolate to obovate, tapering into a long filiform point of which the costa forms the greater part; marginal leaf cells often narrower and yellowish. Spores in summer. I have collected this on hedgehog bones back of the hotel on Mt. Mansfield, Vt., and it has been several times collected around the stables of the hotel on Mt. Washington, N. H.

T. angustàtus (L. fil.) B. & S. is another much rarer alpine species, with lanceolate serrate leaves having a very long filiform point like that in the previous species. The seta is much shorter, the capsule being only slightly exserted.

T. austràlis Sulliv. & Lesq. is not an alpine plant but occurs in swamps along the coast from New Jersey southward. It has once been found as far north as Nova Scotia, so that collectors should be on the lookout for it. The distinctive characters of the species are well shown in the illustration. The leaves are long lanceolate and incised-serrate, sometimes almost pinnatifid; costa percurrent. The hypophysis is only a little broader than the rest of the capsule, or frequently reduced to merely a small neck; the columella is often exserted and the teeth reflexed; the spore-bearing part of a freshly opened capsule is a brick-red and the teeth a brighter shade of the same color; the seta is rather short as in *T. angustatus*, which it somewhat resembles, but the leaves are very much more deeply toothed as a rule, although they are sometimes entire. The difference in habitat is, however, most distinctive.

TAYLÓRIA Hook.

is another genus of this family of which a few very rare species are found in northeastern America. The hypophysis is much smaller than in the two preceding genera, being narrower than the rest of the capsule and appearing as a neck. *T. tenuis* (Dicks.) Schimp., having widely spatulate serrate acuminate leaves costate nearly to apex, is the species most likely to be found. It has been collected as far south as Mt. Mansfield, Vt.

Family 15. Funariaceae

Plants annual, sometimes biennial, growing on soil that is bare or sparsely covered with other vegetation, rather short, with large wide soft leaves much like those of the last family, having a strong costa extending, in most cases, well toward the apex. The leaf cells are parenchymatous, large and thin-walled, elongated hexagonal to oblong above, usually rectangular at base. Capsules subglobose, ovoid, or pyriform, erect and symmetric, or strongly unsymmetric and sometimes cernuous, usually with a distinct neck. Peristome lacking or single or double. The teeth when present are 16, and the segments are opposite the teeth instead of alternate with them as in Mnium or Hypnum. There is no basal membrane or intermediate cilia. Calyptra often inflated, usually with a long beak, cucullate or often split in two or more places.

KEY TO THE GENERA

1.	Capsules erect and symmetric; peristome lacking	2.
	Capsules strongly unsymmetric; peristome present, usually double . .	*Funaria.*
2.	Capsules exserted on a long seta	*Physcomitrium turbinatum.*
	Capsules immersed	3.
3.	Capsule splitting exactly in the middle, with no specially modified cells along the line of dehiscence; angles of cell-walls of capsule thickened (collenchymatous)	*Aphanorhegma.*
	Capsule dehiscing by a regular lid having 1–3 rows of denser cells around its mouth; cell-walls of capsule not thickened at the angles	*Physcomitrium immersum.*

APHANORHÉGMA Sulliv.

A small genus of only two known species. It seems to differ from *Physcomitrium* chiefly in the much less differentiation of the tissues along the line of dehiscence of the capsule.

A. serràtum Sulliv. Plants whitish green, growing more or less thickly clustered. Monoicous, with antheridia in the axils of the leaves or rarely mixed with the archegonia. Lower leaves smaller and more open; upper larger and more nearly erect, oblong to spatulate-lanceolate; costa almost percurrent; capsule immersed, splitting almost exactly half way between seta and apex; cells immediately below the line of dehiscence slightly elongated transversely but not otherwise differentiated. Cell-walls of capsule thickened at the angles (collenchymatous), easily distinguishing this from *Physcomitrium immersum*, which it closely resembles. The spores mature from September to December. On damp soil, apparently preferring clay, frequent in our range except in northern New England.

PHYSCOMÍTRIUM Brid.

Mostly small light green plants, sparingly branching. Leaves oblong, obovate, spatulate or broadly oblanceolate. Calyptra small, mitrate, usually covering less than ½ the capsule. Capsule on a long seta, in a few cases immersed, erect, symmetric, with a distinct lid but no peristome; annulus present, often persistent.

P. immérsum Sulliv. is a widely distributed but rather infrequent species so much like *Aphanorhegma serrata* that it is often mistaken for it. It is, however, readily distinguished by the characters mentioned under that species and in the key, and by the fact that the antheridia are at first terminal on the young plants and later become lateral by the growth of innovations bearing archegonia. This is the only one of our species of the genus which matures its spores in the fall.

FIGURE 96. *Physcomitrium turbinatum* × 4; capsule × 15.

P. turbinàtum (Mx.) Brid., the Common Urn-moss (*P. pyriforme* of the L. & J. Manual, not of Bridel). Plants exceedingly variable according to the conditions under which they develop, as Mrs. Britton has shown (Journ. of N. Y. Bot. Garden 4: 50. 1901. Also, see Bryologist, 4: 50. 1901.) Autoicous, 3–12$^{mm.}$ in height, leaves 3–5^{mm} long, oblanceolate or obovate from

PLATE XLI. *Physcomitrium immersum* (From Sulliv. "Icones") an oblong base, serrate above the middle, costa ending below the apex or rarely excurrent in some of the leaves. Capsules globose-pyriform when fresh, becoming turbinate and constricted below the mouth when dry, dark brown and often urn-shaped when empty; mouth bordered by 8–12 rows of transversely elongated cells; annulus persistent and incurved after falling of the lid. Spores rough, maturing in spring. (Description adapted from Mrs. Britton's "Revision of the Genus Physcomitrium," Bull. Torr. Bot. Club. 21: 199. 1894.)

The Common Urn Moss is common on earth in conservatories, by roadsides and in old fields. It is abundant in moist places by paths in the parks of Greater New York. It must be collected in May to get the calyptra in position. *Pottia truncatula* may be found and confused with the Urn Moss, which it closely resembles. *Pottia*, however, is smaller, being about one-half as large, matures its capsules in winter, and under a lens will be seen to have the midrib excurrent instead of ending in or below the apex of the leaf, as in the Urn Moss.

FUNÀRIA Schreb.

Funaria strongly resembles *Physcomitrium* in everything except sporophyte characters. Calyptra inflated at base, finally oblique with base cucullate. Capsule more or less gibbous, narrowed to a rather short neck, wrinkled to strongly sulcate when dry; mouth more or less one-sided. Peristome double in our species; teeth 16, often twisted spirally and united at their tips; segments 16, opposite the teeth, without basal membrane or intermediate cilia.

KEY

1.	Leaves long acuminate, costa excurrent in some of the leaves of each plant	2.
	Leaves short acuminate, costa percurrent, sometimes very shortly excurrent . . .	3.
2.	Capsules curved and unsymmetric but scarcely cernuous; annulus lacking	*Americana.*
	Capsules plainly cernuous; annulus large	*flavicans.*
3.	Segments of inner peristome at least 2/3 length of teeth; spores 12–16μ in diameter; common everywhere	*hygrometrica.*
	Inner peristome rudimentary; spores 24–32μ; rare	*microstoma.*

F. hygrométrica (L.) Sibth. the Cord Moss, is so called because of the twisted seta, which is very hygroscopic and untwists when moist. Its Latin name, *Funaria*, is derived from *funis*, a rope. This twisting of the seta is not peculiar to this moss, however, but is a very common thing in nearly all moss families. The lower leaves are shorter than the upper, which are rather closely imbricated into a bulb-like tuft, oblong-ovate, acute or short acuminate, entire or nearly so; costa ending in the apex; leaf cells inflated, subhexagonal; capsules very unsymmetric, when dry deeply sulcate with mouth apparently on one side (see glossary, Fig. 23.) at first yellowish, turning brown when old; annulus of two or three rows of cells, falling with the lid; peristome teeth red, hyaline and appendiculate at apex, united by their tips to a small central disk; segments papillose; spores 13–16$^{\mu}$, maturing early in June. (For further illustrations, see Plates I, II, III, IV and V, also Fig. 1.)

FIGURE 97. *Funaria hygrometrica* × 2, with capsules of various ages and degrees of magnification.

The Cord Moss is to be found everywhere, being especially abundant in waste places and on soil recently burned over. I have seen it completely cover the soil in an old strawberry bed. When mature it is easily recognized by the peculiar looking curved capsule with its mouth on one side. When immature it is much harder to recognize, because the capsule is erect and nearly symmetric and the calyptra has not assumed the rakish position indicated in the figures.

This moss has, perhaps, been given a more careful study than any other species; it is described in nearly every text-book on botany. It is quite variable in many respects and at least two described varieties are recorded from in or near our range, but authentic specimens or a large acquaintance with the species are necessary to determine these varieties with certainty.

F. micróstoma B. & S. is a rare species of the western portion of our range, closely resembling *hygrometrica*, but is smaller in size, and the capsules have a much smaller and less unsymmetrically placed mouth. The inner peristome is rudimentary and the spores are about twice as large as in *hygrometrica*.

F. flávicans Mx. is found from New York southwards. We are in-

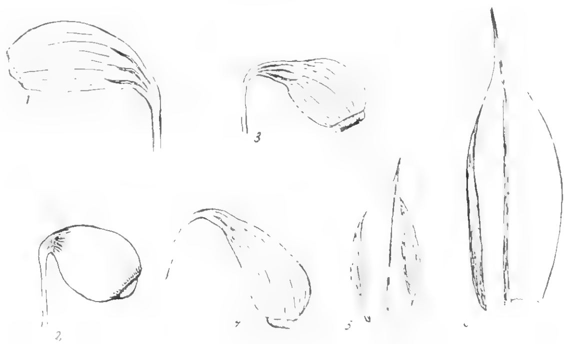


FIGURE 98. *Funaria flavicans* (From the Bryologist, by permission. 1. Capsule not quite mature. 2. Mature capsule with abnormally short neck. 3 and 4. Ripe capsules without lid. 5 and 6. Middle and upper leaves. Figures magnified about 11 diameters.

debted to Mr. R. S. Williams for the drawings and the following notes, which are taken from the "Bryologist" of January, 1901: "The species grows in separate tufts as well as mingled with *hygrometrica*, from which it may be distinguished by the average smaller size, erect pedicel, more pointed leaves, and mouth less oblique, as well as much less furrowed capsule, which matures a week or two earlier than in *hygrometrica*, in this region at least. When well ripened, the capsules are very dark reddish, with a low convex lid, not apiculate." Mr. Williams also states that the mouth of the capsule is constantly smaller in *flavicans*. The spores are about 25$^{\mu}$ in diameter. The long acuminate leaves with the costa often excurrent, are very distinct from those of *hygrometrica*.

FIGURE 99. *Funaria Americana* (From Sulliv. "Icones," slightly reduced.)

F. Americàna Lindb. has been collected in but 5 or 6 localities so far as present records go. But as it has been found in Pennsylvania, Ohio, Georgia and Minnesota, it is widely distributed, and every enthusiastic collector should be on the lookout for it. The small size of the plants, the long acuminate leaves with excurrent costa, the longer necked capsules, without annulus, and nearly smooth above when dry, should render it easy of recognition. The capsules are often contracted below the mouth when dry and empty in a way not shown in the figure. The spores mature in the middle of May.

F. serràta Brid. is a species confined to the southern states and not found in our range. It is easily recognized by its strongly serrate leaves with costa ending below the apex.

Family 16. Meeseaceae

Plants of wet boggy places, frequently growing with Sphagnums. Leaves spreading to squarrose-recurved, of a rather firm structure, ovate-lanceolate to elongated-lanceolate. Costa long and stout, ending a little below the apex. Leaf cells smooth (papillose in *Paludella*), rather small above, large and more elongated below. Seta usually *very long and slender*. Calyptra cucullate. Capsules curved-pyriform, with a conspicuous neck, smooth or somewhat striate when dry; operculum small, short conical; mouth small; annulus of one or two rows of cells; peristome double, the inner usually much longer than the outer and consisting of 16 narrow segments alternating with the teeth, cilia sometimes present.

All our mosses of this family seem to be rather rare. The bog habitat, the long seta and the curved pear-shaped capsules with a small mouth, clearly establish the identity of any member.

MEÈSEA Hedw.

Stems more or less elongated and radiculose. Upper leaf cells rectangular to hexagono-rectangular. Neck of capsules long; segments of inner peristome often united by lateral hairlike appendages bearing nodules; teeth short, usually obtuse. The spores of our species ripen from late June to August.

KEY

1.	Leaf margins revolute, apex rounded	*trichodes.*
	Leaf margins plane, apex acute	2.
2.	Leaves entire	*longiseta.*
	Leaves serrate	*triquetra.*

M. triquétra (L.) Aongstr. (*M. tristicha* B. & S.) is apparently our most frequent species. Limpricht says that the leaves are serrate in the varieties only, but I find them serrate in all the American specimens examined, just as they are represented in Plate XLII by Schimper. They are strongly squarrose from a strongly decurrent and half-clasping base, as is well shown in the plate.

M. longisèta Hedw. has entire leaves, spreading from an erect base without the abrupt bend of those of the preceding species.

M. trichòdes (L.) Spruce (*M. uliginosa* Hedw.) is easily distinguished by its long, narrow leaves with entire and loosely revolute margins, and stout costa ending a little below the very blunt rounded apex.

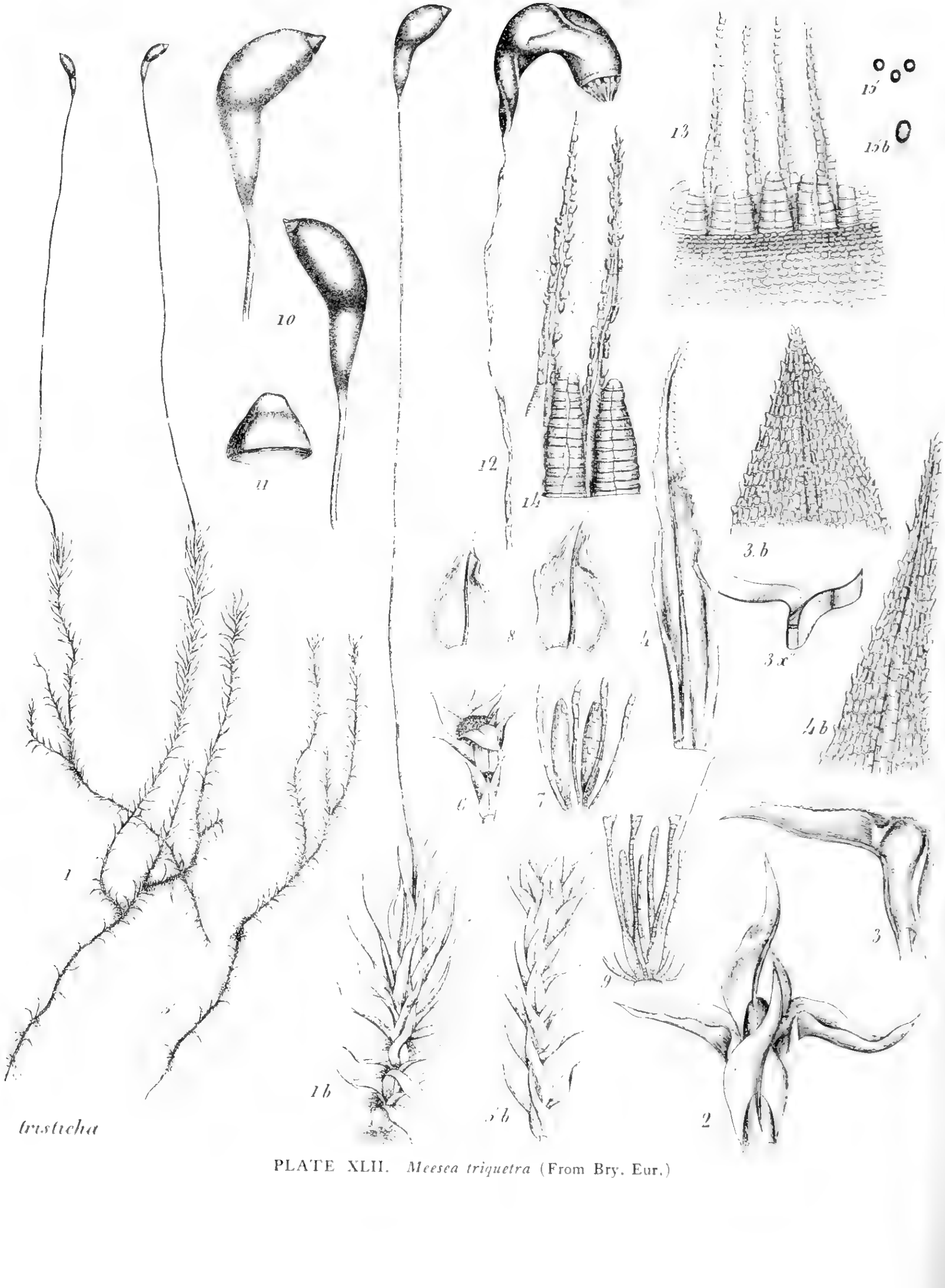


PLATE XLII. *Meesea triquetra* (From Bry. Eur.)

Paludélla squarròsa (L.) Brid. is a rare member of the family with stems densely radiculose, the leaves broadly ovate-lanceolate, densely and finely serrate and *strongly recurved squarrose*. The leaf cells have low broad papillæ on both sides. The capsules are less inclined than in *Meesea* and have a much shorter neck. The outer peristome is fully developed and as long as the inner. The leaves are so strongly recurved as to often appear doubled up when mounted and it is impossible to flatten one out.

Family 17. Timmiaceae

Tall robust mosses resembling *Polytrichum* in appearance when sterile; growing in deep loose tufts on soil and rocks. Leaves lanceolate from an appressed sheathing base, serrate above, strongly costate to apex, but costa much narrower than in *Polytrichum*, and entirely without lamellæ; leaf cells small, round-hexagonal, smooth or rarely lightly papillose. Calyptra cucullate; seta long; capsules often somewhat wrinkled when dry, but scarcely plicate or sulcate, when fresh resembling those of *Mnium* and *Bryum*. Peristome like that of *Mnium*, except that the inner is composed of cilia only, which are grouped together in fours.

TÍMMIA Hedw. (Our only genus.)

T. megapolitána Hedw., as figured in Plate XLIII, is probably found only in the Rocky Mountains and northwards. It is a European species also. Note that in the figure the capsules are nearly or quite symmetric and that the mouth of the capsule is not wider than the lower portions. These figures represent the European form very well, though there are occasionally capsules that are plainly unsymmetric.

The form of the species found in our region has been called *T. cucullata* Mx. It is very much like the European form in gametophyte characters, but the capsules are strongly curved and unsymmetric when dry and empty and the mouth is the widest portion, the capsules tapering gradually from the mouth to the seta. The capsules resemble those figured for *Hypnum curvifolium*, only they taper more rapidly. The spores mature in May. On damp shaded banks, sometimes at base of trees. Frequent. Williams (Bryologist 4:27) says that the median leaf cells of *T. cucullata* are 12^{μ} in diameter and those of *T. megapolitana* 8^{μ}. Limpricht and Roth, it is well to remember, give the cells of *T. megapolitana* as 12^{μ} or more in diameter.

I suspect that *Timmia* is much more common than is generally recognized and that when sterile it is passed over for a *Polytrichum* (See Bryologist, 8:52).

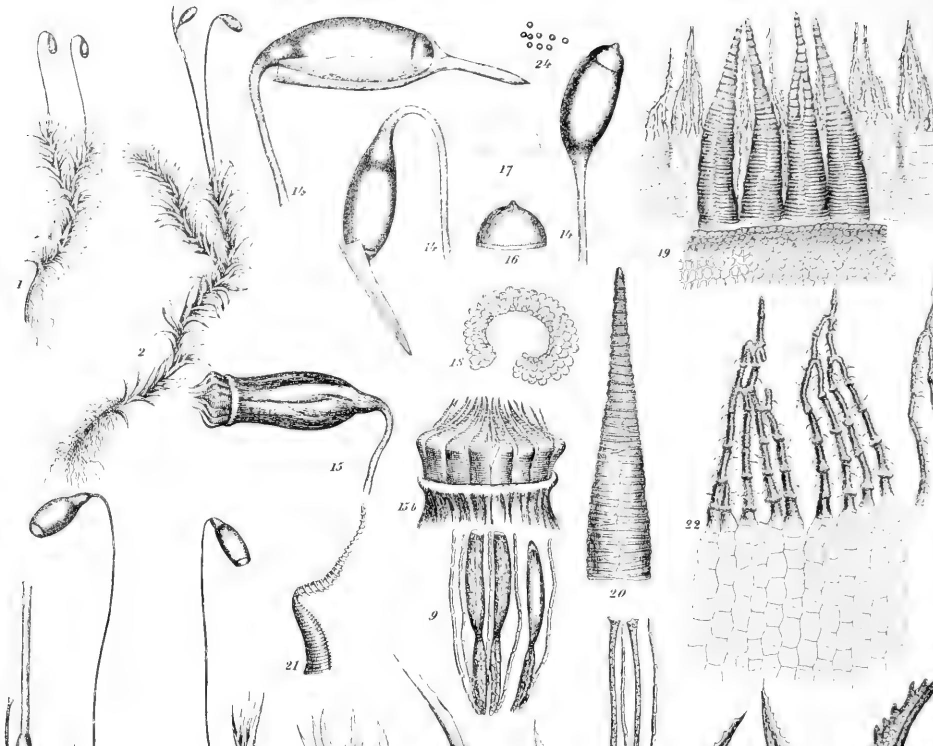


PLATE XLIII *Timmia megapolitana* (From Bry. Eur.)

Family 18. Aulacomniaceae

Intermediate between the *Bartramiaceæ* and the *Mniæ*, with some characters of the *Meeseaceæ*. From the *Mniæ* it differs in the much smaller papillose leaf cells and in having the capsule regularly striate or sulcate when dry. From the *Bartramiaceæ* it differs in the larger broader leaves and the more elongated and less unsymmetrical capsules with well-developed cilia in the inner peristome. It differs from the *Meeseaceæ*, except *Paludella*, in the perfectly developed peristome, less conspicuous neck of the capsule, and the papillose leaf cells.

AULACÓMNIUM Schwaegr.

Usually cæspitose, growing on soil in moist woods or in bogs; green above, often brown or brownish green below; stems often densely matted with radicles. Leaves large strongly costate, nearly or quite to the apex; leaf cells small, rounded, strongly thickened at the angles (collenchymatous), in most species strongly papillose on both sides, each cell bearing a single large papilla

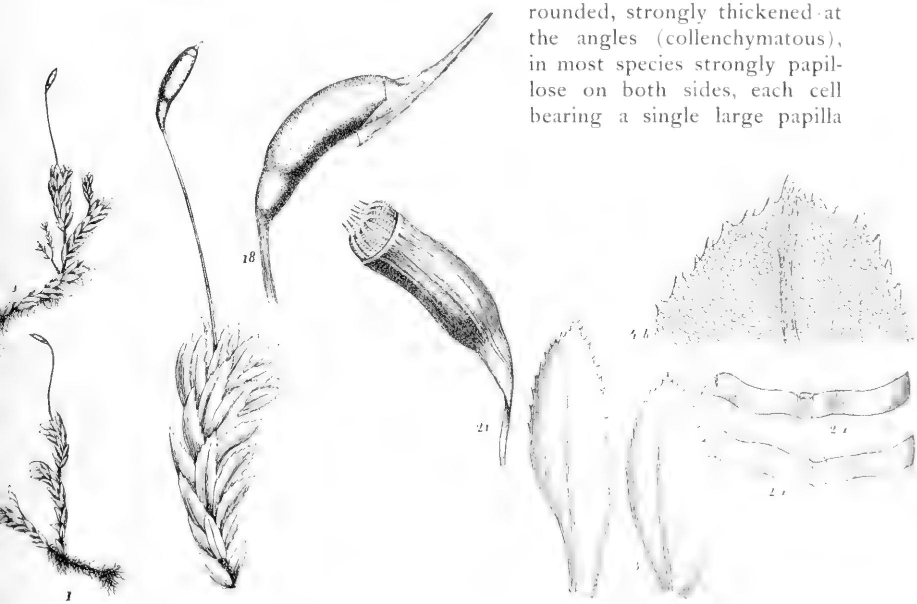


FIGURE 100. *Aulacomnium heterostichum* (From Bry. Eur.). 1. Plants natural size. The other figures are self-explanatory.

in the middle of each surface. Branches frequently terminating in flagelliform pseudopodia bearing propagula at their tips; calyptra cucullate; capsule oblong to subcylindric, cernuous and usually somewhat unsymmetric; with a short neck (so short as to be easily overlooked in some species), regularly plicate or sulcate when dry. Annulus early deciduous. Peristome perfect, as in Mnium.

KEY

1.	Leaves broad, obtuse, entire; dioicous	*turgidum.*
	Leaves broad, apex rounded or acutish, strongly serrate; monoicous	*heterostichum.*
	Leaves lanceolate, acute, serrate or crenulate at apex; dioicous	2.
2.	Basal cells in one layer, scarcely different from the rest; brood bodies like minute ecostate leaves	*palustre.*
	Basal cells swollen, in two or three layers; brood bodies stalked, fusiform	*androgynum.*

A. heteróstichum (Hedw.) B. & S. looks so much like a *Mnium* that it might well be called the Ribbed Mnium. It is common on rich moist soil (not wet) in woods, especially about the bases of trees. The ribbed or wrinkled capsules and broad Mnium-like leaves, coarsely serrate and without border, are its distinguishing marks. The spores mature in early spring, but the young "lances" are well started in the preceding autumn. When thoroughly dry the capsules are more strongly wrinkled, and more contracted under the mouth than is shown in the figure.


FIGURE 101. *Aulacomnium palustre* × x1; capsules × 10; pseudopodia × 4.

A. túrgidum (Wahlenb.) Schwaegr. is a very rare moss of mountain bogs. The stems are not radiculose, except at the very base; the leaves are ovate to oblong-obovate, strongly concave, obtuse, rounded and entire at the apex; margins strongly revolute in the lower part; cells weakly papillose, basal cells in two or three layers; pseudopodia lacking. Capsules much as in the next; spores in summer. Reported from the White Mountains, Adirondacks, Mt. Katahdin and Lake Superior.

A. palústre Schwaegr., the Ribbed Bog Moss, is very abundant in swamps and wet shaded hollows. It is rather lighter in color than most of the accompanying mosses. It varies exceedingly in size ($2–13^{cm}$ in height) and in robustness, some forms being slender and attenuate and others almost as robust as in *A. turgidum.* Stems densely radiculose below; leaves long-lanceolate, acute and finely denticulate or sinuate-crenulate above, strongly revolute below; basal cells somewhat swollen and in two or three layers; pseudopodia frequent, propagula like minute ecostate leaves, very distinct from those of the next species. Capsules plainly curved, unsymmetric and plicate when dry; basal membrane of the inner peristome more than one-half the height of the teeth.

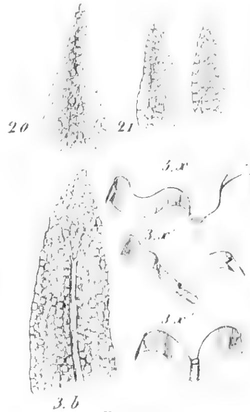


FIGURE 102.

Aulacomnium palustre (From Bry. Eur.) 20, 21. Propagula. 3*b*. Apex of leaf. 3*x*, etc. Different leaf sections.

From the figures the capsules might possibly be mistaken for *Ceratodon*, but they are much lighter colored and much longer, and the plants are 3–10 times as large. The plants appear to fruit sparingly, as is often the case with mosses having a special means of asexual reproduction. In the cranberry bogs of Cape Cod capsules are produced very abundantly, at least in favorable seasons.

Var. **imbricatum** B. & S. is a very robust form approaching *A. turgidum* in appearance, but having acute leaves that are strongly papillose as in the species; they are also very large and broad, 3–6x 1^{mm}, and nearly or quite entire. Limpricht states that this variety lacks pseudopodia.

A. andrógynum (L.) Schwaegr. is common on the western slope of the continent, but is rather rare within our range. It is most like the last, from which it is distinguished by its smaller size, more strongly serrate leaves, with the cells at base in a single layer, scarcely different or a trifle elongated, and the capsules inclined but nearly symmetric. The brood bodies are quite different also. (See Figs. 22–25 of Plate II and Fig. 22 of the Glossary.)

Family 19. Bartramiaceae

Plants of medium or large size, usually growing in large deep tufts or cushions on soil or rocks in moist shaded places; often developing whorled innovations below the places where archegonia or antheridia have been produced. Leaves strongly costate to near the apex or beyond, acute, papillose (except *Bartramia Œderi*), usually serrate. Leaf cells roundish-quadrate to rectangular. Calyptra small, cucullate; seta rather shorter than in the related families; capsule nearly globular, usually without neck, usually cernuous and somewhat unsymmetric, regularly plicate or sulcate when dry; peristome double in all our species, except the rare and alpine *Conostomum;* cilia frequently rudimentary or lacking; segments split along the median line and the halves widely divergent, sometimes appearing as if bordering the teeth.

KEY TO THE GENERA

1. High alpine; peristome single . . . . *Conostomum.*
   Mostly plants of low or median altitudes; peristome double . . . . 2.
2. Leaves elongated-lanceolate to linear-lanceolate; inner peristome with cilia rudimentary or lacking . . . . *Bartramia.*
   Leaves much shorter, ovate-lanceolate; cilia present . . . . *Philonotis.*

PHILONÒTIS Brid.

Our species of this genus are water-loving mosses, growing on wet banks and rocks where water trickles, or on the margins of pools or streams. The stems are densely radiculose below. This genus differs from *Bartramia* chiefly in the characters mentioned in the key and in the much more slender habit, with a strong tendency to the whorled innovations mentioned above. The plants are nearly always dioicous and the perigonial leaves are made the basis of specific distinctions in this genus to a very unusual extent.

FIGURE 103. *Philonotis fontana* × 1; leaf, capsule, and male head × 10.

P. fontána (L.) Brid. Variable in height ($3–15^{cm}$) and robustness; stems slender, red, sometimes partially reclining at base; by reason of this and the abundant branching sometimes taken for a pleurocarpous moss. Leaves ovate-lanceolate, long acuminate, appressed when dry, and usually with one or two plicæ on each side of the costa near the base; margins serrate above, usually revolute below; leaf cells rectangular to hexagono-rectangular, with papillæ on the end walls; costa percurrent or excurrent. Leaves of antheridial stems much shorter acuminate, as shown on the stem in Fig. 103. Many of the leaves are much longer and more slenderly acuminate than the separate stem leaf figured. The perigonial leaves *are spreading, broadly triangular-ovate,* the inner often *obtuse* and *rounded at apex,* serrate, with costa ending below apex. Capsules maturing in May or June; *cilia of inner peristome nearly as long as segments.* Common everywhere, but fruiting rather sparingly. The whorled branching and characteristic perigonial leaves render the determination of sterile specimens possible without much extra effort.

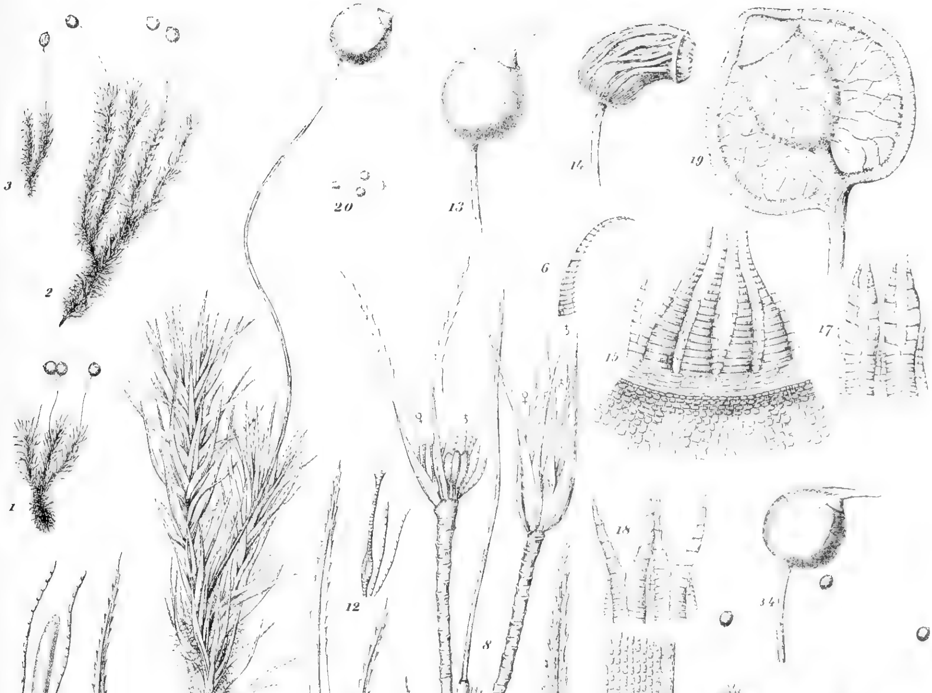


PLATE XLIV. *Bartramia pomiformis* (From Bry. Eur.)

P. Muhlenbérgii (Schwaegr.) Brid. This species is frequent throughout the greater part of our range. It seems to be distinguished from *P. fontana* chiefly by the rudimentary cilia of the inner peristome and by the erect lanceolate acute perigonial leaves with the costa percurrent in inner leaves. The inner perichætial leaves are said to be shorter than the outer, and Sullivant says the leaves lack the plicæ of *P. fontana.*

BARTRÁMIA Hedw.

The Bartramias grow in moist niches in cliffs and on moist shady banks, looking much like tufts of green wool. Their capsules are globular and somewhat unsymmetric when moist, but dry with regular folds and alternate ridges. When very dry the body of the capsule becomes so shrunken as to be smaller than the mouth of the capsule itself. The leaves are long and slender and somewhat curled when dry, and strongly papillose. *B. Œderi* is somewhat of an exception as regards leaf characters, and by recent writers is put in the genus *Plagiopus.*

KEY

1.	Leaves lanceolate, not papillose	*Œderi.*
	Leaves nearly linear, very long and narrow, papillose	2.
2.	Leaves from a sheathing scarious base	*ithyphylla.*
	Leaves without sheathing base	*pomiformis.*

B. pomifórmis (L.) Hedw. is often known as the Apple Moss. It is a common and beautiful plant, 2–7^{cm} in height. The leaves are long linear-lanceolate, 4.5^{mm} long, somewhat crisped when dry, papillose and serrate, with margins recurved; costa excurrent; autoicous or synoicous; spores in April or early May.

FIGURE 104. a. *Bartramia pomiformis* × 1. b. *B. Oderi* × 1. c. Capsule of *B. pomiformis* × 10, and e, mouth of same with operculum. d. Caspule of *B. Oederi* × 10. f and g. Leaves of *B. pomiformis* and *B. Oederi* respectively × 10.

B. Œderi (Gunn.) Swtz. is a smaller, less common plant of cool, moist ravines. The leaves are much shorter, lanceolate, not crisped when dry, not papillose, margins sharply serrate and widely revolute most of the way; spores two or three weeks later than in *B. pomiformis.* The leaves of this species and also of *B. pomiformis* are serrate on the roll, or apparent edge, of the revolute margin. These teeth might possibly be mistaken for papillæ.

B. ithyphýlla (Haller) Brid. is a rare alpine species resembling *B. pomiformis*, but known at once by its very narrow leaves from a wide sheathing scarious base. The costa, though excurrent, is hard to distinguish from the lamina.

Conóstomum boreàle Swtz. is a high alpine plant reported from the Adirondacks and the White Mountains, and from Gaspe, Quebec. It is readily collected near the summit of Mt. Washington. The capsules will at once mark it as a member of this family. The bright glaucous-green color and five-angled leafy stems will easily distinguish it from our other species of the family.

Family 20. Bryaceae

For the most part large conspicuous mosses growing in close tufts, or loosely aggregated, or scattered; some forms spreading by stolons have the habit of sterile pleurocarpous mosses. Leaves usually large, smaller below and increasing in size upward to the upper, which often form a distinct comal tuft, all supported by a strong costa which extends nearly to the apex, or may be somewhat excurrent, and in many species by a thickened border of narrower elongated cells. Leaf cells large and comparatively thin-walled, short and broad in the *Mnieæ*, longer and narrower in the *Bryeæ*. A few species are small with small leaves, but with the characteristic sporophyte of the family. Calyptra cucullate. Capsules proportionately large, pendent or drooping, often light-colored, not striate or plicate when dry, usually symmetric. Peristome characteristically perfect, of the type described on pages 34 and 35 for *Mnium hornum*, cilia sometimes rudimetary or lacking.

KEY TO SUBFAMILIES

Plants larger; leaf cells not more than twice as long as broad; cilia not appendiculate (*Rhodobryum* will be sought here) . . . . *Mnieæ*.
Plants usually smaller; leaf-cells more than twice as long as broad; cilia often appendiculate, occasionally wanting . . . . *Bryeæ*.

SUBFAMILY 1. BRYEÆ

1. Plants large, with the habit of a large *Mnium*, from creeping, rhizomelike stolons; upper leaves in rosettes 12–20^{mm} across; capsules clustered . . . . *Rhodobryum*.
Plants smaller, without rhizomelike stolons . . . . 2.
2. Leaves ovate to ovate-lanceolate; leaf cells rhombic to rhombic-hexagonal, never linear except at margins . . . . 4.
Leaves linear-lanceolate or narrower (the lower are often broader); leaf cells narrowly rhombic to linear . . . . 3.
3. Leaves linear from a broader base, hairlike; cilia appendiculate . . . . *Leptobryum*.
Upper leaves linear-lanceolate; cilia not appendiculate, sometimes wanting . . . *Pohlia*.
4. Leaves not bordered; dioicous; annulus lacking; stomata immersed; leaf cells long and lax; growing in water or very wet places . . . . *Mniobryum*.
Leaves often bordered; inflorescence various; stomata superficial; leaf cells usually shorter . . . . *Bryum*.

With the exception of *Rhodobryum*, *Leptobryum*, *Plagiobryum*, *Bryum argenteum* and possibly *Mniobryum*, it is extremely difficult to determine species of this subfamily unless perfect fruiting specimens can be obtained. It will be a discouraging task to any one except a specialist in the group, and one not worth while under any ordinary circumstances.

LEPTOBRỲUM Schimp.

L. pyrifórme (L.) Wils., the Long-necked Bryum. Plants annual; not branching above; leaves hairlike, from a broader base; costa broad, excurrent; leaf cells narrow, linear. Capsules inclined or pendulous, pear-shaped, with a long narrow neck; cilia of inner peristome strongly appendiculate; spores in June and July.

FIGURE 105. *Leptobryum pyriforme* × 2; leaf and capsule × 10.

This common and pretty species is easily recognized by its long-necked capsule and slender hairlike leaves. Some species of *Pohlia* have very long-necked capsules, but the leaves are so much wider that there is no need of confusing them with this. This species is frequent on moist shaded cliffs and on rocks near water. It is more common than the author once thought, for it is frequent on damp mortared walls in various situations. The author has collected it on the basement of his Brooklyn house and in the cut which leads up to Montague Street from the Brooklyn end of the Wall Street Ferry.

PÒHLIA Hedw.

Plants tufted, usually growing on moist or wet soil and stones. Lower leaves shorter, ovate-lanceolate as a rule, the upper longer, the comal usually linear-lanceolate; costa ending just below apex, percurrent or rarely excurrent; leaf-cells narrowly rhomboidal to linear; capsule pear-shaped or clavate, usually with a proportionately long tapering neck; cilia of inner peristome not appendiculate.

This genus is sometimes treated as a subgenus of *Bryum*, from which it differs in little except the narrower areolation and narrower comal leaves.

KEY

1. Capsule long and narrow, with a very long neck (see Fig. 106) . . . . *elongata.*
   Capsule oblong or pear-shaped, neck shorter . . . . 2.
2. Capsules very short and small (see Plate XLV); stems not red . . . . *Lescuriana.*

Capsules larger and longer; stems often red when old . . . . 3.
3. Bearing gemmæ in the axils of the leaves of the sterile stems; dioicous; infrequent or rare . . . . 5.
Not producing gemmæ; never wholly dioicous, sometimes polygamous . . . . 4.
4. Infrequent, growing principally in the mountains; leaf cells very long and narrow, linear-vermicular, 11–16:1; lower leaves large, broadly ovate . . . . *cruda.*
Common everywhere; leaf cells broader; lower leaves smaller than in *cruda*, ovate . *nutans.*
5. Gemmæ as in Fig. 108 . . . . *annotina.*
Gemmæ as in Fig. 109 . . . . *proligera.*

P. elongàta Hedw. is a rather rare moss found only in the mountains. It grows on damp soil in cool shaded places, especially in crevices of rocks near streams. It is at once known by the slender long-necked capsule, which is never to be confused with the Long-necked Bryum, because of the different position of its capsules and its broader, lanceolate leaves. The spores mature in August.

FIGURE 106. *Pohlia elongata* natural size and capsule enlarged. (From Bry. Eur.)

P. acuminàta Hornsch is a very rare species reported only four or five times from our range. It is very like the last, but differs in having the neck shorter than the rest of the capsule, cilia of inner peristome rudimentary or wanting, and inflorescence autoicous; while in *P. elongata* the neck is longer than the rest of the capsule; the cilia fairly well developed, and inflorescence paroicous.

P. nùtans (Schreb.) Lindb. is one of the mosses most frequently sent me for determination. It grows everywhere in moist or swampy places on peaty soil, rotten wood, etc. The plants vary from 1–5^{cm} in height, rarely over 2^{cm} as I find them. The upper leaves are long and narrowly lanceolate, faintly serrate at apex, and not margined. The costa is strong and ends below the apex as a rule, though occasionally it may be percurrent or rarely even excurrent in the upper perichætial leaves. The lower leaves are shorter and broader than those figured. The antheridia are in the axils of the upper leaves and are very easy to find even after the capsule has disappeared. The capsules are usually contracted below the rather broad mouth when dry. The annulus is broad, the cilia of the inner peristome two, well developed; segments widely open along the middle line, but not split at apex; spores in spring or summer. The plants are variable in appearance and in some of

FIGURE 107. *Pohlia nutans* (From Bry. Eur.). 1 and 2. Plants natural size. 5, 6 and 7. Comal leaves.

their characters also, but the species is so common that one soon becomes familiar with it. The stems and base of costa are often red. Several varieties have been described.

P. cucullàta (Schwaegr.) Bruch is hardly more than a subspecies of the last. It is very rare, being reported from the White Mountains only, within our range. It differs from *nutans* in having some of the rather shorter leaves subentire and rather obtuse, sometimes almost cucullate; cilia of the inner peristome short and easily broken off; capsules narrowed at mouth, but not contracted below it. The capsules are also said to be bent more closely to the seta.

P. crùda (L.) Lindb. is an infrequent alpine or subalpine species growing in the crevices of rocks in cool or elevated situations (N. J., Austin; Lake George, Jelliffe). It is *larger* than any of the preceding species, 2–8^{cm}, with *simple red densely tufted* stems. The lower leaves are broadly ovate, *often deep red at base in lamina* as well as costa; the upper long linear-lanceolate; median leaf cells *linear-vermicular*, longer and narrower than in any of our other species, *11–16:1*, *costa ending below apex*. Autoicous, sometimes synoicous or dioicous. Capsules with an inconspicuous neck, less drooping than in the allied species, sometimes merely inclined; peristome pale yellow, with well-developed cilia; spores in summer. Until one has seen both species, this might be confused with *P. nutans*, but one who has seen both could hardly make this mistake, as the italicized characters are so clear and conspicuous. Dixon says "a very fine and beautiful species known at once by the metallic, almost opalescent sheen on the leaves, which are larger and wider than in the allied species."

P. Lescuriàna (Sulliv.). Plants small, 1–2^{cm}, loosely aggregated, stems never red; lower leaves distant, narrowly lanceolate; the upper linear-lanceolate, very long and narrow; all serrulate above, more or less recurved on the middle margins; leaf cells more elongated than in *nutans*. Dioicous; male plant

PLATE XLV. *Pohlia Lescuriana* (From Sulliv. "Icones") smaller. Capsules very small, maturing in May. On moist soil, infrequent. According to Harald Lindberg this is the same as *P. pulchella* (Hedw.) Lindb.

P. annótina (Hedw.) Lindb. is another rather rare species of a moist mountainous habitat. The plants are small, 2cm or less in height, with the old stems often sending up straight, rather stiff and slender innovations. The sterile stems usually bear *small green ovoid gemmæ in the axils of the upper leaves.* (See Fig. 108 and also Plate II, Figs. 20 and 21.) The leaves are broadly lanceolate below, longer and narrower above, serrulate toward the apex; costa nearly or quite percurrent, often red at base. Dioicous; peristome with well developed cilia; capsules rather small, sometimes almost as small as in the preceding, maturing in summer. Rare.

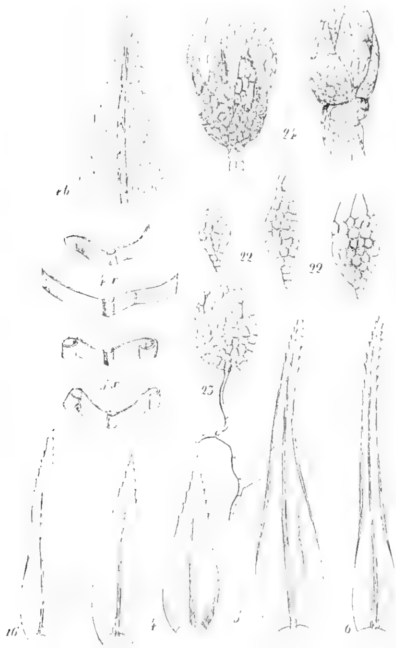
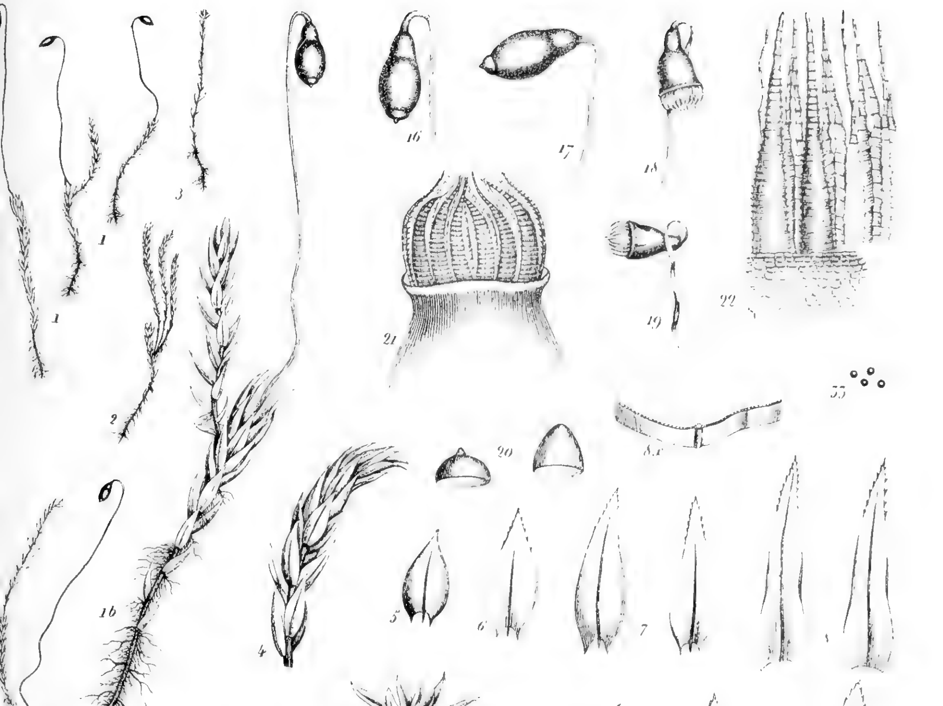


FIGURE 108.
Pohlia annotina (From Bry. Eur.) 4 and 5. Lower leaves. 6. Upper leaves. 22-24. Gemmæ.

FIGURE 109.
Gemmæ in axil of leaf of *P. proligera* × 25, and several gemmæ × 150.

P. prolígera (Lindb.) Correns has until recently been confused with the last, and even now is by some authors regarded as a subspecies of it. It is widely distributed in our range. It is distinguished by the long narrow gemmæ essentially like those figured, although the form varies considerably. The points of the gemmæ are longer than in *annotina* and usually somewhat twisted; the gemmæ are produced from April to November. For a fuller account of this species see the Bryologist 4 : 62.



Wahlenbergii

PLATE XLVI. *Mniobryum albicans* (From Bry. Eur.)

MNIOBRỲUM (Schimper ex parte) Limpr.

All species dioicous; antheridia in the axils of the perigonial leaves. Leaves serrate at apex, not margined, but marginal cells somewhat narrower than the median; leaf cells as a whole broader than in *Bryum* but longer and narrower than in *Mnium*, thin-walled. Capsules pendent, small and short, pear-shaped; *stomata immersed;* annulus lacking; peristome perfect. Plants of wet places, such as springs, ditches, banks of streams and ponds.

M. álbicans (Wahlenb.) Limpr. (*Bryum Wahlenbergii* Schwaegr.). Growing in large soft lax tufts, whitish or glaucous green, 2–8^{cm} high; stems bright red in the older portions. Antheridial plants often branching by innovations. Leaves distant, much shrunken when dry, ovate-lanceolate, often narrowly so, obtusely acute; margins plane, serrate above; leaves of antheridial plants often somewhat narrower; leaf cells rhombic-hexagonal, pellucid, thin-walled, averaging about 20$^{\mu}$ in width, narrower at margins; costa red at base except when very young, not quite percurrent; capsules wide-mouthed when dry and empty, maturing in spring or early summer. Common but fruiting infrequently.

M. cárneum (L.) Limpr. is much smaller, 1–2^{cm} in height, with narrower lanceolate leaves having two or three rows of distinctly narrower marginal cells, which are much more conspicuous than in *albicans*. This species is found in the far west and has been reported from Minnesota and the Central States, and may be found farther east.

BRYUM Dill.

Plants densely tufted, interwoven with radicles, usually with branches arising below the "flowers." Leaves ovate to lanceolate, thin and very little hygroscopic, rarely obtuse; cells smooth, rather large, rhombic to hexagonal, quadrate to rectangular at base, the marginal often very narrow and forming a more or less distinct, sometimes thickened border; costa usually excurrent. Capsule on a long seta, usually more or less pendulous, pyriform but varying from subglobose to elongated-clavate, usually symmetrical; operculum conical, usually apiculate but never rostrate; annulus present; peristome of 16 long-lanceolate, closely articulate teeth; the inner of a basal membrane about half the length of the teeth, bearing 16 lanceolate keeled segments alternating with the teeth, and often split along the keel, usually with 1–3 cilia between the segments. When fully developed these cilia are appendiculate, *i. e.*, bear short transverse appendages at the articulations; the cilia are sometimes rudimentary and in a few species the inner peristome is adherent to the outer. Growing on the ground, rocks and walls, rarely on wood of any sort.

This is a very large and difficult genus, and there seems to have been more hair-splitting in it than in almost any other in the vegetable kingdom, except in the Thorn Apples (*Cratægus*). Indeed, it sometimes seems as if the classification had become so involved that the prominent authorities find it easier to make new species for their specimens than to refer them to their proper place in the species already described. A very large proportion of the species seem to be distinguished by little or nothing except the arrangement of the sexual organs. Until the constancy of these characters has been tested by cultures, one can not help the feeling that this is a very insufficient basis for specific distinction, in many cases at least. The other specific characters, such as border of leaf or length of costa, are often quite variable even on the same plant, so that Bryum is a source of discouragement to nearly every amateur who attempts to study it. Authentic specimens are often a necessity, even to the most experienced.

The border often varies on the same leaf. Lower leaves of Bryum are usually shorter and broader than the upper leaves and always have a shorter costa. The inner comal leaves are usually larger and narrower than the general run of leaves on the plant. The border of a Bryum leaf is usually most distinct near the base and least distinct near the apex. In using the key, select leaves in the lower part of the upper third of the leafy portion of the stem and look for border in the upper third of the leaf. The margin of the leaves is frequently strongly recurved and gives the appearance of a margin whether a margin be really present or not. To make sure, the margin must be flattened out by manipulation with needles and pressure on the cover-glass. It may even be necessary to use scissors.

Some of the species vary in the characters used in the key, hence these species have to be included under more than one of the headings.

A sterile *Bryum* is a practically insoluble problem and should not be attempted by any except the bryologist of long experience; nor should the student attempt to get others to solve such problems unless for some exceptional reason. The key which is given below is an attempt to enable one to work out our species by the most accessible characters, but this will often be found inadequate because of exceptional variation. The contraction of the capsule below the mouth is of value in mature plants only, for only slightly immature capsules of almost any of our species will contract under the mouth in drying.

Besides the easily recognized *B. argenteum*, the student of *Bryum* will collect *B. cæspiticium* and *Pohlia nutans* on every trip, until he despairs of finding anything else. The former will be found on dry soil and the latter in moist places. The elongated sublinear leaf cells of *Pohlia* will serve to distinguish it from *Bryum*.

The leaves on fruiting Bryums are frequently so badly decayed as to make study difficult, and for the same reason it is often hard to make out the position of the antheridia. This seems to be due to the fact that it takes many species of Bryum nearly or quite a year to mature the sporophyte. On specimens of *B. bimum* and also of *B. cæspiticium* I have found, early in August, freshly matured capsules with opercula, and also fertilized archegonia and young sporophytes.

Height as used in keys and descriptions applies to the gametophyte only. The leaves in *Bryum* are markedly smaller than in *Mnium*, and the leaf cells are much more elongated. The capsules are usually more slender, longer necked and more pendent.

Pohlia (*Webera* of the L. & J. Manual) is so much like *Bryum* that a word of warning may not be out of place here. The leaf cells in *Pohlia* are much longer than in *Bryum*. *B. capillare* is frequently mistaken for *Mnium* because of its short leaf cells.

KEY

1.	Leaves bordered	2.
	Leaves not bordered, at least in the upper half	12.
2.	Costa plainly vanishing below apex. (See also *B. capillare*)	3.
	Costa percurrent or excurrent in some of the leaves	4.
3.	Upper leaves orbicular, obtuse	*cyclophyllum.*
	Upper leaves acute, with long-decurrent wings	*Duvalii.*
4.	Leaves very strongly and broadly decurrent; plants slender; capsule long-necked, usually unsymmetric	*pallens.*
	Leaves not decurrent, or, if so, plants robust or capsules short-necked	5.
5.	Teeth of peristome with oblique or vertical lines connecting the transverse articulations (See Fig. 110); inner peristome without cilia, somewhat adherent to the outer	*pendulum.*
	Teeth of peristome without unusual markings; cilia lacking or rudimentary, not appendiculate; all rare	6.
	Teeth of peristome without unusual markings; cilia 2–4, nearly as long as the segments, usually appendiculate	7.
6.	Capsules unsymmetrical, mouth oblique	*uliginosum.*
	Capsules symmetrical	*inclinatum.*
7.	Costa long excurrent; dioicous. (See *B. capillare*)	*cæspiticium.*
	Costa long excurrent; synoicous	8.
	Costa long excurrent; autoicous	*pallescens.*
	Costa percurrent or shortly excurrent	9.
8.	Capsules sometimes unsymmetric; operculum small and persistent; leaves not decurrent	*intermedium.*
	Capsules symmetrical; lid larger; leaves decurrent	*affine.*
9.	Leaves decurrent	10.
	Leaves not decurrent; dioicous	11.
10.	Synoicous	*bimum.*
	Dioicous	*pseudotriquetrum.*
11.	Capsules short and thick, strongly contracted below the wide mouth when dry; leaves short acuminate	*turbinatum.*
	Capsules hardly contracted below the mouth when dry; leaves rather abruptly long acuminate	*capillare.*

12.	Costa plainly vanishing below apex	13.
	Costa excurrent or percurrent	14.
13.	Branches julaceous, plants silvery and shining when dry, common in paths and waste soil	*argenteum.*
	Branches not julaceous; leaves green, larger at summit of stem, forming a tuft. A rare alpine moss	*calophyllum.*
14.	Stems slender, filiform, julaceous; wet rocks in mountain streams; rare.	*concinnatum.*
	Stems not julaceous	15.
15.	Costa excurrent into a long point	16.
	Costa shortly or not at all excurrent	17.
16.	Synoicous	*intermedium.*
	Dioicous	*caespiticium.*
17.	Costa scarcely or not at all excurrent; tufts dense and wide, glossy red and green; capsule red-brown. Wet rocks in mountains; rare and beautifully colored	*alpinum.*
	Costa distinctly excurrent; tufts thin; ripe capsule purple-red	*atropurpureum (bicolor).*

The following divisions into subgenera and groups will be found helpful in identifying the species; for the beginner it may be well at first to try to do little more with some forms than to refer them to the proper group.

SUBGENUS 1. CLADODIUM

Inner peristome more or less adherent to the outer, with cilia lacking or rudimentary; when present the cilia are not appendiculate.

Section 1. Ptychostomum

Outer teeth with irregular oblique or vertical lines on the inner surface, connecting the transverse articulations of the lower portion of the teeth.

B. péndulum (Hornsch.) Schimp. is our only member of this section. It is distinguished from closely related species by the characters given under subgenus and section. Sometimes the inner peristome separates from the outer, and the slender segments, widely split along the median line, look like large cilia. The plants are usually synoicous, sometimes subautoicous. The spores mature in spring or early summer. Sterile specimens of *B. inclinatum* cannot with certainty be separated from this species. *B. cæspiticium* without antheridia is hard to distinguish, except for its free inner peristome and appendiculate cilia. If one overhauls his specimens of *inclinatum* and *cæspiticium*, he is likely to find specimens of *pendulum*, which is clearly distinct by the longitudinal markings on the teeth.

FIG. 110. Tooth and adherent segment of *Bryum pendulum*.

Section 2. Eucladodium

Differing from Section 1 in the lack of oblique or vertical markings between the articulations of the teeth. The species of this section are rare and seldom collected.

B. inclinàtum (Sw.) Bland. except for the differences noted above, is almost identical with *pendulum*. Spores in summer. Rare with us, common on the Pacific slope according to the L. & J. Manual.

B. uliginòsum (Bruch) B. & S. Autoicous. Somewhat like the last, but leaves not so narrowly pointed and costa not so long excurrent; capsules strongly unsymmetric and incurved, mouth small and one-sided; neck long, narrow and tapering; spores in late summer. Rare.

B. calophýllum R. Br. Leaves roundish ovate to suborbicular, concave, entire, obtuse or obtusely apiculate, not bordered; costa ending below apex, or rarely reaching it; autoicous; spores in summer and autumn. Very rare; Franconia Mountains, N. H.

SUBGENUS 1. EUBRYUM

Peristome perfect, inner free from outer, cilia nearly or quite as long as segments, appendiculate. Spores smaller than in *Cladodium*.

Section 1. Leucodontium

Teeth of peristome pale yellow throughout, base of teeth scarcely thicker. (Though European authors emphasize the color of the teeth, I am unable to make much use of it.)

FIGURE 111.
Portion of stem of *Bryum Duvallii* much enlarged (From Bry. Eur.)

B. cyclophýllum (Schwaegr.) B. & S. Leaves suborbicular, *all obtuse and concave, weakly bordered;* costa ending below apex. Resembles *B. calophyllum*, but is distinguished by the italicized characters, and by the perfect cilia. In wet places, rare. Niagara Falls, Pennsylvania, etc.

B. Duvállii Voit. is a rather rare species growing in or near water in mountainous regions. It is dioicous, with antheridial heads discoid, and is so lax and slender, with leaves so distant, that it might almost be mistaken for an *Amblystegium* or other subaquatic hypnaceous moss. It is at once recognized by the very strongly decurrent ovate to lanceolate leaves, as shown in Fig. 111. The leaves are entire and bordered by about two rows of narrow cells, and have the costa ending below the apex. The capsules mature in late summer. This is one of the species that can easily be determined sterile. The next is the only one likely to be mistaken for it. In that species, however, the costa is excurrent and the leaves are not quite so strongly decurrent.

B. pállens Sw. is an interesting alpine or subalpine species, not common, but so well marked as to be distinguished readily. The fresh plants are

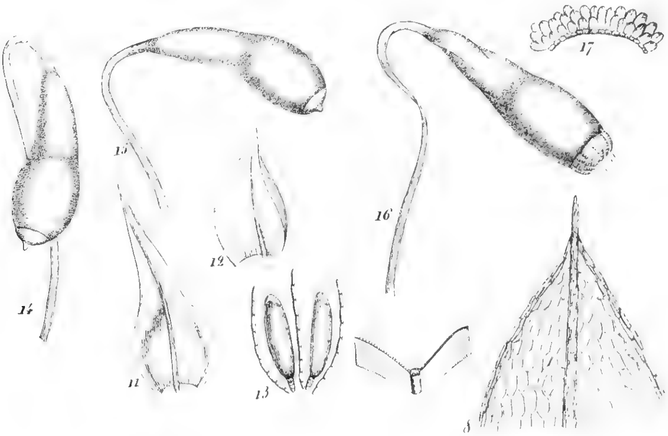


FIGURE 112. *Bryum pallens* (From Bry. Eur.). 11 and 12. Perigonial leaves. 8. Leaf apex.

usually some shade of red; the leaves are strongly decurrent, short pointed, with a reddish costa much as in *B. bimum;* border well defined, revolute. Dioicous: capsule slightly curved, with a long neck, approaching in form that of *Leptobryum pyriforme*, but larger; teeth not darker at base than at the apex; spores in summer. On soil. The capsule somewhat resembles that of *B. uliginosum*, and serves to distinguish this from species with which it might otherwise be confused.

B. turbinàtum (Hedw.) Schwaegr. is another very rare species reported from Niagara Falls, the Rocky Mountain regions; N. H., James and N. J., Austin. The leaves resemble those of the last, but are not so strongly decurrent. The capsules are the characteristic thing. They are symmetric and short pyriform. When dry and deoperculate the mouth flares out, while the capsule immediately below the mouth becomes very strongly contracted, below this the capsule widens and finally tapers rapidly into the neck. This also is dioicous.

Section 2. Pseudotriquetra

Plants robust (for the genus), with strongly decurrent leaves, which are rather sharply acuminate; costa usually excurrent, and leaf apex or excurrent costa serrate or toothed; peristome thickened and reddish at base. This last character is often obscure.

B. bìmum Schreb. is, next to *B. cæspiticium* and *B. argenteum*, our most common species. It is common in wet places of almost every description. The plants vary a great deal in robustness, in the var. *elatum* reaching a height of 5 inches. The stems are matted together by a felt of red-brown radicles. The leaves are long, up to 3^{mm}, decurrent; when dry "usually shrunken, somewhat twisted or appressed, oblong-lanceolate or lanceolate"; costa red, percurrent or excurrent; margins strongly revolute nearly to apex; three or four rows of marginal cells much longer and narrower, forming a distinct border which is less conspicuous near the apex. Synoicous: spores maturing in summer.

"A fine species not likely to be confounded with any other except *B. pseudotriquetrum*, on account of the robust habit, the large leaves with short points, and large long capsule on a tall seta, and the synoicous inflorescence."—Dixon.

B. pseudotriquétrum (Hedw.) Schwaegr. differs from the preceding essentially in nothing but in being dioicous. It has the same range and is sometimes found growing with it. The leaves are more rigid and less shrunken and contracted when dry, and the capsules are more ventricose, but these differences are not constant.

B. affìne (Bruch) Lindb. (*B. cuspidatum* Schimp.) is a rather infrequent species not included in the Lesq. & James Manual. It is close to *B. bimum*, from which it differs in its smaller size, less strongly decurrent leaves with a much longer excurrent costa. It is so close to several other species as to be exceedingly difficult to identify satisfactorily. From *B. intermedium* it differs in its decurrent leaves with a more strongly marked border and in the longer capsules, somewhat contracted below the mouth when dry. It is synoicous, which distinguishes it from *cæspiticium* and *pallescens*. It grows on damp rocks and walls, and matures its spores in summer. So far as my observation goes, the costa in *pallescens* and *affine* is a dark purplish red at base when the leaves are old, as in *B. bimum*. In *cæspiticium* the costa may become reddish, but I have never seen it of such a deep pronounced color.

Section 3. Cæspitibryum

Plants usually smaller than in the last section; leaves not decurrent, long acuminate, with costa excurrent. Peristome as in the last section.

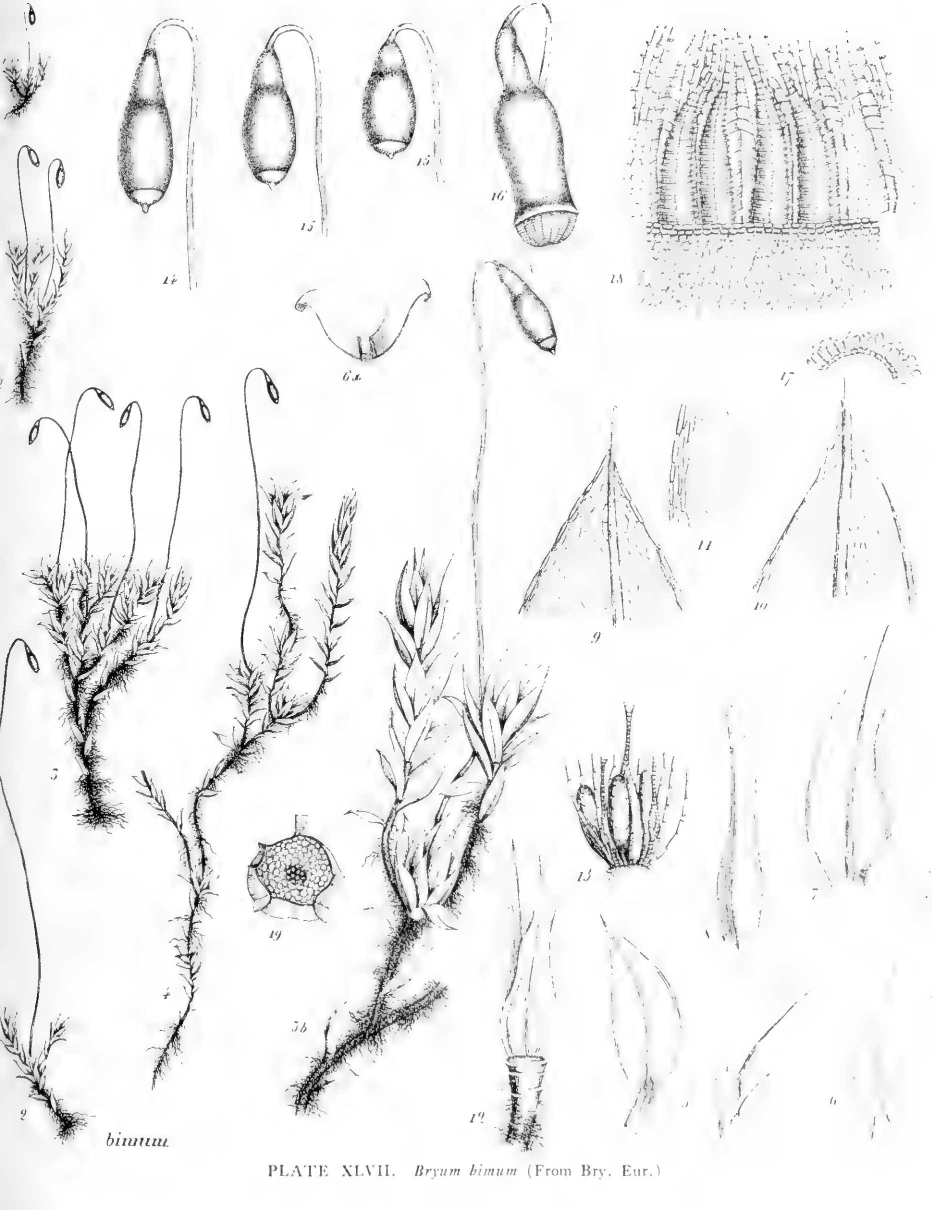


PLATE XLVII. *Bryum bimum* (From Bry. Eur.)

B. palléscens Schleich. is intermediate between this section and the last. It is so much like *B. affine* that Dixon considers it as one of the subspecies of *ventricosum* along with *affine* and *bimum*. From *affine* it differs in its non-decurrent leaves and autoicous "inflorescence." This is a rare species growing chiefly in elevated regions.

B. cæspiticium L. is perhaps the most common of all our species, being found in rather dry soil in all kinds of situations, and on rocks and walls. It is a type of a large group of species which are difficult to distinguish from it and from each other. The plants are densely tufted, averaging less than half an inch in height, said to occasionally reach an inch; leaves ovate-lanceolate, imbricated, but hardly twisted when dry; margin revolute to near the summit, bordered by very narrow marginal cells which are scarcely apparent at the extreme apex; costa long excurrent in the upper leaves, slightly or not at all toothed. *Dioicous:* capsule horizontal or more frequently drooping.

FIGURE 113. *Bryum cæspiticium* (From Bry. Eur.). 3, 4 and 5. Plants natural size. 2*b* and 3*b*. Plants magnified. 6, 7 and 8. Leaves.

The spores

mature in spring and summer. It takes at least a full year for the sporophyte to develop, for I have found antheridia and archegonia at the same season when the capsules were coming to full maturity.

B. intermèdium Brid. is so much like *B. cæspiticium* as to be very troublesome. It is *synoicous*, with shorter, more pendent capsules. It is much less common and prefers moister situations. Dixon says that the spores mature later, but I am not able to verify this in American specimens.

The operculum is smaller and much more persistent. In many of the specimens I have examined the dry capsules have a narrower neck, rather abruptly expanding into the spore-bearing part of the capsule.

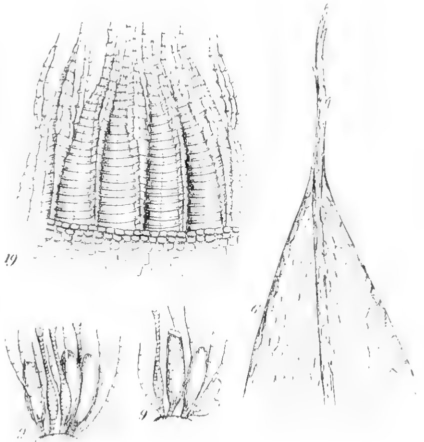


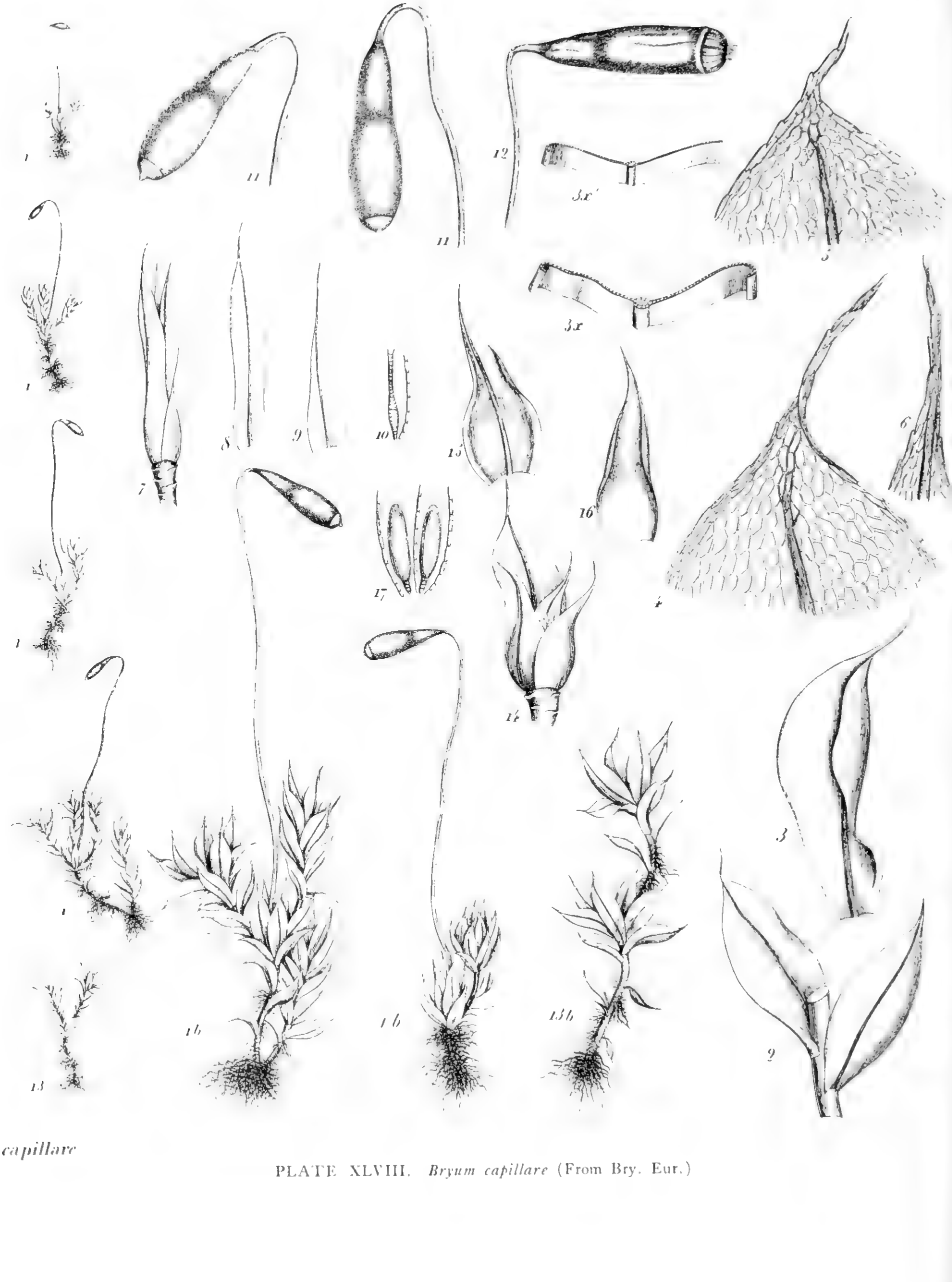
FIGURE 114. (From Bry. Eur.) Peristome, leaf apex and synoicous "inflorescence" of *Bryum intermedium*.

Section 4

The peristome in the following species has the characteristics of the two preceding sections. In this section I have put species which did not fit into any of the others.

B. capillàre L. is a species likely to be mistaken for a *Mnium*, as it is Mnium-like in habit and in shape and structure of leaves, but the capsule is typically that of *Bryum*, with neck one-half as long as the rest of the capsule, or longer. The leaves are spirally twisted when dry; the costa is long excurrent in the uppermost leaves, but often fails to reach the apex in the lower leaves, and it seems to be bordered on the back next the lamina with large inflated cells, at least near the base. On rich loamy soil in woods; often on soil overlying ledges; frequent. The spores mature in August. Usually dioicous.

B. alpìnum L. is an exceedingly robust species, so much so that when dry it somewhat resembles some of the smaller species of *Polytrichum*. The plants are 3–9^{cm} high, with very rigid robust stems, and grow in compact tufts on wet ledges and rocks in the alpine regions of the White Mountains. They are a deep dark red when dry, or variegated red and green in the younger portions; when fresh the colors are brighter. Leaves loosely imbricated when dry, oblong-lanceolate, acute, concave, margins reflexed; costa nearly or quite



capillare

PLATE XLVIII. *Bryum capillare* (From Bry. Eur.)

percurrent; leaf cells so narrow as to be more like *Pohlia* than *Bryum*, thick-walled: dioicous; capsule deep red.

B. atropurpùreum Wahlenb. is a much smaller and less brilliantly colored species having the costa excurrent, the leaf margins revolute and leaf cells of the typical Bryum shape: dioicous; capsule short, oblong or obovate. The revolute margins make the lower edge of the leaf appear as if margined, unless carefully examined. This species is not alpine, but is rather infrequent. Spores in early summer. This might be mistaken for the ever-present *cæspiticium*, but for the more shortly excurrent costa and short, oblong or obovate capsule.

B. argénteum L., the Silvery Bryum, is a small species growing everywhere in dense mats, resembling the pile of an exceedingly coarse natural velvet. It is especially fond of dry compact soil in sandy fields and waste places. It grows abundantly in paths and between the bricks of sidewalks in towns and cities. When fully grown it is a bright silvery gray, due to the fact that the leaves are white and without chlorophyll when old. The young plants are green and may easily be mistaken for something else. The leaves end in a slender bristle and are crowded and closely overlapping, making the stems and branches prettily julaceous.

FIGURE 115. *Bryum argenteum* × 4; branch × 10; capsule × 20. 4. Leaf greatly magnified (From Bry. Eur.)

The leaves are broadly ovate or obovate, not bordered, with costa ending considerably below the apex; margins plane and entire. The capsules mature in autumn, but can be found in recognizable condition at almost any season. When fully mature the seta and capsules are dark red.

On damp soil and stones in the cliffs of elevated regions, there may be found two mosses of the Bryum family that remind one of *Bryum argenteum*. They are slender and julaceous, but are not difficult to distinguish from it.

Plagiobryum Zieri (Dicks.) Lindb. perhaps resembles it most closely when sterile, but it usually has a reddish tinge, the capsule has a neck once to twice the length of the rest of the capsule, the mouth is oblique and on the under side after the manner of the mouth of the capsule in *Funaria;* the costa extends into the base of the leaf point, and the leaf cells are hexagonal-rhomboid and nearly twice as large.

Anomobryum concinnatum (Spruce) Lindb. is a bright glossy green, its stems are longer, the leaf cells are very much narrower, linear-vermicular; costa usually percurrent; capsules unknown.

The habitat alone is sufficient to distinguish these two mosses from *B. argenteum*, and the difference in leaf cells is enough to distinguish these from each other.

RHODOBRỲUM (Schimp.) Hampe.

Nearly always dioicous. Very large plants, sending out subterranean stolons from which other plants are produced.

R. ròseum (Weis.) Limpr., the Giant Bryum, is the largest and showiest of all our species of this family, and, moist and fully expanded, is a striking object in any situation. The stems spring from stolons and are nearly leafless except at the summit, where the very large leaves form a rosette. Under favorable circumstances it forms large mats on old rotten logs or at the base of trees in rich peaty soil. Although common, it fruits infrequently in either America or England, but reproduces freely by its stolons.

FIGURE 116. *Rhodobryum roseum* × 1; leaf and capsule × 4.

The antheridia mature in late August or early September, and the male heads are so large and conspicuous that it is easy to find them in almost any locality where the species grows. The antheridia are so large as to be easily seen with a hand-lens. One who has access to a compound microscope should not fail to study the antherozoids with high powers. The spores mature in autumn. This species is much like a *Mnium* in general appearance, but is larger than any of our species. The large terminal rosettes and elongated leaf cells, like those of *Bryum*, will serve to identify it.

SUBFAMILY 2. MNIEAE

Plants usually larger than in Subfamily 1, with larger broader leaves. Leaf cells nearly as broad as long. Plants rarely branching by innovations below the "flowers," frequently stoloniferous, *i. e.*, with prostrate or creeping sterile shoots that root at their tips. Capsules usually without appreciable neck; stomata usually immersed or partially so, rarely completely superficial.

MNIUM (Dill.) L.

Plants usually large with large leaves, which are broadly oblong, or obovate to lingulate, the lower nearly always shorter and more rounded than the upper, usually with a strong distinct border which is often strongly toothed. Costa usually percurrent or nearly so, sometimes shortly excurrent. *Leaf cells rounded-hexagonal to quadrate-hexagonal*, somewhat larger and elongated at base, not papillose. Calyptra small, cucullate. Capsules oblong-cylindric to ovoid, pendent, *not pyriform;* operculum mammillate to rostrate. Peristome as described on pages 34 and 35; cilia often nodose but not appendiculate.

Nearly all the species are large handsome mosses, easily distinguished even when sterile. The genus, for the most part, is one easily understood by beginners. Moist shaded ground rich in humus, or much decayed wood in moist shaded places, are favorite habitats of the genus.

Rhodobryum roseum is the only plant likely to be confused with *Mnium*.

KEY

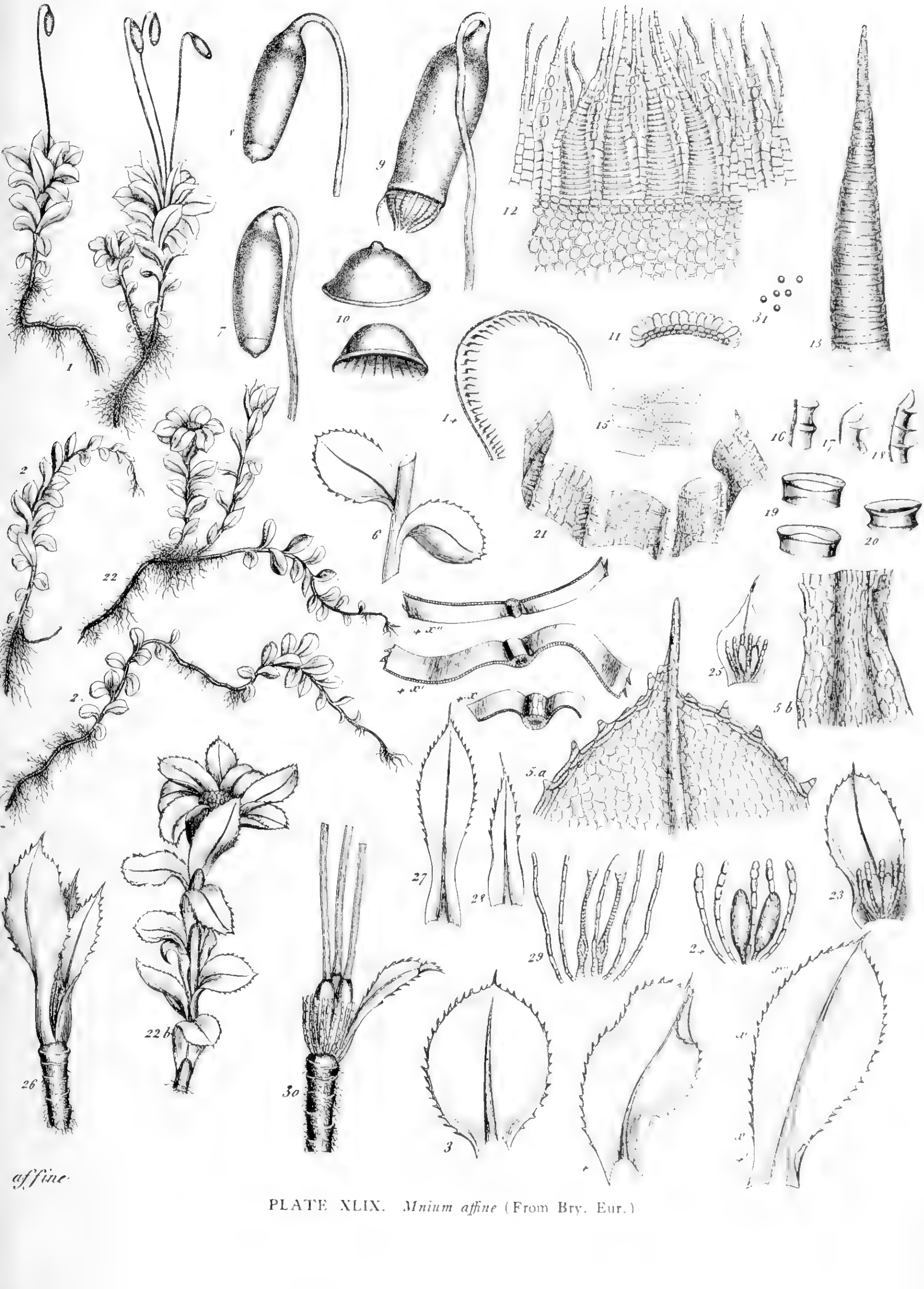
1. Leaves not bordered . . . . 2.
   Leaves bordered . . . . 3.
2. Plants large, leaves entire or very slightly serrate by projecting cells; leaf cells twice as long as broad, marginal cells linear . . . . *cinclidioides*.
   Plants much smaller, leaves usually serrate; leaf cells isodiametric (*i. e.*, as broad as long) . . . . *stellare*.
3. Leaves entire . . . . 4.
   Leaves serrate, with single teeth . . . . 7.
   Leaves serrate, with teeth in pairs . . . . 11.
4. Leaves costate to apex . . . . *punctatum*.
   Costa vanishing below apex . . . . 5.
5. Upper leaf cells isodiametric . . . . *hymenophylloides*.
   Upper leaf cells longer than broad . . . . 6.
6. Margin of leaves thickened, of 2–4 layers; dioicous; capsules oval . . . . . *punctatum*, var. *elatum*.
   Margin of leaves not thickened; synoicous; capsule subglobose . . . . . *subglobosum*.
7. Leaves serrate to base or nearly so; capsules clustered . . . . 8.
   Leaves serrate in the upper ½ or ⅔ only . . . . 10.
8. Teeth of leaf margins of 2–5 cells (except *affine rugicum*); operculum mammillate or apiculate . . . . 9.
   Teeth of leaf margins very short; operculum strongly beaked . . . . . . *rostratum*.
9. Dioicous; many marginal teeth of more than two cells . . . . *affine*.
   Synoicous; marginal teeth shorter, few of more than two cells . . . . . . *medium*.
10. Capsules clustered; leaves little shriveled in drying . . . . *Drummondii*.
    Capsules single; leaves strongly shriveled when dry . . . . *cuspidatum*.
11. Costa vanishing below apex . . . . *hornum*.
    Costa reaching apex in upper leaves . . . . 12.
12. Costa toothed on the back; dioicous . . . . *orthorrhynchum*.
    Costa not toothed on the back; synoicous . . . . 13.
13. Capsules sometimes clustered; peristome forming a conspicuous red-brown band around the mouth of the deoperculate capsule . . . . *spinulosum*.
    Capsules not clustered; peristome yellowish . . . . *marginatum*.

A. Serratæ. Leaves bordered, serrate with single teeth.

M. cuspidàtum (L.) Leyss. (*M. sylvaticum* Lindb.), Woodsy Mnium. One of the first signs of vegetable life in early spring is the array of upright green sporophytes of the Woodsy Mnium, which is common in lawns and parks in moist shady corners, and is to be found abundantly in moist woods everywhere, growing sometimes on the soil, sometimes on rotten wood. The sterile shoots are prostrate or suberect and the leaves decurrent and shaped as in Fig. 117,*e*, all acute, strongly bordered and serrate in the *upper half* or *two-thirds* with one-celled teeth, occasionally there may be teeth of two cells; costa stout, vanishing in or just below the cuspidate apex, often confluent with the border and appearing excurrent; leaf cells hexagonal, small, varying from about 20^{μ} near the apex to 25^{μ} near the middle of the leaf, somewhat collenchymatous. Synoicous; capsules single, maturing in May, but remaining in recognizable condition until August.

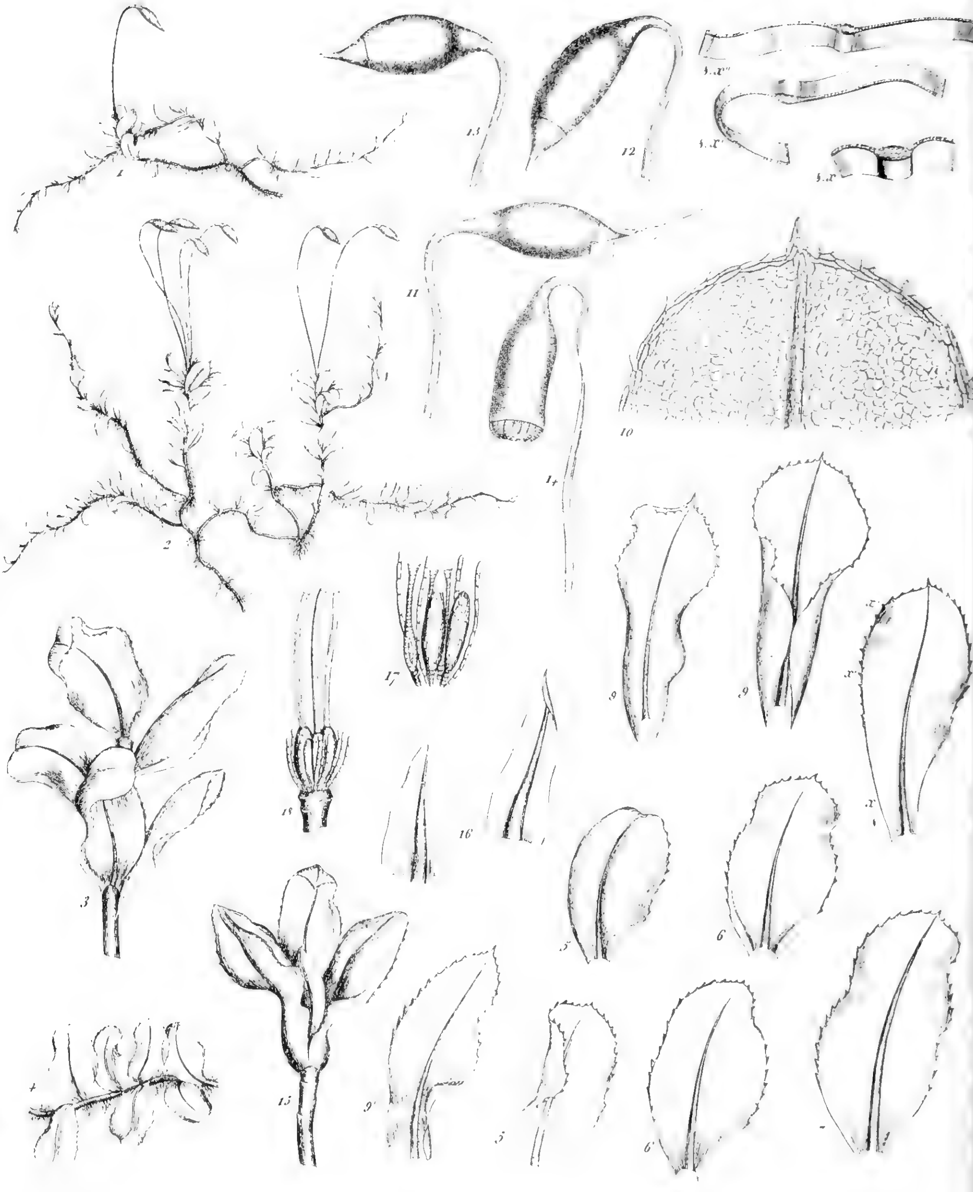
FIGURE 117. a. *Mnium affine ciliare* × 1. b. Leaf × 4. c. Leaf × 10. d. *M. sylvaticum* × 1. e. Leaves of different shapes × 10. f. Capsule × 10. g. *M. affine* × 1.

M. affine ciliàre (Grev.) C. M., the Toothed Mnium, superficially resembles the last, and next to it is our most abundant species. It is larger and *serrate to the base with long slender teeth* composed of 2–4 cells except at the very base. No reliance should be placed on the shape of the leaves as a mark of distinction between these species, as the leaves vary greatly even on different parts of the same plant, as may be seen in Plate XLIX.



affine

PLATE XLIX. *Mnium affine* (From Bry. Eur.)



rostratum

PLATE L. *Mnium rostratum* (From Bry. Eur.)

The leaf cells are nearly twice as large as in the last, 25–40$^{\mu}$, somewhat longer than broad, sometimes reaching 70$^{\mu}$ in length according to Limpricht. *Dioicous;* capsules usually single, maturing in May.

M. affine Bland. The common form of this species is the variety described above. The species is rather rare and is a more puzzling form for the student. It has the capsules clustered, and teeth on the margins of the leaves shorter than in the Toothed Mnium.

M. affine rùgicum B. & S. is a puzzling plant, with leaves strikingly different from the species in extreme forms. They are shorter, broadly oval or oblong, to suborbicular on the sterile shoots, and little or not at all serrate; the apex is as rounded and short apiculate as in *rostratum*. (See that species for distinctions.) The plants are smaller than in the species and of a darker, almost blackish green, except at the growing tips.

M. mèdium B. & S. is very close to *affine*. It is usually larger, *less shriveled when dry;* marginal teeth of leaves shorter and of fewer cells; *synoicous;* operculum longer apiculate. Because this species is synoicous it is often mistaken for *Drummondii*, but in that species the leaves are not serrate to the base. Not common but widely spread; maturing spores at the same time as *affine*.

M. rostràtum Schrad. is a third large stoloniferous species with clustered capsules, leaves margined and serrate with a single row of teeth. The leaves are broadly oblong, rounded at both ends, less tapering at base and less decurrent than in the preceding, apiculate by the percurrent costa as shown in Plate L. The margins are very wide and strong and the *marginal teeth are short and mostly of one cell* and do not extend so near the base as in *affine* and *medium;* leaf cells about the size of those in *affine* but *thicker walled* and plainly collenchymatous: *synoicous; operculum long-beaked;* spores maturing in early spring. The italicized characters readily differentiate this from all of the preceding except forms of *affine* approaching *rugicum* and that variety itself. These forms of *affine* are usually darker colored with thinner walled leaf cells that radiate in apparent rows from the costa in a manner not noticeable in *rostratum*. In perfect fruit the long rostrate operculum clearly distinguishes this from any of its allies in our range.

M. Drummóndii B. & S. is a rather infrequent species, sometimes confused with *affine* but easily distinguished by the fact that, like *cuspidatum*, its leaves are serrate in the upper half only. The plants are smaller than in *affine*, the capsules are shorter and the marginal serrations consist of but one greatly elongated cell, as a rule. The leaves are broader and proportionately shorter than in either *affine* or *cuspidatum* and shrivel much less in drying. This last is so apparent that, after a little experience, specimens of *Drummondii* can be differentiated from the other two at a glance. The sterile shoots are mostly erect, not creeping but sometimes arched at the tips. The much larger leaf cells, slender marginal teeth of the leaves, and clustered capsules, easily distinguish this from *cuspidatum*. It is synoicous and its spores mature in spring.

B. Biserratæ. Leaves margined, serrate with double teeth.

M. spinulòsum B. & S., the Red-mouthed Mnium, is another species somewhat resembling the Woodsy Mnium and growing in similar situations, but less common and usually growing in woods. The peristome is a very bright red-brown and after the operculum has fallen it makes a *very conspicuous red band about the mouth of the yellowish-white capsule.* If the leaves of the Red-mouthed Mnium be carefully studied, the teeth on the margins will be seen to be in pairs.

FIGURE 118. *a*. *M. punctatum* × 1. *b*. Capsule and operculum × 10. *c*. Leaf × 4. *d*. Var. *elatum* × 1. *e*. Leaf of var. *elatum* × 4. *f*. Leaf of *M. spinulosum* × 20. *g* and *h*. Apex and margin of same × 40. *o*. Leaf of *M. hornum* × 10. *p*. Apex of the same × 40.

The leaves are clustered toward the top of the fruiting stems in a manner very different from the loose and distant arrangement in the other species of this section; they are slightly shriveled when dry, obovate, to spatulate in the perichætium; costa percurrent, not toothed at back; leaf cells 20–30$^{\mu}$ in diameter, angled, *not collenchymatous.* Synoicous; capsules maturing at least two weeks later than those of the Woodsy Mnium. Before the lid has fallen its pronounced beak is an aid in identification. In Europe the capsules of this species are usually clustered, but in the eastern United States I find the great majority of plants with single capsules.

The plants also seem rather smaller than the western and European forms.

M. hórnum L., the Long-leaved Mnium, has narrower leaves than is usual in the genus; *costa ending below the apex*, usually toothed on the back above; leaf cells about the same size as in the last, not collenchymatous. The operculum is conic and apiculate and the capsule has an apparent neck.

This species is dioicous and the disc-like male heads are an additional aid in identification. It is more abundant southwards and is frequent around New York City in shaded springy places. It does not appear to fruit freely, but if one can find fruit in April with the calyptra in its queer position on the seta, instead of on the capsule, he can make no mistake. (See Fig. 119.)

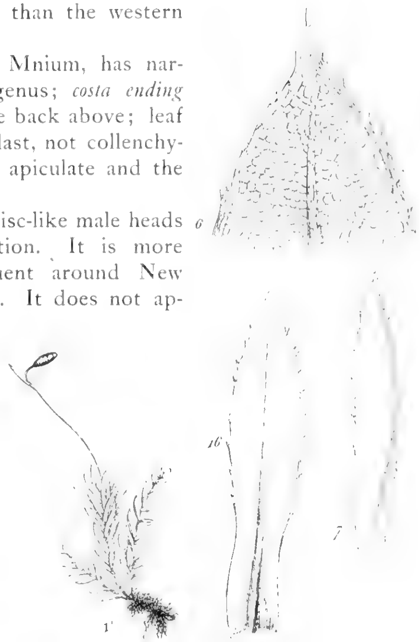


FIGURE 119. *Mnium hornum* (From Bry. Eur.).
1. Plant natural size. 6. Apex of leaf. 7. Leaf, side view. 16. Upper leaf.

M. marginàtum (Dicks.) P. Beauv. (*M. serratum* Schrad.). More slender than *M. hornum*, with rather broader leaves costate to apex in the upper portion of stem, long and narrowly decurrent, the wing often extending as far down as the next leaf; costa not toothed on the back; leaf cells 22–30μ in diameter, irregular, *rounded*, *strongly collenchymatous*. *Synoicous*; operculum short-beaked; peristome brownish, sometimes so dark as to simulate the appearance of *M. spinulosum*. Crevices of rocks in moist places and margins of streams; not rare. *M. riparium* Mitt. is a rare and obscure species resembling *marginatum*, but *dioicous* and "with more distinct broader leaves, usually more quickly narrowed at base." Rockland Co., N. Y. and Bergen Co., N. J., Austin.

M. orthorrhŷnchum B. & S. is similar to the last, but has *much smaller leaf cells*, 15–18μ, occasionally some of the largest as large as the smallest in *marginatum;* thick-walled, scarcely collenchymatous; costa toothed at back. *Dioicous;* peristome yellowish; operculum short-beaked; capsule with an apparent neck and more Bryum-like than in the species most like it, sometimes much more elongated than is shown in the plate. *Spores in July and August.* On moist rocks along streams in cool or elevated regions.

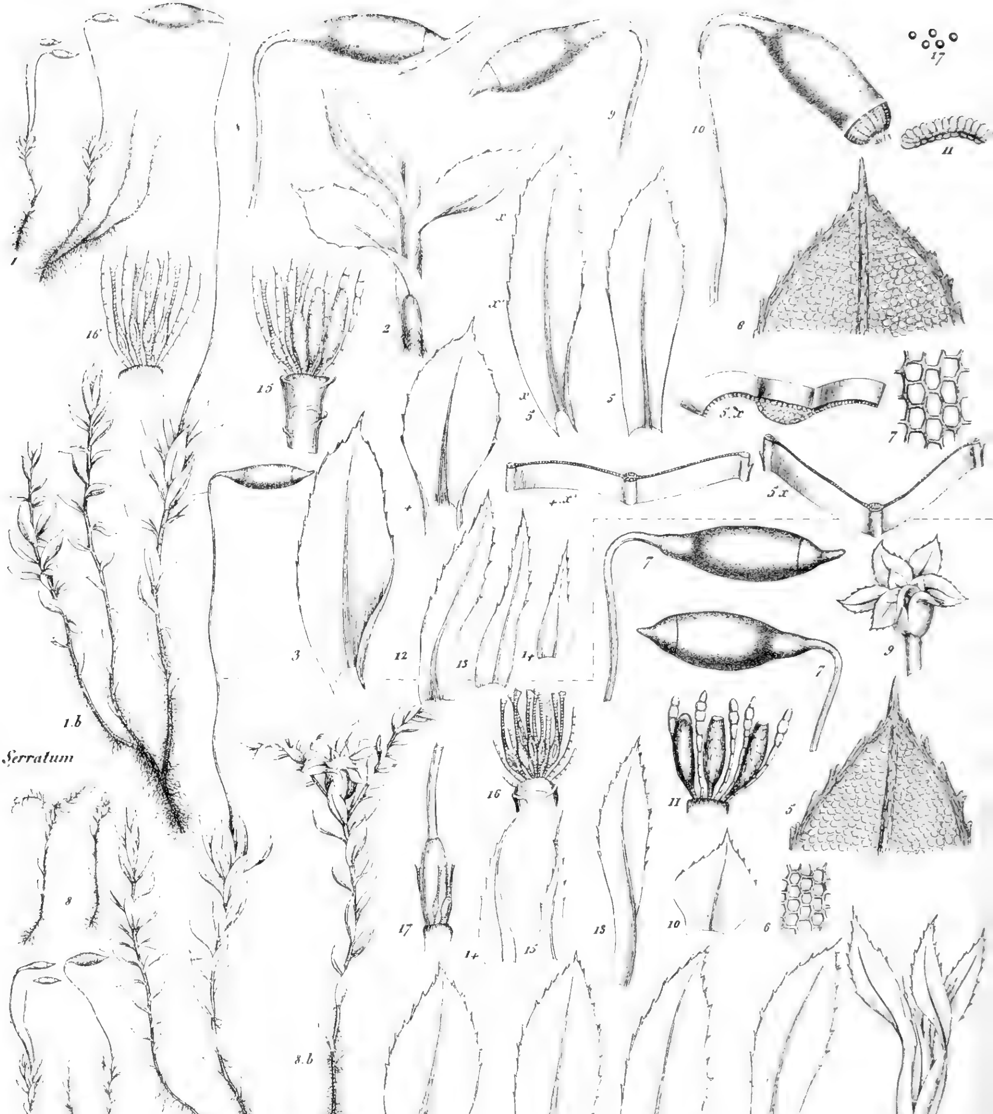


PLATE LI. *Mnium serratum* and *M. orthorrhynchum* (From Bry. Eur.)

In both *marginatum* and *orthorrhynchum* the costa in the lower leaves does not reach the apex and in the latter the lower leaves are often almost entire. Both species have the leaves a good deal shriveled when dry, especially on the sterile shoots.

C. Leaves bordered, entire.

M. punctàtum L., the Early Mnium, grows on moist stones in the bed of brooks. It matures its capsules in April, long before any other species. It is at once recognized by its obovate margined entire leaves and beaked operculum. The leaves are usually minutely apiculate and the costa percurrent, although in some of the leaves it may stop just a little short of the apex. The margin is composed of 2–4 rows of cells in several layers. Dioicous. Common.

M. punctatum elàtum Schimp., the Large-leaved Mnium, is said to be merely a variety of the Early Mnium growing in the mud in swampy places. It is often much larger than the figure, sometimes having leaves half an inch long. The leaf cells are so large as easily to be seen with a lens and in some cases with the naked eye of a trained observer. *Leaves not usually apiculate; costa ending below apex.* Very common in swamps, but not fruiting freely. (See Fig. 118.)

M. subglobòsum B. & S. is a rare northern form found in our range in the extreme northern part only. In general appearance it very closely resembles the preceding, especially the var. *elatum*, but the margins are of one layer of cells, 1–3 cells wide; it is synoicous and the capsules are usually subglobose. As in *M. punctatum elatum* the costa ends below the non-apiculate apex.

M. cinclidio`des (Blytt.) Hueben. is a very large moss 10 to 15 cm. high, said to have been found 3 dm. long, and looking almost exactly like an overgrown Large-leaved Mnium. The leaves are larger and oblong and are not margined after the manner of the preceding species of this section, but the marginal cells gradually become longer and narrower, the very outermost linear; *leaf margins entire*, except for an occasional slightly projecting cell. Dioicous. A rare species of cool bogs.

FIGURE 120. *Mnium cinclidioides* (From Bry. Eur.). 8 and 9. Upper leaves. 7. Leaf cells. 6 Leaf apex.

M. hymenophylloídes Hueben. is a rare northern species found on cliffs in Vermont, New York and northwards. There is no authentic record of fruit, though archegonia have been seen. The leaves are *two ranked and mostly in one plane*, the lower rounded-ovate, the upper more elongated, ovate to obovate (uppermost elliptic-spatulate according to Limpricht), 2.5–3 x 1.5–2 mm., *strongly apiculate;* costa usually reaching apex; most of the *leaf cells little if any longer than broad, only about half the size of the other species of this section.*

D. Leaves not margined, serrate.

M. stellàre Reich. is a small moss usually about 2 cm. high, though sometimes reaching 5 or 6 cm. It grows in rather dense cushions at the base of trees in swampy woods and, although frequent, it rarely fruits. The leaves are elliptic-oblong, not margined but serrate above. The costa ends farther below the apex than in any other species included here.

FIGURE 121. *Mnium stellare* (From Bry. Eur). Leaves and leaf apex.

*SUBGROUP 2. PLEUROCARPAE**

Sporophyte from a lateral bud on a branching prostrate or ascending plant; occasionally the plants are erect, as in Climacium. Peristome for the most part almost like that in the *Bryaceæ*, except that in the *Hypnaceæ* and some closely allied genera, the basal segments of the peristome teeth are ornamented by very fine transverse lines.

Family 21. Leskeaceae

Mosses of varying habit and size, growing on shaded earth, stones, trunks of trees, or decayed wood, usually lusterless; main stems creeping with ascending or erect secondary stems. In *Thuidium* the stems are regularly pinnately branched and ascending, having somewhat the appearance of miniature

* For a more extended discussion of the classification of this subgroup, see Revue Bryologique, p. 73, 1899.

ferns. Stem leaves often very different from the branch leaves, both strongly costate in most species, costa never excurrent; leaf cells rarely more than three times as long as broad, often less, mostly papillose, papillæ often very large; leaf cells of the basal portion of the leaves more elongated and less strongly papillose, often smooth. Paraphyllia present in most species, varying in form but mostly slender and branched. Seta long, smooth, twisted when dry. Capsule erect and symmetric in most of our species, except in the genus *Thuidium*. *Thuidium* also has the perfect hypnaceous peristome, but most of the other genera illustrate well the degeneracy of the peristome in erect capsules, as explained on p. 28; the cilia are usually vestigial or lacking and the segments often very narrow, or, in some cases, imperfect.

I must acknowledge my very great obligation to Dr. Best for assistance with this family, which he has studied so long and much of which he has monographed in a most excellent manner. Some of the illustrations are from his monographs and portions of the text, though no quotation marks have been used.

KEY TO THE GENERA

1.	Plants regularly and pinnately branching; capsules usually curved with perfect peristomes. (See also *Heterocladium*)	*Thuidium*.
	Secondary stems usually ascending from prostrate main stems, not regularly pinnate; peristomes usually imperfect, and capsules erect and symmetric	2.
2.	Plants bluish or glaucous green (scarcely so in *Thelia hirtella*); leaf papillæ very large, often lobed or branched; paraphyllia lacking	3.
	Not bluish or glaucous green; papillæ smaller, or rarely lacking; paraphyllia present except in *Anomodon* and part of *Leskea*	4.
3.	Costa short or double	*Myurella*.
	Costa single, usually reaching the middle of the leaf	*Thelia*.
4.	Costa double or short or almost lacking. (See also *Leskea denticulata*)	5.
	Costa single, strong	6.
5.	Leaves widely spreading when moist; capsule curved; peristome with cilia	*Heterocladium*.
	Leaves loosely imbricated when moist; capsule erect and symmetric; cilia lacking.	*Pterigynandrum*.
6.	♀ buds and sporophytes borne on secondary stems; paraphyllia lacking	*Anomodon*.
	♀ buds and sporophytes borne on primary stems; paraphyllia present in part of the species	*Leskea*.

THUÍDIUM B. & S. The Fern Mosses*

The Fern Mosses are widely distributed and have been noted by every lover of out-of-door life because of their delicate and beautiful fern-like form. The branches are given off very regularly like the pinnæ of a fern, and the

*The species mentioned in Lesquereux & James' Manual of the Mosses of North America and here omitted, are as follows: *Thuidium erectum* is *T. delicatulum*; *T. calyptratum* is a form of *T. microphyllum*; *T. remotifolium* is not a *Thuidium* and *T. tamariscinum* is not known from North America.

branches themselves often give off branchlets as regularly as the pinna of a fern is divided into pinnules.

The stems bear paraphyllia of various sizes and shapes, but all are more or less linear or filamentose, often divided and branched, but not leaf-like. There is often considerable difference between the stem and branch leaves in shape and size. The ovate-triangular stem leaves are usually papillose on both surfaces, unicostate, the costa passing the middle. The median leaf cells vary from roundish quadrate-hexagonal to rhombic-oblong; in two species linear-rhomboidal. The capsules, on smooth pedicels, are annulate, more or less curved. The opercula vary from conic to rostrate; the peristomes are well developed; the endostomial band 1/3 the length of the teeth, with segments and cilia.

KEY (Illustrated)

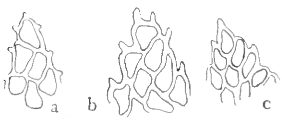


FIGURE 122.

FIGURE 123.

1. Apical cells of branch leaves crowned with 2–4 papillæ (Fig. 122, *a* and *b*); median cells quadrate-hexagonal to oblong-rhomboidal (Fig. 126) . . . 2.
   Apical cells of branch leaves with a single terminal papilla (Fig. 122, *c*); median cells as in 2. Paraphyllia numerous, branched . . . . 7.
   Apical cells of branch leaves not papillose; median leaf cells linear-rhomboidal (Fig. 124). Paraphyllia long-linear or filamentose (Fig. 123, *c*) . . 8.
2. Paraphyllia few, small, linear-oblong, 2–6 cells long (Fig. 123, *a*); branch leaves subcrispate-incurved when dry . . . . 3.
   Paraphyllia numerous, more or less branched (Fig. 123, *b*) . . . . 4.
3. Plants very small, 1–2 cm.; stem and branches filiform, branches papillose (Fig. 125); growing in thin mats on limestone rocks . . . . *pygmæum*.
   Plants small, 2–4 cm.; loosely cæspitose; branches smooth; growing on the ground and rotten wood . *minutulum*.


FIG. 125.

FIGURE 124.

4. Stems closely pinnately branched, branches terete-foliate when dry . . . . 5.
   Stems loosely pinnately or bipinnately branched . 6.
5. Plants soft; leaf cells with 2–5 small papillae on each surface (Fig. 126, *a*) . . . . *scitum*.
   Plants rigid; leaf cells with a single papilla on each surface (Fig. 126, *b*) . . . . *abietinum*.
6. Pinnate or bipinnate; stem leaves spreading-recurved when moist (Fig. 127), costa subpercurrent; perichætial leaves not ciliate . . *recognitum*.
   Bipinnate or tripinnate; stem leaves erect spreading when moist (Fig. 128), costate to 4/5; perichætial leaves ciliate . . . . *delicatulum*.

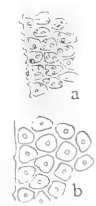


FIG. 126.

Bipinnate; stem leaves with a hyaline filiform acumination; perichætial leaves scarcely ciliate . . . . *Philiberti.*

7. Stem leaves (Fig. 129) roundish ovate, abruptly linear-oblong-acuminate, margins erose-serrate . . . . *Virginianum.*

FIGURE 127.

FIGURE 128.

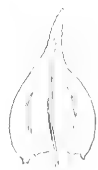


FIG. 129.

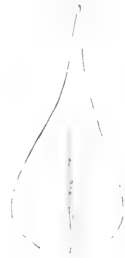


FIGURE 130.

Stem leaves broadly ovate, long and narrowly acuminate, margins crenulate-serrulate or entire (Fig. 130) . . . . *microphyllum.*

8. Stem leaves plicate striate, the decurrent base with one to three cilia (Fig. 131); branch leaves loosely appressed when dry . . . . *paludosum.*

Stem leaves sulcate, contracted to a decurrent subclasping paraphyllose base (Fig. 132); branch leaves subcrispate when dry . . . *Blandowii.*

FIG. 131.

FIGURE 132.

DESCRIPTION OF FIGURES IN THE KEY

FIGURE 122. Apical cells × 430: *a*, of *T. minutulum; b*, of *T. delicatulum; c*, of *T. Virginianum.* (Papillæ on surface of cells not shown.)

FIGURE 123. Paraphyllia × 215: *a*, of *T. minutulum; b*, of *T. delicatulum; c*, of *T. Blandowii*

FIGURE 124. Leaf cells of *T. Blandowii* × 430; *c*, papillæ of back of leaf seen in profile.

FIGURE 125. Portion of branch of *T. pygmæum* × 110.

FIGURE 126. Leaf cells × 430: *a*, of *T. scitum; b*, of *T. abietinum.*

FIGURE 127. Stem × 15 and leaf × 20 of *T. recognitum.*

FIGURE 128. Stem × 10 and leaf × 20 of *T. delicatulum.*

FIGURE 129. Leaf of *T. Virginianum* × 60.

FIGURE 130. Leaf of *T. microphyllum* × 60

FIGURE 131. Leaf of *T. paludosum* × 12.

FIGURE 132. Leaves of *T. Blandowii* × 12.

**Large species*, see Plate LII.

T. delicátulum (L.) Mitt., the Common Fern Moss, grows in damp shady places over stones and earth, rotten logs and the like. It is bright green at the ends, darker below and very regularly twice or even three times pinnate. It is abundant throughout our range, but does not always fruit freely.

The stem leaves are triangular-ovate, rather gradually acuminate, appressed when dry, *erect-spreading when moist*, margins serrate, more or less recurved;

costa vanishing in the acumen; medium leaf cells quadrate-oblong to oval rhombic; *perichætial leaves ciliate on the margins;* dioicous; capsule cylindrical, curved; operculum conic-rostrate; *spores maturing in winter.* (See Figs. 122, 123, 128, 133 and Plate LII.)

T. recognitum (Hedw.) Lindb. is somewhat less common than the preceding and often grows intertangled with it. The two species are very generally confused and are not always easy to distinguish when sterile. This species is mostly bipinnate and bright yellowish green at the ends of the stems and branches. The broadly triangular, auriculo-cordate, abruptly acuminate stem leaves are sulcate when dry, spreading recurved when moist, usually plane on the serrulate margins; costa subpercurrent, somewhat spreading at apex; median leaf cells oblong-rhombic, passing to oblong-linear at the apex; perichætial leaves not ciliate; dioicous; capsule cylindrical, curved; operculum rostellate; spores in July. (See Figs. 127 and Plate LII.)

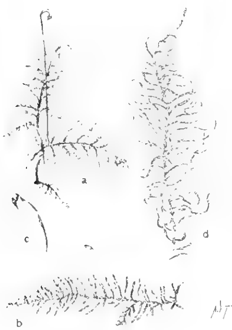


FIGURE 133. *a. Thuidium delicatulum* × 2/3. *b. T. scitum* × 1. *c.* Capsule of the same × 5. *d. T. abietinum* × 1.

The difference in appearance of the stem leaves, particularly when moist, is the most convenient character for distinguishing these two species. Young perichætial leaves of *T. delicatulum* are sometimes destitute of cilia.

T. Philiberti Limpr. is a rare species much like a degenerate form of *delicatulum.* The distinguishing character of this rare species is the hyaline, filiform acumination of the stem leaves which are somewhat intermediate between those of *T. recognitum* and *T. delicatulum;* the median leaf cells are quadrate-oblong rather than oblong-rhombic; costa thin, disappearing above the middle; dioicous; capsule cylindrical, curved; annulus not clearly differentiated; operculum conic-rostrate; spores maturing in October. On swampy grounds and about the base of small trees in wet places. New Jersey, Pennsylvania, Ontario and New Brunswick.

T. Alleni Aust. According to Dr. Best this is synonymous with *T. glaucinum* var. *ludovicianum* Card. This differs from *T. glaucinum* in the lower papillæ, stronger costa and less denticulate branch leaves. From *T. delicatulum* in the non-ciliate perichætial leaves. It is bipinnate; "stem leaves ovate-lanceolate, broadly, shortly and obtusely acuminate." Rare. Connecticut to Louisiana.

T. abietinum (L.) B. & S., the Wiry Fern Moss, is a rather less common moss about the size of *delicatalum*, but simply pinnate and stiff, growing in dense tufts on stones and ledges in drier situations and on dry sterile soil; stem leaves broadly ovate, acuminate, deeply biplicate, margins serrulate;

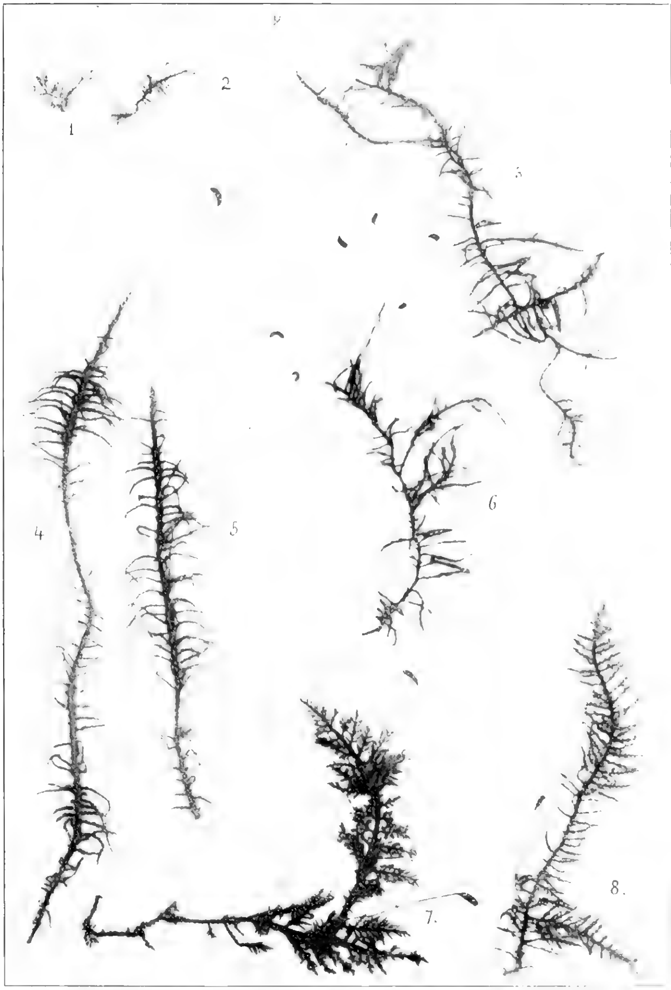


PLATE LII. 1. *Thuidium pygmæum.* 2. *T. minutulum.* 3 and 6. *T. paludosum.* 4 and 5. *T. Blandowii.* 7. *T. delicatulum.* 8. *T. recognitum.*

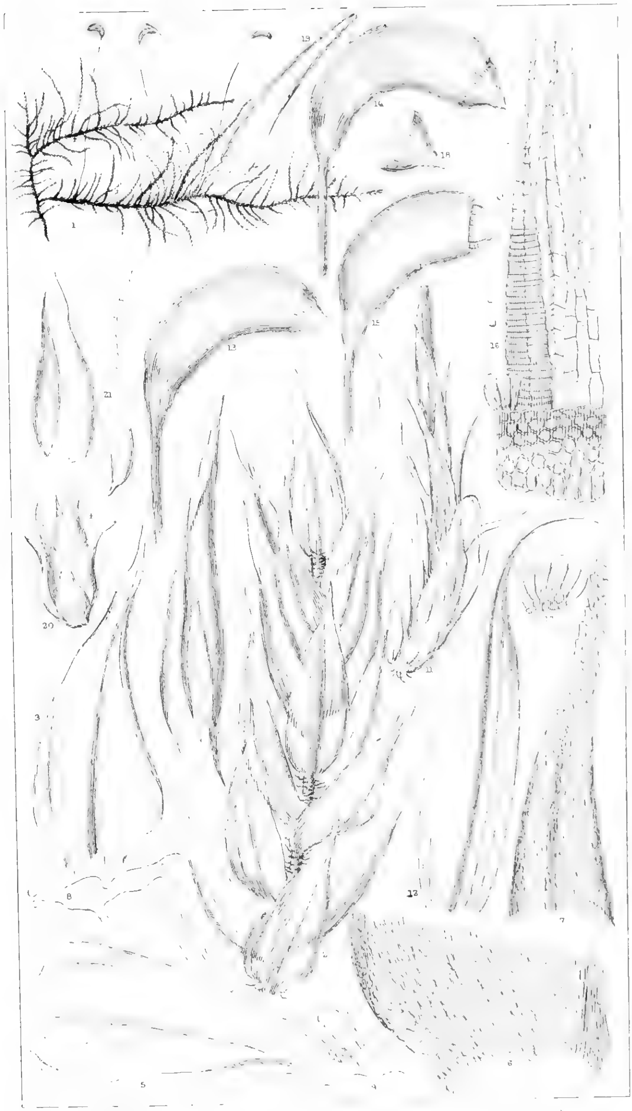


PLATE LIII. *Thuidium paludosum* (From Sulliv. "Icones.")

median leaf cells oval-rhombic; dioicous; capsule narrowly cylindrical, curved; operculum long conic. From Greenland to Virginia and from New Foundland to British Columbia. Sterile here but fruiting in Colorado and Montana and fruiting freely in Alaska. (Fig. 133.)

T. Blandówii (W. & M.) B. & S. is another large species regularly and simply pinnate, erect, and softer than most species. The stems and branches are covered with a paraphyllose tomentum; the stem leaves have long paraphyllia-like appendages at base, as shown in Fig. 132; the stem leaves are ovate-triangular, narrowly acuminate, margins sinuate-serrulate, costa disappearing above the middle; median leaf cells oblong-fusiform to linear-rhomboidal, with a large papilla on the distal end of each on the lower surface, smooth or nearly so on the upper; monoicous; capsule oblong cylindrical, curved; operculum conic; spores maturing in July. On marshy ground, with a northern range. From Greenland to Vermont, southward to New Jersey, westward to Idaho and British Columbia. (Figs. 123, 124, 132 and Plate LII.)

T. paludòsum (Sulliv.) Rau and Hervey (*Hypnum paludosum* Sulliv.) is a common species in swamps and wet grassy fields in the Eastern and Middle States. At first sight the student will hardly place it among the Fern Mosses, as it is irregularly pinnate with leaves often scarcely papillose. It will perhaps be most easily recognized by the paraphyllia, somewhat similar to those on the preceding species, and the somewhat similar paraphyllose filaments at the base of the stem leaves, which are somewhat rigid, oblong-lanceolate, acuminate, plicate-striate; costa subpercurrent; median leaf cells oblong to linear-rhomboidal, smooth or with a small papilla at the distal end of each on the lower surface, rarely on both; monoicous; capsule oblong-cylindrical, curved; operculum conic, apiculate; spores maturing in winter—var. *elodioides* (R. & C.) Best; often dark green, leaves smaller, more strongly papillose, papillæ sometimes subcentral, margins dentate-serrate. New York and westward. (Fig. 131, and Plates LII and LIII.)

* * *Medium-sized species simply and regularly pinnate.*

T. sc`tum (Beauv.) Aust. This neat trim moss grows in mats on the roots and bases of trees. Stem leaves broadly triangular, auriculo-cordate, narrowly acuminate; branch leaves broadly ovate-acuminate; median leaf cells roundish-hexagonal *with 2 to 5 small bead-like papillæ on each surface;* monoicous; capsule cylindrical, *straight*, or *but slightly curved;* operculum conic-rostrate; spores maturing in autumn and winter. Var. *æstivale* (Aust.) Best; stems not so closely pinnate; capsule oblong-cylindrical, inclined to horizontal; operculum shorter beaked. From Canada to North Carolina and from Vermont to Wisconsin. (Fig. 133.)

T. Virginiànum (Brid.) Lindb. (*T. gracile* var. *Lancastriense* S. & L.). Plants small, dark or dirty green, in open woods on the ground or about stumps and

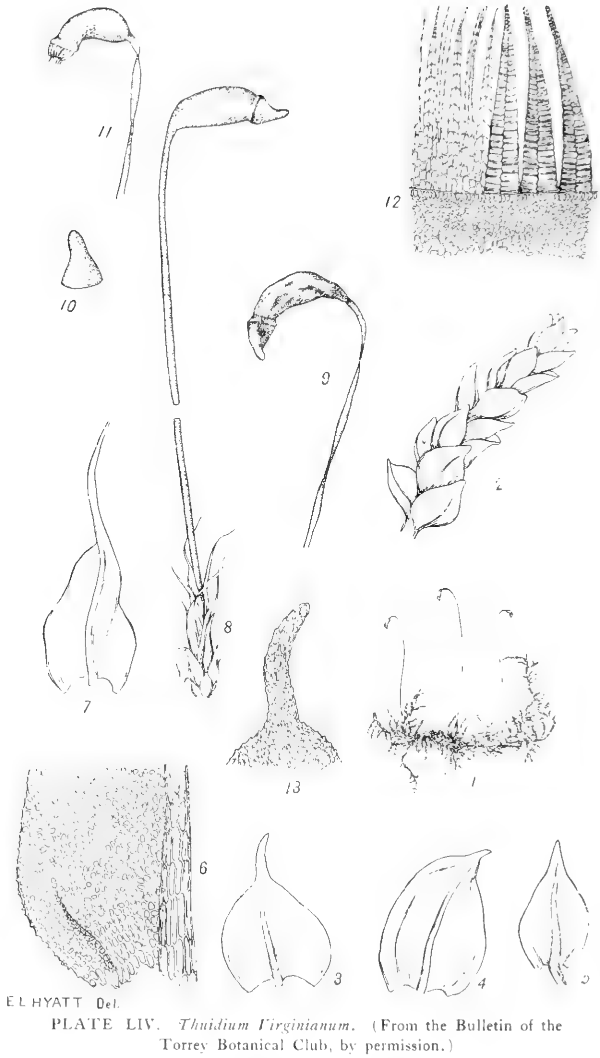


PLATE LIV. *Thuidium Virginianum.* (From the Bulletin of the Torrey Botanical Club, by permission.)

roots of trees; *stem leaves roundish ovate, abruptly acuminate* (Fig. 129); costa vanishing in the acumen; erose-dentate below, serrate above; leaf cells oblong-quadrate to hexagonal *with a single papilla;* acumen of the branch leaves short, broad, sharply serrate; median leaf cells quadrate-hexagonal; monoicous; capsule cylindrical, curved; operculum short beaked, obtuse; spores maturing in spring. From Massachusetts to Minnesota, south to Mexico. This is readily distinguished from the preceding by the unipapillate leaf cells and curved capsules, and from the next by the shape of the stem leaves (Figs. 122, 129, and Plate LIV).

T. microphýllum (Sw.) Best. (*T. gracile* Br. & Sch.). Plants of medium size, pale green, becoming yellowish. Stem leaves broadly ovate to ovate-lanceolate, *long and narrowly acuminate;* margins sinuate-serrulate or entire; costa subpercurrent; median leaf cells quadrate-oblong to oval-rhombic, *unipapillate*, monoicous; capsule oblong, curved; operculum short-conic, acute or obtuse; spores maturing in summer. Var. *Ravenellii* S. & L.: a stunted form growing in sand or on stones in the Southern States. Var. *lignicola* (Kindb.) Best: somewhat larger than the type, yellowish or rufescent, margins of stem leaves more or less recurved, median leaf cells rhombic to short rhomboidal; capsule more turgid. Northward and westward—on rotten wood, bark of decaying trees, rarely on stones or the ground. From New Mexico to Florida, northward to Canada, westward to British Columbia. (Fig. 130 and Plate LV.)

* * * *Species small, simply pinnate (see Plate LII); papillæ several on each cell.*

T. pygmæum Br. & Sch. For fineness and for beauty this little moss, appearing when dry like miniature embroidery, leads the Thuidiums. The paraphyllia, found only on the papillose branches, are so small as easily to be overlooked. The median leaf cells of the triangular-ovate stem leaves are quadrate-hexagonal and the operculum of the asymmetric oblong-ovate capsule obliquely rostrate; monoicous; spores maturing in autumn. Canada, Ohio, New Jersey and Pennsylvania.

T. minùtulum (Hedw.) Br. & Sch. Although quite small, this species differs from the preceding chiefly in being larger. Paraphyllia on both stems and smooth branches; median leaf cells quadrate-hexagonal, the marginal somewhat larger; monoicous; capsule oblong-oval, rough, slenderly rostrate.

Its usual habitat, in the northern part of its range, is rotten wood; in its southern, the ground. The spores mature in autumn. From New Brunswick to Minnesota and from Canada to Florida.

Heteroclàdium squarròsulum (Voit.) Lindb. is a rare subalpine species strongly resembling the smaller species of *Thuidium*, but the plants are less regularly pinnate and the costa is *short, thin, divided or bicostate.* It has been found in southern Vermont and northwards. It should be looked for in the northern Berkskires and in the Adirondacks.

PLATE LV. *Thuidium microphyllum.* (From Sulliv. " Icones.")

LÉSKEA Hedw.

Plants small to medium-sized, growing in tufts about the base of trees, on bark of lower trunk, on rotten wood, more rarely on stones, rocks or the ground, in damp shady places. Stems prostrate, usually radiculose, sometimes paraphyllose, pinnately to fasciculately branched, rarely stoloniferous; leaves often papillose, ovate to ovate-lanceolate, acute, acuminate or obtuse, usually unicostate, sometimes shortly bicostate, nearly or quite entire (excl. *L. denticulata*); leaf cells somewhat uniform, median quadrate-hexagonal to oval-oblong, rarely elongated; setæ smooth; capsules *usually straight and erect*, sometimes curved, oval to subcylindric, annulate; teeth well developed; segments linear, often keeled and cleft; cilia usually none or rudimentary; opercula mammillate to long-conic, rarely rostellate; calyptræ cucullate, smooth.

Many of the Leskeas grow at bases of trees or on stones, overflowed at high water, and these are frequently so full of sand and dirt as to render examination difficult.

KEY

1.	Leaves papillose, costate; median cells usually isodiametric; peristomial teeth abruptly incurved from a bulging base when dry . . . . EULESKEA	2.
	Leaves smooth or nearly so, costate or ecostate; peristomial teeth erect when dry HETEROLESKEA	5.
2.	Leaves ovate-lanceolate, acute to acuminate, more than twice as long as wide . . .	3.
	Leaves ovate, subacute to obtuse, less than twice as long as wide	4.
3.	Capsules straight (except var. *paludosa*); operculum short-conic	*polycarpa*.
	Capsules curved; operculum long-conic	*arenicola*.
4.	Leaves symmetric, biplicate, margins often revolute	*gracilescens*.
	Leaves asymmetric, not plicate, margins plane	*obscura*.
5.	Leaves entire or nearly so, costate	*nervosa*.
	Leaves denticulate, ecostate	*denticulata*.

The four species of *Euleskea* so intergrade as to be exceedingly puzzling. The typical form of *L. polycarpa* is not so common in North America as is generally supposed, and when it does occur it is usually smaller. Between it and *L. obscura* are a large number of transitional forms. These differ from *L. polycarpa* in having their leaves smaller, straighter and more obtuse and by their shorter, often unequal, segments of the inner peristome. These intermediate forms are much more common than typical forms of either of the above-mentioned species, and approach both in their extreme variations without being satisfactorily disposed of as varieties. These intermediate forms Dr. Best has called *L. gracilescens*. Some of these forms will probably never be classified to suit more than one student at a time, as their position will be largely a matter of individual opinion. These forms should not be ignored, but the student should not allow them to worry him.

To add to the difficulties of this group, *L. polycarpa* intergrades into its variety *paludosa* and through it into *L. arenicola*. These two last-mentioned forms are the only ones which ever have *conspicuously* curved and unsymmetric capsules.

When one gets a *Leskea* with the leaves plainly rounded-obtuse he may feel sure he has *L. obscura*. If he gets a specimen with beaked operculum, long curved capsule and long slender peristome as in Plate LVII, Figs. 11 and 12, he may feel sure he has *arenicola*. Other forms will need careful comparisons with figures and descriptions, and with authentic specimens if possible.

Dr. Best's descriptions are followed pretty closely in this genus and are given with comparatively little change other than abbreviation. The descriptions of leaves are of those taken from the middle third of the stem or branch as the case may be.

Some of the *Fabroniaceæ*, especially *Clasmatodon parvulus*, may be sought here, but their leaves are not papillose and none are so strongly costate as *L. nervosa*.

All our species of *Euleskea* are monoicous, those of *Heteroleskea*, dioicous.

L. polycárpa Ehrh. Stems prostrate, 2–4^{cm} long: paraphyllia few, linear-lanceolate: stem-leaves loosely appressed when dry, erect-spreading when moist, 0.8–1.2^{mm} long, 0.35–0.45^{mm} wide, from a subcordate, slightly decurrent, ovate or oblong-ovate base, lanceolate, *gradually acute* to *abruptly acuminate*, more or less secund and obliquely pointed, biplicate, entire, one or both basal margins usually recurved, costa disappearing below apex; branch-leaves smaller, often obtuse or blunt-pointed; median cells of stem-leaves roundish quadrate-hexagonal, 7–8μ wide, *with one or two small papillæ on each surface;* basal quadrate-oblong; alar quadrate or transversely oval: monoicous: capsule erect, straight or slightly curved, sub-cylindric, tapering at base, wrinkled when dry and contracted below mouth; segments linear, nearly as long as teeth, scarcely open on the keel; cilia rudimentary or none; spores mature in early summer. On the base of trees, rotten wood, rarely on stones or the ground.

From Newfoundland westward through Canada to Montana and southward.

L. polycarpa paludòsa (Hedw.) Schimp. Stouter, more diffusely branched; stems and branches longer, somewhat curved at tips: stem-leaves usually secund, distant, ovate-lanceolate, acute to obtuse, sometimes obliquely acuminate, up to 1.4^{mm} long and 0.5^{mm} wide; median leaf-cells roundish quadrate, unipapillate on both surfaces: capsule longer, often slightly bent or curved, reddish-brown with age. In wet places, sometimes submerged, about the base of trees and on rotten wood, rarely on stones.

With the type, but less frequent; more common in the Northwest.

L. arenícola Best. Plants somewhat rigid; paraphyllia multiform, mostly linear-lanceolate; stem-leaves rigid, secund, 0.8–1^{mm} long, ovate to ovate-lanceolate, obliquely acuminate, acute to blunt-pointed, scarcely biplicate, margins

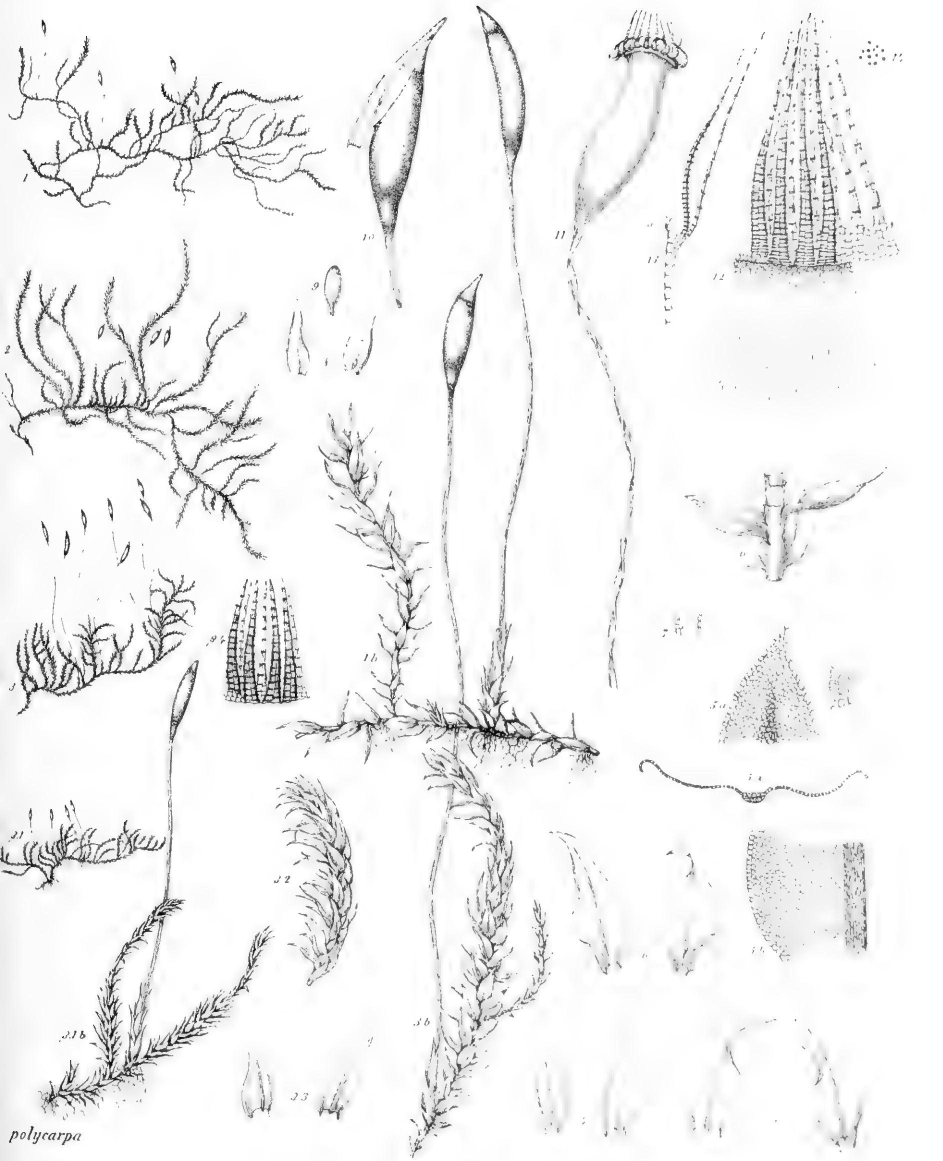


PLATE LVI. *Leskea polycarpa* (From Bry. Eur.)
(Figures 1-4 β represent the European var. *tenella*, which is not yet recorded from North America, and Dr. Best thinks the other figures are probably var. *paludosa*)


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PLATE LVII

usually recurved at base, entire or sinuate-serrulate above; costa disappearing in the acumen; leaf-cells somewhat clear, stoutly unipapillate on under surface, usually smooth on upper; alar cells quadrate, in 5 or 6 rows; median oval-rhombic to oblong-fusiform, 7–9μ wide and about twice as long; branch-leaves smaller, broadly lanceolate, scarcely secund; capsule oblong-cylindric, curved, tapering at base, wrinkled when dry; urn about 2^{mm} long, operculum $\frac{1}{3}$–$\frac{1}{2}$ as long as the urn; teeth of peristome very long ($0.6–0.7^{mm}$) and slender, densely papillose, median line faint, segments of inner peristome as long as the teeth, from a basal membrane *about* $\frac{1}{3}$ *their length;* cilia rudimentary; spores in early summer. On the base of trees, rarely on decaying wood in sandy places. From Maine southward along the coast to Virginia and northward and westward to Minnesota and Dakota.

The distinguishing marks of *L. arenicola* are its curved capsules, longer teeth and segments, longer and narrower opercula, and its rhombic elongated leaf-cells. In general appearance it is approached by some forms of *L. polycarpa paludosa* which agrees in the above-named characters only in the often somewhat curved capsules, and has a wider basal membrane.

L. graciléscens Hedw. Branches simple, erect, often subjulaceous: paraphyllia few, lanceolate, rarely none: stem-leaves appressed-imbricate when dry, erect-spreading when moist, $0.4–0.5^{mm}$ wide, $0.65–0.9^{mm}$ long, ovate, gradually acute, obtuse or blunt-pointed, straight, lightly biplicate, margins entire, often more or less revolute, costa subpercurrent; branch-leaves similar, not plicate; leaf-cells somewhat uniform, unipapillate on lower surface, usually smooth on upper; median quadrate-hexagonal, 8–10μ broad; alar and basal quadrate; apical roundish; capsule erect, oblong-cylindric, tapering at base; teeth whitish, lanceolate-linear, median line faint, lamellate, $0.35–0.45^{mm}$ long; endostomial band about one-quarter the length of the teeth; segments linear, usually shorter than the teeth, carinate, open, sometimes poorly developed and unequal; cilia none; operculum conic, obtuse or acute; spores in early summer. On the base of trees or rotten wood. Common and widely distributed, ranging through the Eastern, Middle, Northern and Western States, rare in Canada and in the Southern States and absent west of the Rocky Mountains.

EXPLANATION OF PLATE LVII. (From the Bulletin of the Torrey Botanical Club, by permission.)

Figs. 1–13, *Leskea arenicola*. 1. Plant, natural size. 2, 3. Outlines of stem-leaves, × 44. 4, 5. Outlines of branch-leaves, × 44. 6. Apex of stem-leaf, × 170. 7. Median cells of leaf, × 390. 8. Cross-section of stem, × 235. 9. Perichetial bud, × 7½. 10. Inner perichetial bract, × 18. 11. Capsule, × 9. 12. Peristome (annulus of three rows), × 100. 13. Spores, × 100. Figs. 14–27, *Leskea obscura*. 14. Plant, natural size. 15, 16. Outlines of stem-leaves, × 44. 17. Outlines of branch-leaves, × 44. 18. Apex of stem-leaf, × 170. 19. Median cells from leaf, × 390. 20. Cross-section of stem, × 235. 21, 22. Perichetial buds, × 7½. 23. Inner perichetial bract, × 18. 24. Capsule, × 9. 25. Peristome (annulus for the most part of two rows), × 100. 26. Spores, × 100. 27. Longitudinal section through peristome, × 130. Figs. 41–54, *Leskea nervosa*. 41. Plant, natural size. 42, 43. Outlines of stem-leaves, × 44. 44, 45. Outlines of branch-leaves, × 44. 46. Apex of stem-leaf, × 130. 47. Median cells of leaf, × 310. 48. Cross-section of leaf, × 130. 49. Cross-section of stem, × 130. 50. Perichetial bud, × 7½. 51. Perichetial leaf, × 20. 52. Capsule, × 15½. 53. Peristome, × 130. 54. Spores, × 130.

L. obscùra Hedw. Stems prostrate, $3–5^{cm}$ long, sparingly branched; paraphyllia few, lanceolate, or none: stem-leaves incurved-appressed when dry, spreading when moist, oblong-ovate, $0.8–1.3^{mm}$ long, straight or slightly curved, thickish, concave, subcarinate, unsymmetric, margins plane, *apex rounded-obtuse* or at most subacute, entire or serrulate; costa disappearing below apex; branch-leaves similar, more symmetric, obtuse, acute, or short acuminate; leaf-cells somewhat uniform, *pluripapillate on lower surface with small papillæ*, papillose or nearly smooth on upper surface; median cells quadrate-hexagonal, $8–10^{\mu}$ wide; basal quadrate-oblong; apical smaller and roundish; capsule erect, straight, oblong-cylindric, wrinkled and slightly contracted below mouth when dry; teeth yellowish, papillose, basal membrane yellowish, about one-fifth the length of the teeth; segments linear, densely papillose, more or less open, shorter than the teeth; operculum short-conic, obtuse or apiculate; spores in early summer. On the base of trees or rotten wood; more rarely on stones or the ground in wet places. "Sulliv. Icon. Musc. *pl.* 77 is probably a form of *L. gracilescens*, as the margins of the stem-leaves are recurved. Dr. Robinson is unable to find the specimen in the Sullivant collection from which these drawings were made."

"*L. obscura* has about the same range as the preceding, except that it is more frequent southward. Not rarely it grows mixed with *Anomodon attenuatus* and *A. obtusifolius*, to both of which it bears a superficial resemblance." "In its typical form *L. obscura* differs from *L. polycarpa* and *L. gracilescens* by its thicker, asymmetric, rounded-obtuse leaves, not plicate and with plane margins; the segments moreover are stouter, more densely papillose and usually more open." "The most valuable character in differentiating *L. obscura* from the preceding species is the thicker texture of the leaves, the cells of which are covered with minute papillæ, resembling those of *Anomodon attenuatus*, but not so many, nor so distinct."

L. nervòsa (Schwaegr.) Myrin. In thin appressed tufts, pale green to dark green, older parts *rusty brown or black;* stems creeping, $4–7^{cm}$ long, radiculose, not paraphyllose, pinnately branched; stem-leaves broadly ovate, subcordate, slightly decurrent, *abruptly long-acuminate*, $0.35–0.5^{mm}$ wide, $0.8–1.3^{mm}$ long; acumen more or less recurved, margins plane, subsinuate; body concave, biplicate, margins sometimes recurved on one or both sides; costa subpercurrent, narrow, scarcely tapering; branch-leaves narrow, rigid, erect-spreading, smaller, leaf-cells *smooth or scarcely papillose*, somewhat uniform; median cells oval-hexagonal to oval-oblong; alar quadrate to transversely oval in 5 or 6 rows, extending well up the margins and becoming roundish: capsule erect, subcylindric, brownish, wrinkled when dry; teeth erect, confluent at base, yellowish, margined, dorsal surface finely striate; segments irregular, unequal, sometimes rudimentary; spores in summer.

From Labrador to British Columbia, southward to Pennsylvania and Colorado.

This species is readily distinguished from all the others of the genus by the slenderly acuminate smooth leaves. As it is rarely fertile in the United States, although it is frequently so in Canada, it is usually overlooked. Rough bark at base of hardwood trees in open places or on the edge of a forest is the favorite habitat of this species. Depauperate forms with flagelliform branches are common, and nearly every colony of the plants will in some portions bear clusters of gemmæ at the ends of their stems and branches. Transitional forms between the species and the var. *nigrescens*, which has the gemmæ on flagellate branches and less clustered, are common in Vermont, and in nearly all forms of the variety some portions may be found with the typical leaves of the species.

L. nervosa nigréscens (Kindb.) Best. In intricate tufts or mats, dirty yellowish green to dark green or black; stems creeping, *scarcely radiculose*, defoliate or with distant ovate narrowly acuminate recurved leaves, irregularly branched; branches usually few, short, ascending with numerous flagelliform branchlets, commonly bearing bulbils at their tips; branch-leaves as in type but smaller, 0.2–0.3^{mm} wide, 0.4–0.6^{mm} long; leaf-cells quadrate-hexagonal, smooth or slightly papillose; leaves of branchlets rudimentary, scarcely costate; sterile. On the base of trees, sometimes on stones and rocks; with the type but less common.

L. denticulàta Sulliv. Plants small, pale green, soft, somewhat silky; stems prostrate, 2–4^{cm} long, irregularly branched, without paraphyllia; stems and branches flattened when moist, sometimes subjulaceous when dry: stem-leaves close, erect-spreading, concave, subdecurrent, ovate, somewhat abruptly and narrowly acuminate, 0.5–0.7^{mm} long, 0.3–0.4^{mm} wide, ecostate, rarely with diverging striæ; margins plane, minutely papillose-denticulate; leaf-cells unipapillate on lower surface; median cells oval-oblong to sublinear-rhomboidal, 6–8$^{\mu}$ wide, two to four times as long, rarely longer and subvermicular; alar quadrate, thick-walled, passing abrubtly to the median; marginal curvilinear, in a single row; branch-leaves smaller, more gradually acuminate; cells shorter, oval-rhombic to oblong; dioicous; capsule suberect; segments nearly as long and as broad as teeth, cleft between the joints; cilia none; *annulus none*. On base of trees, rarely on rocks; seldom fruiting; sometimes flagelliferous.

From New York westward to Indiana and southward to Florida.

This species differs from all our other Leskeas in having the leaves ecostate. M. Cardot has put it in the genus *Schwetschkea* C. M. and probably will be followed in this by other bryologists. Its leaves resemble those of the *Fabroniaceæ* in shape and areolation and it is one of the forms likely to be confused with that family.

Leskea Austínii Sulliv. has been separated as *Fabroleskea Austinii* (Sulliv.) Best. It is a rather rare species widely distributed in our region. When in fruit it is easily distinguished by its densely papillose peristome teeth and lack of any

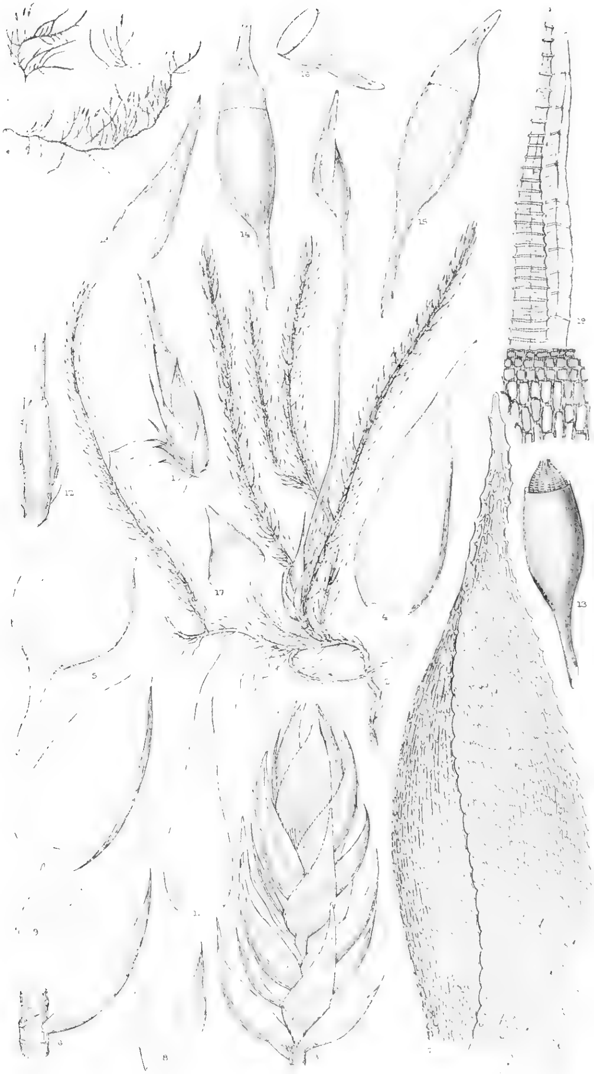


PLATE LVIII. *Leskea denticulata* (From Sulliv. "Icones.")

inner peristome except a very narrow and inconspicuous membrane. The leaves are *strongly papillose* and more slenderly acuminate than in any of our species, except *L. nervosa*, but the costa is much shorter than in that species.

Both this species and the preceding belong undoubtedly in other genera, as indicated, but are given the above treatment for convenience.

Pterigynandrum filiforme, *Anomodon rostratus* and *A. tristis* are species likely to be occasionally sought under *Leskea*. For distinctions refer to figures and illustrations of those species.

PTERIGYNÁNDRUM Hedw.

Somewhat resembles *Leskea* in general appearance and inhabits similar places, roots and bases of trees, damp stones, etc. It is distinguished from *Leskea* by the much shorter costa, which may be single and reach the middle of the leaf or be shorter and double, or even almost wanting: leaves much narrowed at base, often obovate, very concave, inner peristome of 16 rather short, linear to irregular segments without basal membrane or cilia.

P. filifórme (Timm.) Hedw. is our only species. Primary stems creeping; secondary stems with numerous irregular slender, often flagelliform branches; paraphyllia small, varying from filiform to many-branched forms; leaves small, obovate to oval-elliptic, closely imbricate when dry, concave, not plicate, acute, slightly denticulate above, papillose at back; costa as described above; median leaf cells 3–5 times as long as broad, long and narrowly rhomboidal and somewhat vermicular, broader and shorter at apex, quadrate to rectangular at base; capsule small, erect and symmetric, operculum short-beaked; spores in summer.

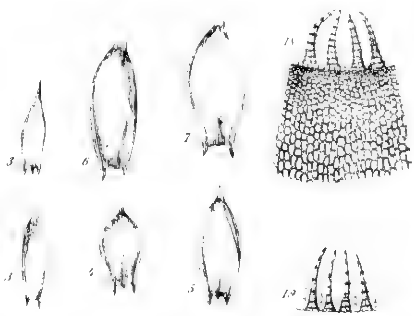


FIGURE 134. *Pterigynandrum filiforme* (From Bry. Eur.) 3–7. Leaves. 18 and 19. Peristome.

The fully developed fruiting plant I find to be infrequent, but degenerate forms grading toward the var. *minus* and the variety itself appear frequent.

Var. **mìnus** L. & J. is a small degenerate, often darker colored form with leaves less markedly papillose and more nearly entire, costa almost obsolete. On boulders and ledges. The original description says that the segments in this variety are as long as the teeth, but I have not been able to verify this.

ANÓMODON Hook. & Taylor

Much like *Leskea* in habit of growth but much larger and coarser (excl. *A. rostratus* and *A. tristis*), when fully developed growing in mats consisting of a network of nearly leafless primary stems growing close to the substratum and sending up secondary stems and branches in great numbers. The leaves described are those of the secondary stems and branches, those of the primary stems are usually quite different. The stems lack paraphyllia. The leaves are densely papillose on both sides and almost opaque, and have a single long, strong, pellucid costa (shorter in *tristis*); leaf cells irregularly hexagonal, a few in the median basal area usually elongated and pellucid. Capsules and peristome much as in *Leskea* but the former borne on the branches, the latter very brittle; inner peristome as a rule less developed than in *Leskea*. All our species are dioicous.

KEY

1. Secondary stems and branches slender, usually julaceous when dry . . . . 2.
   Secondary stems and branches coarse, scarcely julaceous . . . . 3.
2. Leaves slenderly acuminate, ending in a hair point; plants growing in moist places at base of trees and about ledges . . . . *rostratus*.
   Leaves narrowly lingulate from an ovate base, obtuse to apiculate; plants growing on bark of trees as a rule . . . . *tristis*.
3. Secondary stems much branched as a rule, many branches attenuate to flagelliform; some of the leaves apiculate and toothed at the apex . . . . *attenuatus*.
   Secondary stems more sparingly branched, no attenuate branches . . . . 4.
4. Upper portion of leaves lingulate-lanceolate, conspicuously tapering to the apex, somewhat contorted and crisped when dry, often secund: plants usually growing on rocks . . . . *viticulosus*.
   Upper portion of leaves lingulate and of nearly equal breadth, not secund; plants nearly always growing on bark of trees, stumps or logs . . . . 5.
5. Leaves somewhat crisped when dry with points incurved, not decurrent, having large fimbriate-papillose auricles, often apiculate . . . . *apiculatus*.
   Leaves scarcely contorted when dry, somewhat irregularly appressed, decurrent, without auricles, not apiculate . . . . *minor*.

A. minor (P. Beauv.) Fuern. (*A. obtusifolius* B. & S.) Blunt-leaved Anomodon. This species and the next resemble each other in general appearance and habit of growth; both are rather large coarse mosses whose favorite habitat is the basal three feet of rough-barked trees in cool moist woods. Both have large (up to 2^{mm} long) leaves, more or less two-ranked, which are tongue-shaped above from a broadly ovate base, entire, very densely papillose; segments of inner peristome very short from a narrow basal membrane; spores mature in late autumn to winter; both frequent in most parts of our range, more common in mountainous regions.

PLATE LIX. *Anomodon minor.* (From Sulliv. "Icones"

FIGURE 135. *a. Anomodon apiculatus* × 2. *b.* Capsule and peristome × 10. *c.* Leaf × 10. 5-6. Base and apex of leaves much magnified. *d.* Branch of *A. attenuatus*, moist × 2. (5-6. From Sulliv. "Icones")

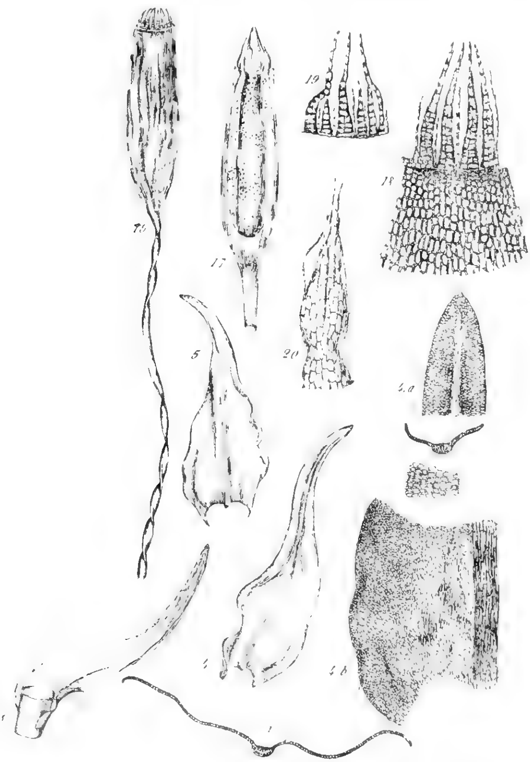


FIGURE 136. *Anomodon viticulosus* (From Bry. Eur.)

This species is distinguished by the very obtuse, somewhat decurrent leaves not auricled or apiculate, not markedly contorted or crisped when dry, but merely irregularly appressed.

A. apiculàtus B. & S. *Leaves not decurrent but with large fimbriate papillose auricles*, often apiculate, somewhat crisped when dry *with apex incurved* and borders broadly incurved in the upper lingulate portion. The broader apex and more suddenly enlarged basal portion, together with its smaller size, will serve to distinguish this from *viticulosus* with the hand-lens.

A. viticulòsus (L.) Hook. & Taylor is very similar to the species described above but is larger and usually more yellowish in color and more commonly found on rocks and has leaves *more tapering in the upper portion* with a narrower apex, somewhat contorted to subcrisped when dry and often somewhat secund, frequently subserrulate at apex; segments of inner peristome rather better developed than in the preceding species; capsules rare, maturing in winter to spring. Less common than the two preceding but widely distributed.

A. attenuàtus (Schreb.) Hueben., Slender Anomodon, is considerably more slender than any of the preceding and is easily recognized at sight by the *numerous, slender to flagelliform branches as shown in Fig. 135*, but not all branches are of this sort, many are blunt and somewhat curved at the ends when dry, and, especially in spring, of a lighter yellowish green than the rest of the plant; leaves broadly lanceolate from an ovate base which is much more narrowed to the insertion than in any of the preceding species, *acute and minutely apiculate at*

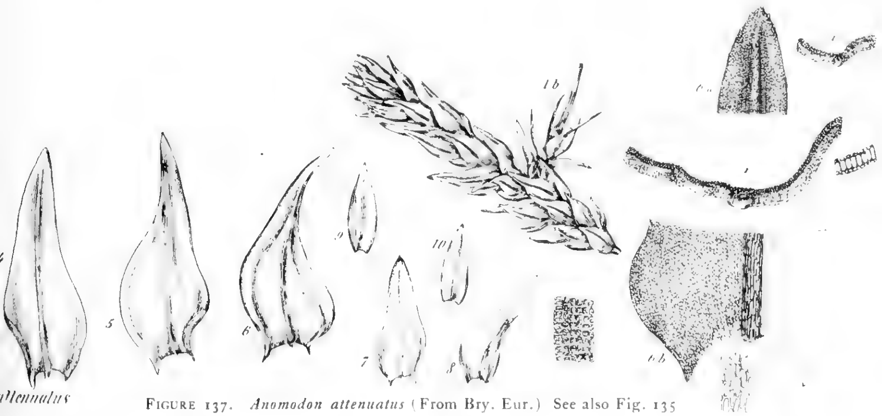


FIGURE 137. *Anomodon attenuatus* (From Bry. Eur.) See also Fig. 135

apex with usually a few minute teeth near the apiculus: capsules rather rare; segments of inner peristome nearly as long as the teeth; spores in autumn or early winter. This is probably our most common species, growing freely on both rocks and bases of trees but nearly always sterile.

A. rostràtus (Hedw.) Schimp. grows in dense yellowish-green mats like coarse velvet. It is found in wet places at the foot of trees, growing on the ground rather than on the tree. It is also common at the base of wet cliffs and on wet rocks where a little soil has collected. It is easily distinguished from all the preceding by the slender julaceous secondary stems and branches, fully as slender as in *Leskea* to which it was formerly assigned; and it is easily distinguished from all related forms by the slenderly acuminate leaves ending in a hair point (Fig. 138, 6a): capsules oblong-ovoid with beaked operculum; segments as long as the teeth; spores in autumn. Very common.

A. tristis (Cesat.) Sulliv. (*Leskea tristis* Cesat.) is extremely slender, the smallest of the genus. It grows chiefly on the rough bark of trees and is rather infrequent northwards, but more abundant and of a denser growth in the southern portion of our range. The leaves are appressed when dry, squarrose-spreading when moist, variable in shape but mainly narrowly lingulate from an ovate base, apex rounded or acute, often apiculate, costa slender for the genus, *ending about the middle of the leaf; leaf cells more translucent than in the other species, turgid and bulging on margins and surface and bearing several large papillae on each face:* these large bulging cells on the margin cause the leaf to appear crenulate-serrulate; probably reproducing by fragments of the very brittle leaves, as fruit is unknown. Sometimes the leaves are hardly more than broadly ovate-acuminate, at others almost strap-shaped from a wider base, and again the upper portion of the leaf will be almost lanceolate, but the small size and more translucent bulging cells with coarse papillae are very characteristic.

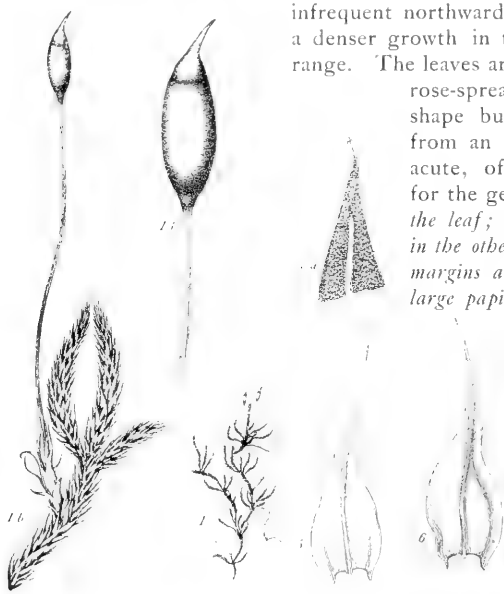


FIGURE 138. *Anomodon rostratus* (From Bry. Eur.)
1. Plant natural size. 6*a*. Leaf-apex highly magnified

THELIA Sulliv.

Plants of this genus are as a rule easily recognized by the light color, *very light to glaucous-green*, and the rather *short crowded julaceous stems* from creeping primary stems. In depauperate or very young plants the branches are often scattered. Under the microscope the most striking thing is the *enormous single papilla* on the back of each leaf cell. The costa is usually single and extends about half the length of the leaf. Capsules ovoid-cylindric, operculum beaked; outer peristome teeth conspicuously whitish, slender; inner of a well developed basal membrane with segments very rudimentary or none.

KEY

1. Growing on rather dry sandy soil, rarely on bases of trees . . . . *Lescurii.*
   Growing on the base of trees, never on the ground . . . . 2.
2. Plants distinctly glaucous; leaf *papillae forked* . . . . *asprella.*
   Plants scarcely or not at all glaucous; *papillae simple* . . . . *hirtella.*

T. hirtélla (Hedw.) Sulliv. is very common in the southern and coastwise portion of our range, less frequent in the interior, especially in elevated regions. It forms thin, loosely adherent mats on the bases of trees and stumps, easily recognized by their whitish-green color, julaceous branches, concave, sub-orbicular leaves which are abruptly and narrowly acuminate with borders spinulose-dentate above and fimbriate-ciliate below, and by the erect symmetric capsules with whitish peristomes. The spores mature in autumn.

T. asprélla (Schimp.) Sulliv. has the same range and habitat as the preceding but is less abundant as a rule. It is a light glaucous-green color, more marked when fresh, and *has branched or star-shaped papillae on the back of the leaves.* The spores mature in early autumn.

T. Lescùrii Sulliv. This is very close to the last and grades into it. "The fasciculate branching of the stouter stems and the faintly bluish tint of the glaucous green color, with the habitat on sand or rocks, are the characters that mark *Thelia Lescurii* better than any others." It is confined to the more southern coast regions, northern limit, Connecticut. Capsules are rarely produced.

FIGURE 139
Thelia hirtella × 4; leaves × 20

MYURÉLLA B. & S.

M. Careyàna Sulliv. reminds one very strongly of a *slender delicate Thelia asprella.* The color is a pale glaucous green, the branches are julaceous but with less crowded leaves, the leaves are about the same shape and have very large papillae on the back of each cell, but the papillae are simple, the margins are merely serrate with projecting cells, and the costa is very short and double or almost lacking. The capsules are oblong-obovate, and the peristome perfect with well developed cilia. Spores infrequently produced. Frequent in moist places on cool shaded rocks in cool or elevated regions. Much more abundant in limestone regions.

M. julàcea (Vill.) B. & S. is a rare infrequent subalpine form growing in damp crevices of rocks. The slender julaceous light green branches will indicate

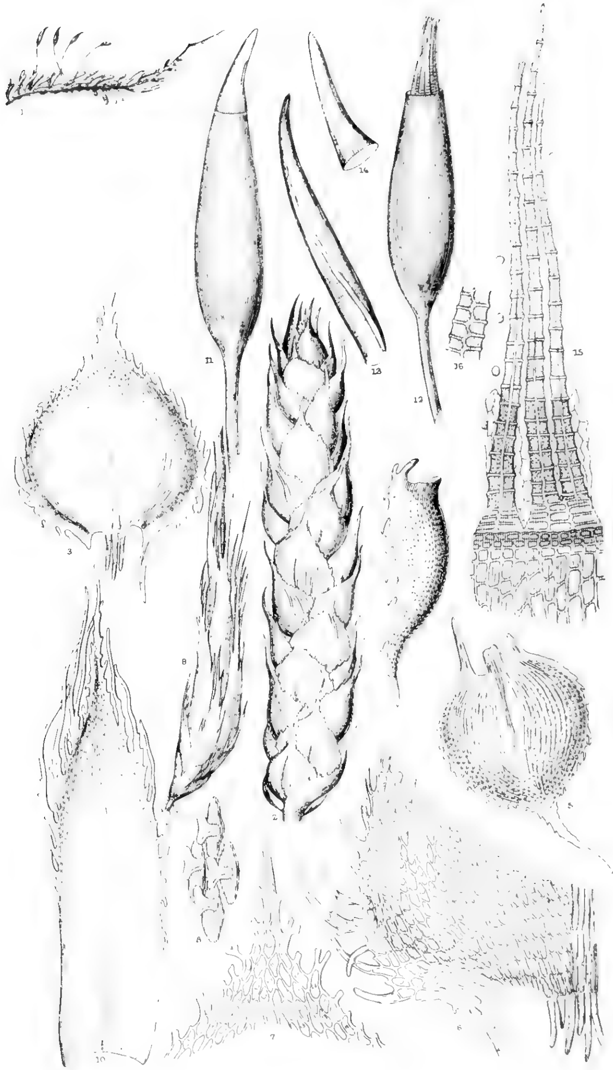


PLATE LX. *Thelia asprella* (From Sulliv. "Icones") its relationship at once. Leaves broadly ovate, obtuse or acuminate, serrulate with projecting cells, papillae of leaves much reduced and often nearly lacking, produced from the angles of the cells instead of their faces: capsules much as in the last, spores in July and August.

Family 22. The Hypnaceae

Plants creeping in habit, forming mats of more or less closely interwoven stems and branches, growing mainly on soil and rotten wood, less frequently but commonly on stones and trunks of trees, a few aquatic.

Leaves costate or ecostate, not papillose, except *Bryhnia* and *Hylocomium* species. Capsules on elongated setæ more or less curved and unsymmetric except in the *Climacieæ*, *Entodoneæ* and a few anomalous mosses. Peristome usually perfect, the cilia often lacking in mosses with erect capsules, segments always keeled; teeth strongly articulate, marked at base between the articulations by characteristic fine transverse lines except in a few forms with erect capsules and degenerate peristomes. A very large family closely related to the *Leskeaceæ*, from which it differs in the non-papillose leaves and also usually in the longer leaf cells and unsymmetric cernuous capsules. The peristomes are very close to those of the *Bryaceæ* except for the fine transverse lines on the peristome teeth.

This family is a large and somewhat heterogeneous one and includes practically all the pleurocarpous mosses with elongated smooth leaf cells and well developed peristomes, *i. e.*, having broad keeled segments and, usually, well developed cilia. Although the leaf cells are often short and broad, they are more or less rhomboidal or elongated-hexagonal in outline and in the middle of the leaf are never regularly oval, rounded, or quadrate.

The mosses of this family may be found in all kinds of habitats, and some individual species have a wide range of habitat.

The classification of this family is a matter upon which no two bryologists would be likely to agree. No single character can be relied upon as a basis of classification, and it is extremely difficult to select combinations of characters that will indicate relationships with any degree of accuracy. Many characters relied upon in the past are almost certainly very highly modified, if not actually produced, by habitat conditions. Short thick-walled leaf cells are so frequently correlated with a xerophytic habitat as to suggest a causal relation. There is almost certainly a relation between habitat and the curvature and direction assumed by the capsule, and between this last and the completeness of the peristome. These statements, of course, apply to mosses outside this family, but the difficulties in classification caused by these facts are particularly prominent here.

The following grouping into subfamilies is primarily based more on the structure and robustness of the costa and the presence or absence of central strand in the stems than most of the older groupings. For exceptions to the characters indicated in this key see the descriptions of the subfamilies.

KEY TO SUBFAMILIES OF THE HYPNACEAE

1. Costa strong and extending to the middle of the leaf or beyond, nearly always single, (exceptions in *Hylocomium* and *Campylium*) . . . . 3.
   Costa short and double or lacking . . . . 2.
2. Capsules erect and symmetrical, or nearly so; cilia of inner peristome rudimentary or lacking . . . . *Entodonteæ*.
   Capsules unsymmetric, more or less curved, usually cernuous . . . . *Hypneæ*.
3. Plants large, secondary stems stout and dendroid from creeping or stoloniferous primary stems . . . . 4.
   Plants smaller, scarcely dendroid . . . . 5.
4. Capsules erect and symmetric; peristone without cilia . . . . *Climacieæ*.
   Capsules curved, cernuous; peristome perfect . . . . *Porotricheæ*.
5. Capsules ovoid, short, thick and unsymmetric, usually little contracted under the mouth when dry; stem and branch leaves often quite different . . . . 6.
   Capsules longer, arcuate-cylindric as a rule, usually more contracted under the mouth when dry . . . . *Amblystegieæ*.
6. Costa single and usually reaching well beyond middle of leaf; seta often rough; paraphyllia lacking . . . . *Brachythecieæ*.
   Costa frequently double, often short; paraphyllia large and abundant in many species; seta smooth . . . . *Hylocomieæ*.

SUBFAMILY HYLOCOMIEÆ

The characters of this subfamily are pretty well enumerated under *Hylocomium*. Its position is somewhat of a novelty as the usually double costa has caused it to be most frequently put with the *Hypneæ*, yet the large and abundant paraphyllia of some of the species as well as gross appearance resemble the *Thuidia* while the capsules are certainly more like the *Brachythecieæ* than the *Hypneæ*. The stems, moreover, possess a central strand.

KEY TO GENERA

Leaves secund, strongly rugose; no paraphyllia . . . . *Rhytidium*.
Leaves not secund nor rugose; paraphyllia very abundant in some species . . . . . . *Hylocomium*.

HYLOCÒMIUM B. & S.

Large robust mosses growing in wide, loose patches, characteristically in cool moist woods (the name signifies "inhabitants of the wood"), of a various habit yet for the most part with a common facies that is more easily recognized than described. Some are complanately branched and regularly bi-tri-pinnate after the manner of *Thuidium*, most are rather irregularly branched. A number of the species have the stems densely covered with large branched paraphyllia. Leaves usually large and strongly plicate to sulcate. Costa single and strong but never percurrent, or double and more or less well developed. This genus, *Hygrohypnum* and *Campylium* contain species with the costa single and double or even wanting, yet the species of these genera that vary in the development of the costa and also in that of the central strand are often very closely related. This goes to show conclusively that no one character can be relied upon for the purposes of classification but that all characters must be taken into consideration.

The leaf cells in this genus are narrowly linear, frequently papillose at the back of the leaf by the thickening of the angles of the cell-walls as in *Brybnia*, comparatively little differentiated at base and angles, usually somewhat shorter and broader and often colored. Our species are dioicous; capsules large, short, inclined and unsymmetric, much as in the *Brachythecia*: peristome perfect with well-developed cilia.

KEY

1.	Paraphyllia lacking	2.
	Paraphyllia present, usually very abundant	3.
2.	Stem leaves not plicate, strongly squarrose-recurved	*squarrosum.*
	Stem leaves plicate, widely spreading but not recurved	*triquetrum.*
3.	Plants regularly and closely bi-tri-pinnate	*proliferum.*
	Plants rather irregularly branched	4.
4.	Costa single, extending to middle of leaf	*Pyrenaicum.*
	Costa double	5.
5.	Stem leaves decurrent at base, coarsely serrate . . .	*umbratum.*
	Stem leaves rounded at base, more finely serrate, squarrose	*brevirostre.*

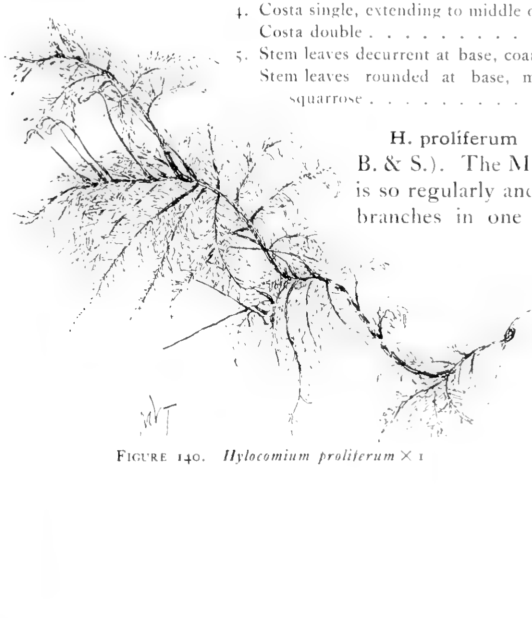


FIGURE 140. *Hylocomium proliferum* × 1

H. proliferum (L.) Lindb. (*H. splendens* B. & S.). The Mountain Fern Moss. This is so regularly and evenly bi-tri-pinnate with branches in one plane as to remind one very strongly of an overgrown *Thuidium*. The proliferous mode of growth is very striking and is well shown in the illustration. Each year's new growth is produced by a fern-like shoot developing from the middle

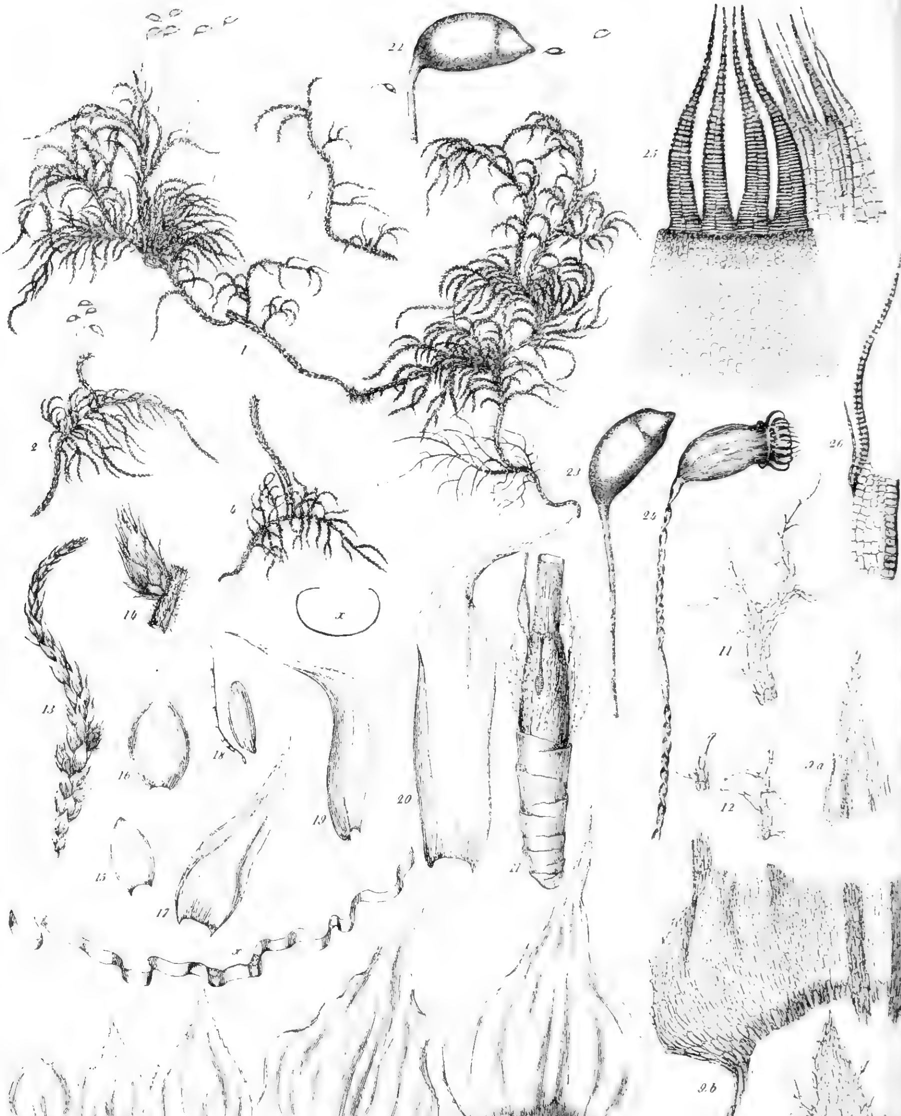


PLATE LXI. *Hylocomium umbratum* (From Bry. Eur.)

of the upper side of the shoot of the previous season. When growing in its favorite habitat, over stones and logs in rich moist mountain woods, this is one of our most beautiful mosses. In less favorable localities its growth is frequently so stunted as to give little idea of its true beauty. The stems are covered with branched paraphyllia. The leaves of the primary stems are widely ovate to oblong-ovate, rather abruptly acuminate with a long strongly cirrhose acumen, somewhat plicate, concave; basal leaf cells thicker walled and orange; costa double, ¼–⅓ the length of the leaf; branch leaves smaller, not plicate, usually acute; leaves of secondary stems intermediate between those of primary stems and the branches; all leaves with strongly denticulate margins; papillose at back, papillæ less abundant on leaves of primary stems: capsules not common; operculum beaked; spores mature in early spring.

H. umbràtum (Ehrh.) B. & S. This species is more closely confined to mountain woods than the last with a habit of growth somewhat similar but less regularly pinnate and not complanately branched. The stems are covered with branched conspicuous paraphyllia; the branches slender, attenuate and often drooping; stem leaves almost equilaterally triangular-ovate, deeply sulcate, decurrent, papillose at back, very strongly serrate; double costa strong reaching about ½ the length of the leaf; spores mature in early spring. Common in mountainous regions.

H. breviróstre (Ehrh.) B. & S. is rather rare and confined pretty closely to mountainous regions. It is distinguished from the last by its much larger size and coarser appearance, smaller, and less conspicuous paraphyllia and squarrose stem leaves with rounded auricles and less strongly serrate margins: These leaves are cordate-ovate to cordate-triangular, suddenly contracted to the rather long acumen. The spores mature from late autumn to early spring.

H. Pyrenaicum (Spruce) Lindb. (*H. Oakesii* Sulliv.) is another subalpine species. The paraphyllia are exceedingly abundant and very large, bipinnately branched; leaves not spreading or squarrose, serrate at apex, with costa single and extending to the middle, rarely double; stem leaves widely ovate, concave rather short-acuminate and strongly plicate; branch leaves smaller and more gradually and longer-acuminate; spores mature in late autumn.

FIGURE 141. *Hylocomium triquetrum* × 1; stem-leaf × 4

H. triquétrum (L.) B. & S., the Shaggy Moss. This is common on shaded banks with a medium amount of moisture. It is yellowish green in color; usually its branching is rather irregularly pinnate as shown in Fig. 141, but sometimes in deep mountain woods it branches regularly, though not complanately, and grows to a length of five or six inches. The stems are very stout and rigid but elastic. For this reason it is used in packing china and other brittle objects. The stem leaves are very large, 4–5^{mm} in length, spreading at nearly right angles, widely deltoid-triangular to broadly ovate, rounded at basal angles and narrowed to the insertion, plicate, denticulate, papillose at back, with two slender parallel costæ extending about ¾ the length of the leaf; basal cells thick-walled, pitted, orange: capsules striate when dry; spores mature from winter to early spring.

H. squarrŏsum (L.) B. & S. is a rather rare moss of cool swamps, more common in the mountains but occurring in the lowlands, even near the coast. It is much more slender than the last and less rigid, bright green; leaves

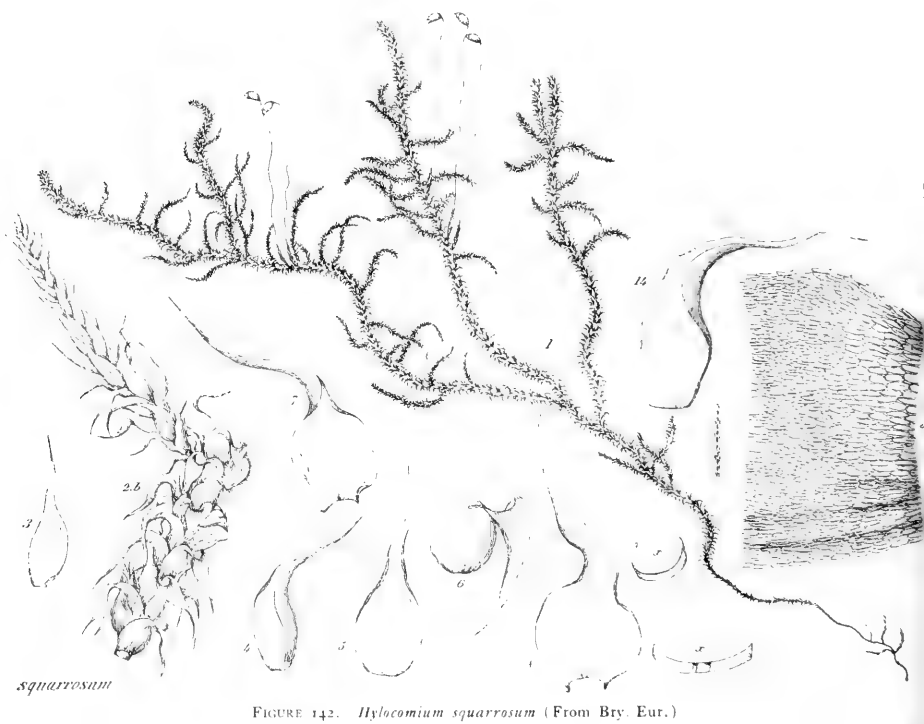


FIGURE 142. *Hylocomium squarrosum* (From Bry. Eur.)

strongly *squarrose-recurved from a sheathing base, not plicate or papillose*, double costa much shorter than in the last; spores in winter and spring.

RHYTÍDIUM (Sulliv.) Kindb.

R. rùgosum (L.) Kindb. When well developed this is a very striking moss; the stems reach a length of four inches or more, and with the leaves are as thick as an ordinary lead-pencil. The branching may be sparse and irregular or more abundant and pinnate. The rather dense mats are usually a bright, glossy yellowish green. The leaves are 3^{mm} or more in length, strongly secund, strongly rugose; papillose at back; costa single, extending ⅔ the length of the leaf; margin narrowly reflexed; a large number of alar cells smaller and quadrate as shown in Fig. 143. Most commonly found on rather dry bluffs and ledges; never fruiting here but fruiting freely in the Klondike.

FIGURE 143. *Rhytidium rugosum* × 1; leaves × 5. Leaf cells highly magnified

This species has more the appearance of a gigantic *Hypnum* or *Drepanocladus* than a *Hylocomium*, yet is probably better placed here than in any other sub-family.

SUBFAMILY BRACHYTHECIEÆ

Hypnaceous mosses differing but little in general appearance from many of the *Hypneæ*, nearly always more or less glossy. The leaves are straight and imbricated when dry, occasionally loosely spreading, erect-open when moist. Very rarely falcate or secund except in *B. velutinum* and its allies, often strongly plicate or sulcate, at least when dry, simply costate half way or more, leaf-cells linear-vermicular (except *B. reflexum*, *B. digastrum* and *B. cyrtophyllum*). Alar cells differentiated, often inflated and hyaline, sometimes quadrate and densely chlorophyllose.

Capsules brown to chestnut-brown, ovoid, short, cernuous and unsymmetric except in *Homalotheciella* and in *B. oxycladon*, and *B. acuminatum* and its allies, rarely or never plicate or strongly contracted under the mouth when dry;

dry; operculum conic or conic-apiculate or long-rostrate, seta often roughened with prominent papillæ, peristome perfect except in species having erect capsules.

KEY TO THE GENERA

1. Operculum with very long, needle-like beak . . . . 2.
   Operculum conic or at most with a very short beak . . . . 3.
2. Apices of branch leaves abruptly long-acuminate from a spoon-shaped base, apical cells not broader or shorter than the median . . . . *Cirriphyllum.*
   Apices of branch leaves acute to obtusely-acute, with apical cells broader and shorter than the median (except *E. serrulatum*) . . . . *Eurhynchium.*
3. Leaves markedly papillose on the back with projections from the angles of the cell-walls; seta rough . . . . *Bryhnia.*
   Leaves not papillose, seta rough or smooth . . . . 4.
4. Leaves all elongated-lanceolate, very strongly sulcate with numerous folds, plants very glossy, golden green . . . . *Camptothecium.*
   Leaves broader, less strongly sulcate or even smooth, less glossy . . . . 5.
5. Calyptra smooth; inner peristome free . . . . *Brachythecium.*
   Calyptra hairy; inner peristome, adherent to teeth . . . . *Homalotheciella.*

BRACHYTHÈCIUM

Plants mostly of medium size and typically hypnaceous habit, very rarely pinnately branching with any degree of regularity. Branch leaves acute to acuminate, never obtuse, usually somewhat concave and often plicate or sulcate, costate to above the middle, median leaf cells sinuous-linear to linear-rhomboidal (broader and shorter in *B. reflexum*, *B. digastrum* and in some leaves of *B. cyrtophyllum*), basal cells broader and shorter, alar quadrate, rarely inflated and hyaline.

Stem leaves notably different in most species, larger and proportionately broader, often more slenderly acuminate and less strongly serrate; seta smooth to very rough, twisted to the right, capsules short-ovoid to oblong-ovoid, cernuous-arcuate and 2–4:1 (cylindric in *B. oxycladon* and nearly erect and symmetric in *B. acuminatum* and *B. cyrtophyllum*) slightly contracted under the mouth when dry and empty, operculum conic to short rostrate; peristome characteristically hypnaceous and perfect except in the species with erect capsules. When in fruit this genus is easily recognized in most cases by the short, thick, dark-colored capsules which are usually unsymmetric and horizontal; spores almost without exception maturing in late autumn or early winter.

The grouping of species given below is a little different from that given in my monograph of the genus, in Vol. VI of the Memoirs of the Torrey Botanical Club, but represents opinions based on a great deal of additional study.

(1) The Salebrosum group consisting of *B. salebrosum*, *B. flexicaule*, *B. acutum*, *B. campestre*, *B. oxycladon*, and *B. digastrum*.

This group is characterized by smooth seta (except *B. campestre*), leaves plicate or sulcate when dry (except *B. acutum*) slenderly acuminate, concave and excavate at basal angles with the margins turned back parallel to the plane of the leaf (or reflexed in the ordinary descriptive language) in the lower portion; basal cells broader and shorter, quadrate alar cells numerous, hyaline or slightly chlorophyllose, stem-leaves ovate-lanceolate; annulus poorly developed, fairly well developed in *B. acutum*.

(2) The Rutabulum group including *B. rutabulum*, *B. rivulare*, *B. Starkei*, and *B. reflexum* characterized by rough setæ, well-developed annulus, ovate-deltoid stem-leaves with leaves less concave and alar cells less numerous, except in *B. rivulare*.

(3) The Acuminatum group resembling the salebrosum group in gametophyte characters but with nearly erect symmetric capsules and peristomes without cilia, consisting of *B. acuminatum*, *B. cyrtophyllum* and some southern species.

(4) The Plumosum group including *B. plumosum* and *B. populeum*, characterized by rough setæ and densely chlorophyllose quadrate alar cells.

(5) The Velutinum group including *B. velutinum*, *B. erythrorrhizon* and a number of western species, characterized by small size and in our species by somewhat secund leaves.

KEY

1. Costa percurrent or nearly so . . . . 2.
   Costa extending ½–⅔ the length of the leaf . . . . 3.
2. Seta rough throughout: plants very slender; leaf-cells 3–5 : 1 . . . . *reflexum.*
   Seta rough above, nearly smooth at base, plants more robust, leaf cells 5–8 : 1 . . . *populeum.*
3. Seta smooth . . . . 4.
   Seta rough above, smooth below . . . . 10.
   Seta rough throughout . . . . 11.
4. Capsules erect and symmetric or nearly so, cilia of peristome rudimentary or lacking . . . . 5.
   Capsules more or less cernuous and inclined, unsymmetric, cilia well developed . . 6.
5. Plants very slender, leaves rarely more than 0.7^{mm} long . . . . *cyrtophyllum.*
   Plants with the facies and size of *B. oxycladon;* leaves 1–1.6^{mm} long . . . . *acuminatum.*
6. Capsules suberect, 3–4 : 1 . . . . *oxycladon.*
   Capsules strongly inclined, and unsymmetric, 2–3 : 1. . . . . 7.
7. Leaves not plicate or striate; stem leaves gradually narrowed from base to apex . . *acutum.*
   Leaves plicate or striate . . . . 8.
8. Stem leaves lanceolate, 0.6^{mm} broad at base gradually and evenly narrowed from base to apex . . . . *flexicaule.*
   Stem leaves ovate, at least 1^{mm} broad at base, more abruptly narrowed to a slender acumination . . . . 9.
9. Stem leaves ovate-lanceolate, 2–2.5 by 0.8–1.1^{mm}, median leaf cells 10 : 1 . . . . . *salebrosum.*
   Stem leaves triangular-ovate, 1.2–0.8^{mm}, median cells 4–6 : 1 . . . . *digastrum.*

10. Leaves plicate, long-acuminate, branch leaves strongly serrate . . . . *campestre.*
Leaves not plicate, shorter-acuminate branch leaves entire or serrate . . . . *plumosum.*
11. Secondary stems often dendroid, stem leaves ovate and very short-pointed with enlarged and inflated alar cells . . . . *rivulare.*
Not dendroid, stem leaves slenderly acuminate . . . . 12.
12. Slender; leaves somewhat secund, in most American plants, stem leaves lanceolate . *velutinum.*
Robust; leaves not secund, stem leaves ovate to triangular-ovate . . . . 13.
13. Complanate-foliate like a *Plagiothecium*; leaves cordate-triangular and strongly and widely decurrent; cilia of inner peristome appendiculate . . . . *Starkei.*
Not flattened; leaves ovate and less strongly decurrent; cilia not appendiculate . *rutabulum.*

The structure of the leaves in this genus and some other species of the family needs a little extra explanation. Very often the leaves are concave so as to be like the base of a spoon at base, although it is only occasionally that the apex is spoon-like. If we imagine the spoon-handle round and about the size of a large lead-pencil and continuing beyond the bowl of the spoon in both directions it will represent the stem. The lower basal edges of these spoon-like leaves are gathered up around the stem so that when the leaves are torn off it leaves a more or less semicircular indentation at the base of the leaves. Such leaves are said to be excavate (see Plate LXII). The lower margins of these leaves are "reflexed" in many cases, *i. e.*, they are turned back so as to lie parallel to the plane of the entire leaf, but are not really revolute or at least rarely so (see Plate LXII). This reflexed portion is often decurrent and its basal cells are nearly always different from the median cells, usually being subquadrate; this band of shorter cells may extend across the entire base of the leaf, but is usually widest at the basal angles. The leaves thus constructed are usually plicate with narrow longitudinal folds in the central portion, or sometimes strongly sulcate. These folds are most conspicuous when the leaves are dry, but persist in a greater or less degree even when the leaves are moistened and removed. These concave leaves, excavate at the base, do not flatten out readily under a cover on the slide and preserve a very characteristic appearance.

I do not believe that the position of antheridia and archegonia in this genus has become sufficiently fixed to be a distinguishing mark of a species. Mr. Francis Windle and myself have been carrying on some investigations in this direction with reference to *B. salebrosum* and *B. oxycladon*, and *B. rutabulum* and *B. rivulare* that have confirmed the above opinion with respect to those species. There seems to be some evidence that archegonia may be borne one year and antheridia the next on the same plant.

B. salebrosum (Hoffm.) Br. & Sch. Plants growing in wide, glossy, yellow-green mats; stems 5^{cm} or more long, creeping and irregularly branching; all leaves plicate when dry; branch leaves lanceolate, 1.8–2.3 by $0.5\text{–}0.6^{mm}$ long, acuminate, serrate above, concave with margins reflexed, median cells, linear—vermicular, 10 : 1, basal much shorter and broader, alar quadrate, usually thin-

PLATE LXII. *Brachythecium salebrosum* (From Bry. Eur.)

walled; stem leaves ovate-lanceolate, reaching 2.5 by 1.1^{mm}: *monoicous;* seta $1–2^{cm}$ long, smooth; capsule oblong-ovoid, 2.5–3 : 1, usually strongly arcuate and horizontal; annulus very narrow and inconspicuous; spores maturing in autumn or early winter. Common, growing on earth, stones, roots and trunks of trees and rotting wood in moist, shady places. This species varies greatly in the position and nearness of the leaves, from densely to loosely foliate, and from leaves appressed when dry to leaves erect-open when dry.

This species and the next four are so closely related that much detail in description is needed to separate them.

Mr. Dixon states that he finds it hard to distinguish forms of *B. salebrosum* and *B. rutabulum* when sterile. I have never found this difficulty with American specimens, as the basal leaf cells of *salebrosum* are so much more distinct from those just above, and the leaves also are more concave with more reflexed margins than is the case with *rutabulum*.

Var. **flaccidum** B. & S. has branch leaves distant and somewhat complanate, stem leaves very broadly triangular-ovate, 2 x 1.2^{mm} slenderly acuminate and slightly serrulate, capsule like *B. oxycladon*, apparently a separate species. More material of this interesting form is needed. It has thus far been collected only in New Brunswick, New Jersey, and in New York.

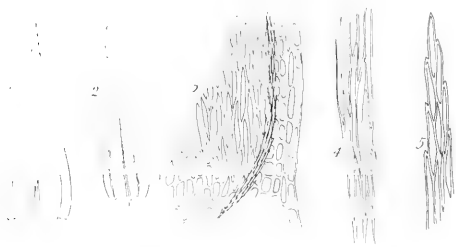


FIGURE 144. *Brachythecium flexicaule.* 1 and 2. Stem and branch leaves respectively × 20. 3, 4 and 5. Basal, median and apical cells respectively × 200.

B. flexicaule R. & C. This seems almost surely to be *B. salebrosum densum* B. & S. It is to my mind a good variety of *B. salebrosum*, quite distinct when typical but freely intergrading. The distinguishing marks are the very narrow leaves, branch leaves narrowly lanceolate, reaching 2.5 x 0.65^{mm}, stem leaves but little larger and about the same shape, gradually and evenly narrowed from the base to the long slender apex.

Habitat and time of maturing spores as in *B. salebrosum*.

Probably frequent throughout our range.

B. oxycládon (Brid.) J. & S. (*B. lætum* B. & S.). Typically with branch leaves broader than in *salebrosum*, reaching 2 x 0.8^{mm}, less slenderly acuminate; stem leaves broader, more strongly plicate, with the quadrate alar cells smaller, thicker walled and often apparently more numerous: typically dioicous but not constantly so; capsules oblong-cylindric, suberect, about 4:1, reaching 3.5^{mm} in length.

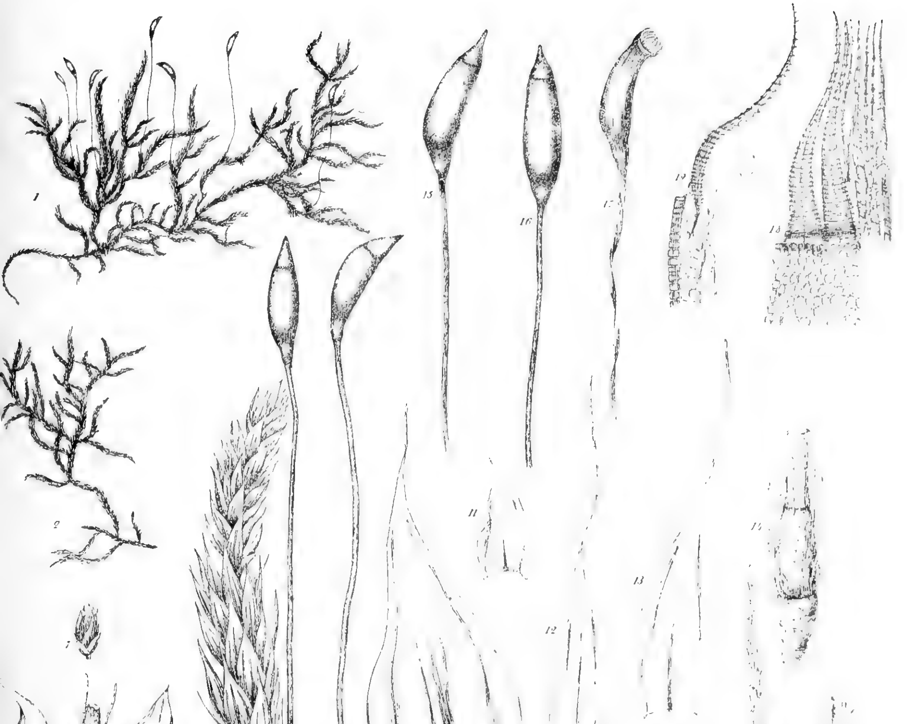


PLATE LXIII. *Brachythecium oxycladon* (From Bry. Eur.)

It has the same habits and range as *B. salebrosum*, but it less frequently grows on decaying wood. In many cases the sporophyte of *B. salebrosum* is very much darker than in this species.

I have seen *salebrosum*, with the capsules as long and slender as those of *oxycladon* and *oxycladon* with capsules as short as those of *salebrosum* but this is not very frequent and the sporophyte characteristics are usually sufficient to separate these two species.

I am able usually to differentiate sterile and ambiguous specimens of *B. salebrosum* and *B. oxycladon* by the difference in the alar and basal cells which are fairly well illustrated in the figures. In *B. salebrosum* there are usually two or three rows of shorter, rather irregular cells along the whole base of the leaf and at the angles these large loose subquadrate cells are quite characteristic. In *oxycladon* these basal and alar cells are rather smaller and thicker walled. This difference in structure seems somewhat exaggerated in Plate LXIII while the basal cells of *salebrosum* in Plate LXII are very well represented. Neither plate emphasizes sufficiently the concavity of the leaf base as commonly found in our American plants. The leaves, especially the stem leaves of *oxycladon* in Plate LXIII, are much more longly and slenderly acuminate than is usual in American plants, as a rule the leaves are conspicuously broader and shorter pointed than in *salebrosum*.

B. oxycladon resembles *Hypnum Haldanianum* in appearance but has plicate leaves, is more glossy and has a shorter operculum. Under the microscope the presence of a costa at once differentiates it.

To sum up: if one has a *Brachythecium* that answers in a general way to the descriptions of *salebrosum* and *oxycladon*, is monoicous, has short curved capsules, leaves little plicate when soaked out on a slide (exclusive of the two large folds due to the concavity of the base), long and slenderly acuminate with basal cells rather loose like those figured in Plate LXII, then he has a clear case of *B. salebrosum*.

If the plant be dioicous, with long-cylindric, little curved capsules, stem leaves strongly plicate even when mounted in water, basal and alar cells smaller and denser as figured in Plate LXIII, then he has a clear case of *B. oxycladon*. If one has a plant that will not exactly fit either of the above cases let him study it carefully and put it with the species it most resembles. There are a large number of intermediate forms in America that cannot be placed certainly, especially if sterile.

There seems to be good reason for believing that the American *salebrosum* approaches *oxycladon* much more closely than the European forms of the species.

I have what is considered to be a portion of the plant from which Sullivant made his drawings of *B. lætum* and it is one of the forms running close to our *salebrosum*. European *salebrosum* seems to have the leaves less concave at base and more like *rutabulum*. The plant called *lætum* in Europe is much closer to our var. *dentatum* than the plant figured by Sullivant.

B. oxycladon dentatum (L. & J.) Grout is a very common form growing on moist rocks. The leaves are more strongly plicate, shorter and broader, shorter acuminate to acute; the leaf cells are also broader and shorter, the short basal and the quadrate alar cells much more numerous; seta occasionally somewhat roughened at base; operculum short rostrate; apparently more common than the species in our region and passing into the next species by intergrading forms.

Forms of *B. oxycladon dentatum* from Green Knob, N. C., alt. 5,000 ft., show *B. digastrum* in the same tuft and sometimes one portion of a plant appears to be *B. oxycladon dentatum* and another portion, *B. digastrum*.

B. digastrum C. M. & Kindb. Plants usually olive-green, creeping; branch leaves ovate to oblong-ovate, acute to short acuminate with apex more or less twisted, reaching 1^{mm} long and ½ as broad, decurrent, concave with margins reflexed below, serrulate; median cells fusiform, 5–7:1, with a large area of broader and shorter basal cells; quadrate alar cells numerous, stem leaves triangular-ovate and longer acuminate, more loosely areolate at base, less serrulate, 1.2 by 0.8^{mm}; monoicous, seta smooth, capsule brown, oblong, arcuate at base, subhorizontal, about 3:1.

On rocks, Canada, Macoun and others, but probably to be found in the northeastern United States as well as in North Carolina.

FIGURE 145. *Brachythecium digastrum*. (Drawn from cotype). 6. Stem leaf × 20. 3. Branch leaf × 25. 1, 2, 4, 5. Alar, median basal, median and apical cells respectively, of a branch leaf × 225.

A careful study of *B. oxycladon* in its varying forms has led me to repudiate my former statement about it and *B. digastrum*. I regard *B. digastrum* as a derivative of *oxycladon* through the var. *dentatum* even though it is monoicous. It has been so little collected that the variations of the capsules are not well known and I expect forms to be found with capsules longer than those described above.

B. acutum (Mitt.) Sulliv. is a derivative of *B. salebrosum* with rather distant open leaves, frequently appearing somewhat flattened; the branch leaves reaching 2 by 0.7^{mm}, lanceolate to almost ovate-lanceolate, gradually and evenly narrowed from base to apex, distantly serrulate or almost entire, slightly or not at all concave, *with plane margins*, *not at all striate*, slightly decurrent, areolation that of *salebrosum;* stem leaves reaching 2.5 by 1^{mm}, triangulate-ovate, slenderly acuminate, nearly entire.

The capsule resembles that of *salebrosum*, but is lighter colored, less unsymmetric and the cilia of the peristome are strongly nodose or appendiculate.

Common in swampy woods on the ground and rotting logs. The lax habit and distant open leaves, not at all striate or plicate, are easily recognized hand-lens characters. The slender, evenly tapering, nearly entire leaves are the salient microscopic characters. So evenly are the leaves narrowed from the broadest part of the base to the apex, that the margin is almost exactly a straight line. I cannot agree with Lindberg that this is the same as the European *B. Mildeanum*.

FIGURE 146. *Brachythecium acutum* (From Sulliv. "Icones")

B. campéstre B. & S. This species is scarcely to be distinguished from *B. salebrosum*, except by the roughness of the upper portions of the seta, the lower part is smooth or nearly so. As a rule our specimens are more distantly and loosely foliate.

On earth and stones in woods and in damp grassy places. Not yet reported from farther south than New Jersey. Not infrequent.

B. rutábulum (L.) B. & S. Plants in wide loose mats, glossy yellow-green; stems often stoloniferous at the end, branch leaves ovate-lanceolate, reaching 2 by 0.7^{mm}, very slightly decurrent, slightly concave,

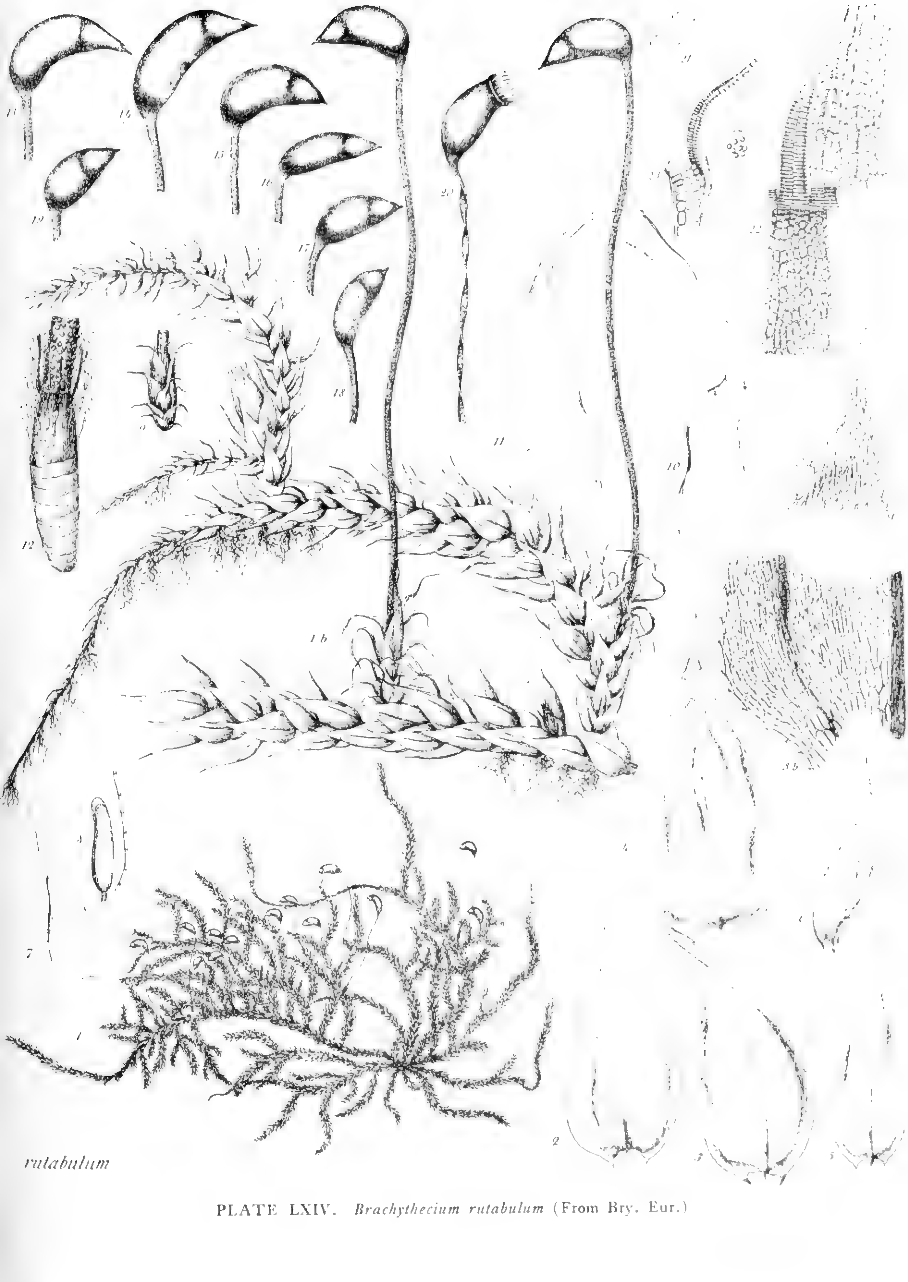


PLATE LXIV. *Brachythecium rutabulum* (From Bry. Eur.)

faintly plicate when dry, margin plane or nearly so, median leaf cells linear, 15:1, basal cells little differentiated, somewhat shorter and broader; stem leaves broadly ovate, as a rule less concave than figured in Plate LXIV, Fig. *3b*, more abruptly acuminate than branch leaves, 2–3 by 1–1.5^{mm}, less serrate, more decurrent, basal leaf cells conspicuously shorter and broader, a very few at the extreme angles enlarged and somewhat inflated, monoicous or rarely polygamous; seta 2–3^{cm} long, very rough throughout, capsule oblong to oblong-ovoid, unsymmetric and horizontal; spores roughened, maturing in early winter.

On the ground and stones in wet places, less frequently on roots and bases of trees and decaying logs. Common from New Jersey northward. Collected in Missouri by Bush and probably occurring well into the southern states.

Very variable, ranging from loose, lax forms that simulate forms of *B. salebrosum* or *campestre* to very turgid robust forms.

Var. **flavéscens** B. & S. is a very robust straw-yellow form with elongated stems and branches and very broad leaves with short and broad apices, growing in rather dense tufts. It is more abundant in the far west than in our range.

Var. **turgéscens** Limpr. In swampy places not far removed from tide-water, there occurs a form which is golden-green with rather short and very thick turgid branches densely foliate with leaves somewhat striate and loosely imbricate, which I have referred to var. *turgescens*. The turgid terete leafy branches are 2^{mm} or more in diameter.

B. rivulàre B. & S. Plants variable but usually very robust, in wide, thick mats, dark green to yellow-green, stems woody, creeping, filiform, leafless when old, distantly foliate with small leaves when young, secondary stems typically somewhat dendroid, stout, ascending-arcuate, 3–6^{cm} long, nearly free from branches below, irregularly branching above; branch leaves ovate to ovate-lanceolate, somewhat decurrent, reaching 1.5 by 0.6^{mm}, *acute to short-acuminate*, dentate above with small sharp pointed teeth, strongly concave and often somewhat plicate, margins plane or slightly reflexed below; median cells 10–15:1, basal broader and shorter; *extreme alar cells abruptly enlarged;* leaves of secondary stems very characteristic, distant, *broadly ovate, rather abruptly short acuminate*, reaching 2 by 1.4^{mm}, concave, more or less plicate, denticulate, costa often forking, median cells 8–10:1, *alar cells abruptly enlarged and inflated;* dioicous; seta 1.5–2^{cm} high, red-brown, very rough; capsule 2–3 by 1^{mm} oblong-ovoid, unsymmetric to arcuate, inclined or horizontal, spores maturing in early autumn. Common on stones in bed of brooks and in other places that are always moist and are occasionally submerged but not always under water. The broad, short-pointed leaves of the secondary stems and their enlarged and inflated alar cells are characteristics which readily distinguish this species in all its protean forms.

On moist ground near the edges of water it becomes glossy yellow-green, approaching *B. salebrosum* in appearance; growing in quiet streams it often becomes long, slender, and almost floating, the secondary stems reaching a length of 10^{cm} or more. Another form will have the secondary stems simple and long flagelliform. Like *B. oxycladon* this species is imperfectly dioicous. There is some evidence that plants bear antheridia one year and archegonia the next.

In the swampy lands near the coast and possibly in other localities there occur numerous forms intermediate between *B. rivulare* and *B. rutabulum*. Some of these are very puzzling and have suggested hybrids to me. One of these forms was named *B. Noveboracense* by me and described in the "Bryologist," but the peculiar capsules of the specimens described I believe to have been freakish and unusual. It is probably nearer *rutabulum*. The alar cells are larger and the leaf

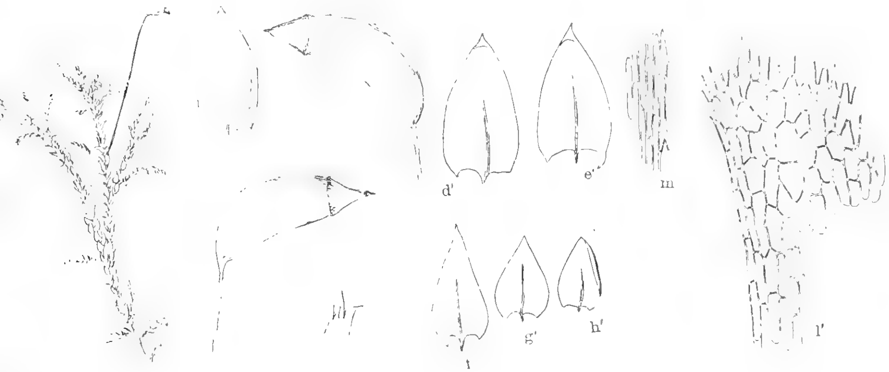


FIGURE 147. (At the left), *Brachythecium rivulare* × 1, and leaf and capsules × 10. (At the right), d', e'. Stem leaves. f', g', h'. Leaves from the upper middle and lower portion of a branch respectively. i'. Alar cells. m'. Median cells of leaf. (From the Bryologist by permission.)

apices shorter as a rule. The leaf apices are longer and alar cells smaller than is usual in *B. rivulare*. The leaf characters are somewhat intermediate between these two species and those of *B. Starkei*, but the stem leaves are longer and ovate rather than deltoid ovate. The stem leaves are more distant than in any of the related species, reminding one of *Hypnum cordifolium*.

B. Stárkei (Brid.) B. & S. Plants dark green, growing in wide, thin mats over humus and decayed wood in moist elevated regions; leaves appearing more or less two-ranked giving the plants the flattened appearance of a *Plagiothecium*, from which it is readily recognized by the very dark sporophyte with rough seta, and short stout capsule, $2–2.5^{mm}$ long and half as thick. The branch leaves are not plicate and resemble those of *B. rutabulum*, but are rather more strongly serrate and decurrent, the stem leaves are very characteristic, being broadly deltoid-ovate, decurrent and broadly long-acuminate something like those figured for *B. reflexum* in outline with basal cells broader and shorter, the lower row or two partially oblong-rectangular, differentiated alar cells more numerous than in *B. rutabulum* but not inflated, oblong-hexagonal to nearly rectangular.

The American form of this species is more markedly flattened than most of the European specimens and it seems rather less variable with us. Spores maturing in winter. Extending south to New Jersey and Pennsylvania and westward across the continent.

B. refléxum (Starke) B. & S. Much more slender than any other species, and in the field would not be recognized as belonging to this genus except for the short ovoid capsule (2 by 1^{mm}) and rough seta. The leaves are decurrent, costate to the apex and with cells very broad and short for the genus, (3–5:1). These characters render it one of the easiest species to identify.

FIG. 148. *Brachythecium reflexum*. 2. Plant natural size. 7 and 8. Leaves. 8*b*. Areolation. (From Bry. Eur.)

Frequent in most of the mountainous portion of our range.

Some, at least, of the eastern material referred to *B. glaciale* B. & S. belongs in this species, so that I doubt the presence of *B. glaciale* within our range.

B. plumòsum (Sw.) B. & S. Plants variable in size and color, growing in wide loose mats, green on the surface, brownish underneath; stems clinging closely to the substratum; branches suberect, branch leaves equally spreading or somewhat secund, loosely erect-spreading, l a n c e o l a t e to b r o a d l y ovate-lanceolate, long acuminate, 1–1.5 by $0.4–0.5^{mm}$, serrate to serrulate above or sometimes entire, more or less concave, decurrent, *smooth or slightly striate* *when dry*, somewhat narrowed at base and often asymmetrical; median cells linear, 8–12:1, basal broader and shorter, alar quadrate and more densely filled than in most other species and thus appearing more opaque; stem leaves narrowly triangular-ovate to broadly ovate, acuminate, more loosely areolate, serrate to nearly entire above; monoicous; *rough above, nearly smooth below*, capsule oblong-ovoid, 2.5 by 1^{mm}, horizontal to suberect, somewhat unsymmetric, operculum slenderly conical, annulus of a single row of cells. Common on rocks in and near streams and on very moist rocks in other situations.

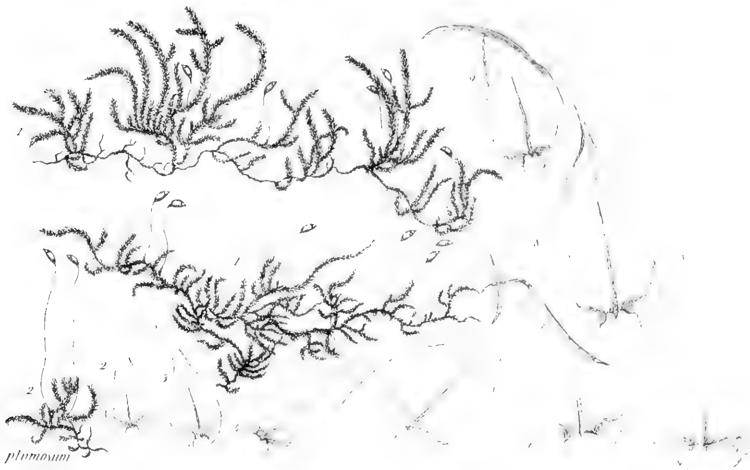


FIGURE 149. *Brachythecium plumosum* (From Bry. Eur.)

The seta rough only above, the densely filled alar cells and the subaquatic habitat render this species a fairly easy one to determine in spite of the wide range of variations. The leaves are often more or less falcate-secund and the extreme variation in this direction is known as var. *homomallum*.

B. populeum (Hedw.) B. & S. This is a rather slender somewhat glossy moss, dark green to yellowish green, growing chiefly on boulders, but found also on smaller stones and the roots and trunks of trees. The upper branch leaves are lanceolate, the lower ovate-lanceolate with the costa extending into the apex, serrate to nearly entire, 1.2 by 0.4^{mm}, median cells 5–8:1, stem leaves broadly ovate, slenderly acuminate, *not striate*, basal and alar cells like those of *B. plumosum: seta rough above, nearly smooth below*, annulus persistent. Common in most localities, especially inland. The percurrent costa and partially smooth seta render this species easy of recognition.

PLATE LXV. *Brachythecium acuminatum* (From Sulliv. "Icones")

On very dry rocks in such situations as suit *Grimmia apocarpa*, the var. *ovatum* Grout may be found. It has broadly ovate, rather short-acuminate stem leaves

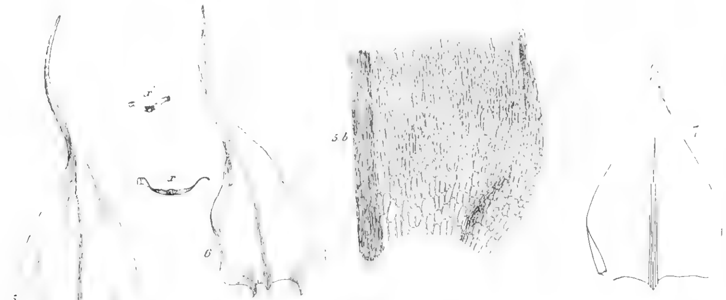


FIGURE 150. *Brachythecium populeum.* 5 and 6. Leaves. 5*b*. Basal areolation (From Bry. Eur.) 7. Stem leaf of var. *ovatum*.

with several rows of nearly quadrate basal cells and the costa extending only about three-fourths the length of the leaf.

B. acuminàtum (Hedw.) Kindb. This species has leaves much like *B. oxycladon* and resembles it in gross appearance and in being dioicous, but the leaves are less striate with more numerous differentiated basal and alar cells, median cells rather shorter. The capsules are cylindric and erect, occasionally very slightly curved, 1.5–3^{mm} long, annulus none, cilia of inner peristome none or rudimentary, segments narrow; spores maturing in autumn. On decaying wood, bases of trees, rock and earth in woods and shady places. Frequent in the eastern United States but seemingly rare in New England, especially in the northern part.

This species is very variable in width of basal membrane, shape of leaves and robustness of growth. In the northwestern portion of our range from Pennsylvania to Minnesota and extending into Canada, it seems to pass into the next which is evidently a derivative of it.

B. cyrtophýllum Kindb. Cespitose, glossy to dark green, branches filiform, often subjulaceous; branch leaves ovate to ovate-lanceolate, acute to short acuminate, 0.7 by 0.3^{mm}, serrulate, very concave with margins reflexed below, median cells fusiform, 4–8:1, many basal cells shorter and broader, quadrate alar cells more

FIGURE 151. *Brachythecium cyrtophyllum.* 1 and 2. Stem leaves. 6. Branch leaf. 4 and 5. Basal and median cells of same. 3. Median cells of stem leaf.

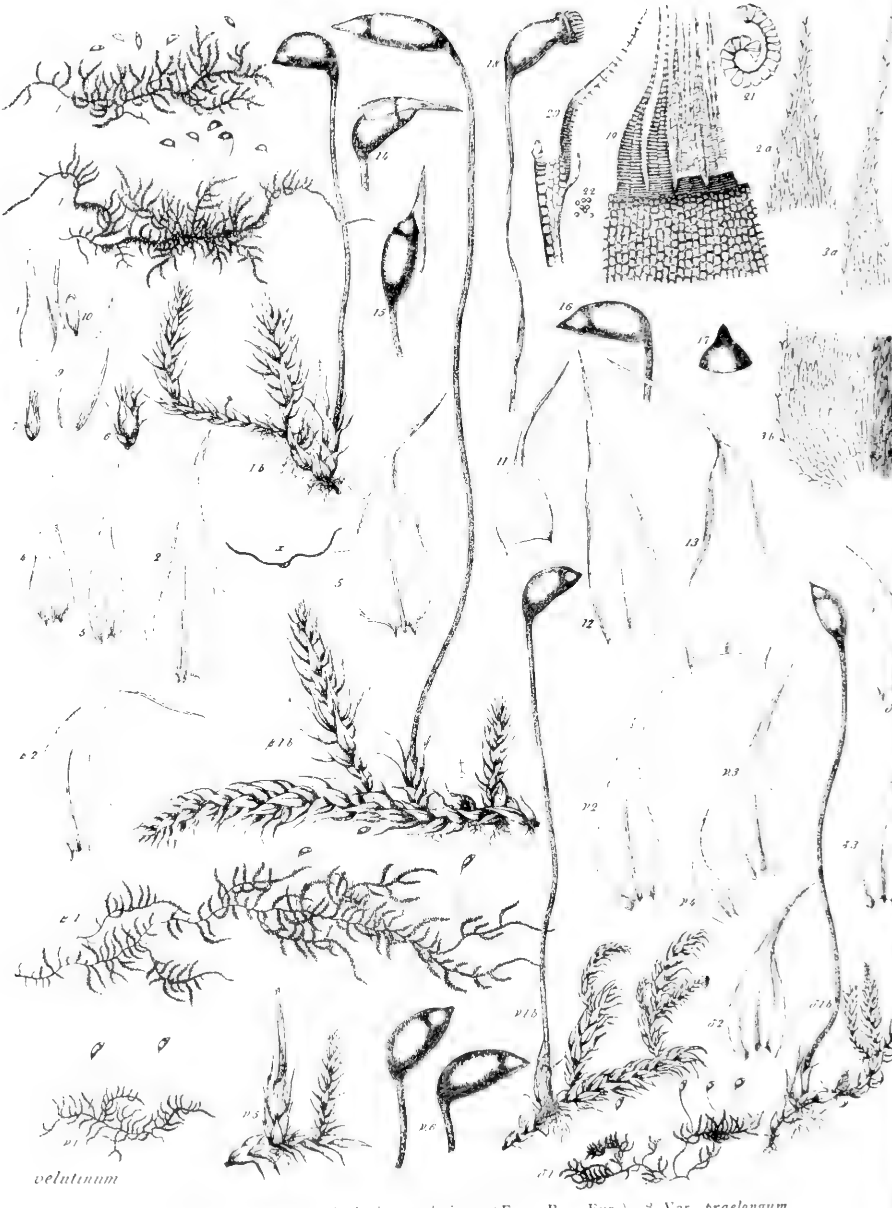


PLATE LXVI. *Brachythecium velutinum* (From Bry. Eur.) β, Var. *praelongum*. γ, Var. *intricatum*. δ, Var. *condensatum*.

numerous than in the preceding, stem leaves longer and more slenderly acuminate; seta and capsule as in the preceding, but capsule narrower. On roots of trees and old logs. As above and also in mountains of western North Carolina.

B. velutinum (L.) B. & S. Plants *slender*, growing in silky tufts on earth or stones or more frequently at the base of trees, dark green to yellowish green; branch leaves loosely spreading when dry, often somewhat falcate-secund, especially at the ends of the branches, lanceolate to ovate-lanceolate, reaching 1.3–0.3^{mm}, serrate, gradually long acuminate, apex usually falcate or twisted, median cells linear 12:1, quadrate alar cells very few, confined to the extreme angles, stem leaves more narrowly lanceolate, usually longer acuminate, often much reduced in size; monoicous, seta 15^{mm} long, very rough, capsule brown, short-oblong, 2–2.5^{mm} long, 2–3:1, contracted under the mouth when dry and empty. Not rare. South to New Jersey.

Excepting the capsules, in gross appearance this moss does not look like a *Brachythecium* but the rough seta and short capsules locate it easily, and the very narrow stem leaves and falcate branch leaves separate it from all our other species of the genus. The leaves seem to be more frequently falcate here than in Europe. If one examines carefully the bases of trees or knolls in rather dry woods, he will be likely to meet with this species if he lives inland. It appears to be less common along the coast.

BRÝHNIA Kaurin.

Closely related to *Brachythecium*, but distinguished by shorter leaf cells (4–6:1), papillose at the angles by the projecting cell walls. The papillæ are sometimes wanting in *B. Novæ-Angliæ* which leads M. Cardot to refuse this group generic rank.

KEY

Branch leaves acute to short acuminate, apex twisted . . . . *Novæ-Angliæ*
Branch leaves longer acuminate, apex not twisted . . . . *graminicolor*

B. Novæ-Angliæ (Sulliv. & Lesq.) Grout. [*Hypnum Novæ-Angliæ* Sulliv. & Lesq.] Plants growing in wide, loose mats, bright green on the outside, dirty brownish green below, secondary stems suberect, rather irregularly branching, sometimes appearing subdendroid; branch leaves erect-open, *very loosely appressed-imbricate* when dry, ovate to broadly ovate-lanceolate, serrulate, decurrent, concave, reaching 1.2 by 0.6^{mm}, *papillose on the back by the thickened angles of the cell walls*, long-acute to short-acuminate, *apex twisted ½ turn to the right*, median leaf cells 5:1, alar and basal cells little differentiated; dioicous, sporophyte like that of *Brachythecium*, seta rough, capsule dark red-brown, almost black when old, oblong-cylindric, 3–3.5^{mm} long, 4–5:1, *operculum long-conic to subrostellate*, annulus large. On earth and stones in wet shady places. West to western Pennsylvania, south to the mountains of North Carolina.

Easily distinguished from all forms of *Brachythecium* by the italicised characters. This species presents quite a range of variation in size, color and shape

FIGURE 152. *Bryhnia Novæ-Angliæ* (From Sulliv. "Icones")

of leaves, but is not likely to be mistaken for anything but the next, from which it is distinguished by its more robust habit, larger and less slenderly acuminate leaves with less strongly papillose cell walls, and by its longer capsule.

B. graminícolor (Brid.) Grout (*Hypnum Sullivantii* Spruce). Plants much more slender than in the preceding, branch leaves reaching 0.8 by 0.3^{mm}, decurrent, long-acuminate, sharply serrate nearly to base; concave with margins reflexed below, strongly papillose at back by the thickened angles of the cell walls;

stem leaves reaching 1 by 0.45^{mm}, more slenderly acuminate: dioicous; capsule ovoid to subglobose, a little more than 2^{mm} long, operculum short beaked, annulus present. In much the same habitats as the preceding, especially in deep

FIGURE 153. *a*. Leaves of *B. graminicolor* from type. *b*. Leaves of var. *Holzingeri* from type. (Drawings by M. Cardot × 43).

cool ravines. West to Minnesota, south to Florida and Missouri. Not common and rarely fruiting.

The var. **Holzingeri** R. & C. is a form more densely cespitose, with leaves broader and shorter acuminate.

EURHÝNCHIUM B. & S.

Resembling *Brachythecium* in general appearance; leaves costate to the middle or beyond, apical cells of branch leaves *much broader and shorter than the* median in *some* species, in others as long or longer. Stem leaves acute to long and slenderly acuminate; sporophyte as in *Brachythecium*, except for the long-beaked operculum, the beak being 1/3–1/2 the length of the rest of the capsule.

The meaning and origin of the fantastic needle-like beak on the operculum in this and many other species of mosses, notably *Dicranum*, is a great puzzle. That it can be of any use so as to be favored by natural selection seems improbable. The only possible utility that I can imagine is that it serves to aid in dehiscence, causing the operculum to be knocked off more readily. As every collector knows, it is rather a difficult matter to find matured capsules of these long-beaked species in good condition and keep them so in the herbarium. One year I collected *E. rusciforme* on August 15 in excellent condition, but apparently immature. When I collected for my North American Musci Pleurocarpi, I collected three weeks later and most of the opercula had fallen. In the *Hypnaceae* at least, the capsules with long-beaked opercula are short and I am of the opinion that they are descended from ancestral forms with longer capsules and that as the spore-producing portion has been reduced (for reasons not yet understood), the line of dehiscence of the operculum has approached nearer to the base of the capsule, leaving the upper portion as an undeveloped rudiment; that is, when the capsule begins to form at the lance-like stage of the sporophyte, this portion does not fill out but simply remains in an undeveloped state.

KEY

1.	Apical cells of branch leaves oblong-rhomboidal to circular	2
	Apical cells of branch leaves not materially different from the median cells	*serrulatum*
2.	Aquatic or subaquatic	*rusciforme*
	Terrestrial	3
3.	Seta rough	*hians*
	Seta smooth	*strigosum*

E. hians (Hedw.) J. & S. Plants in loose spreading mats, green to yellow-green, shining, creeping, often appearing flattened in a horizontal plane, branch leaves erect-speading, reaching 1.1 by 0.7^{mm}, ovate, not decurrent, obtusely acute to short-acuminate with the apex often twisted toward the right, sharply serrate to the base, usually nearly plane, sometimes slightly concave, sometimes appearing papillose by the thickening of the angles of the cell walls, costa stout, extending four-fifths to five-sixths the length of the leaf, ending in a spine at back of leaf, median cells 6–10:1, quadrate alar cells few and indistinct, apical cells rhombic, 2–3:1; stem leaves much like the branch leaves, short-acuminate; those on the stolons much smaller, abruptly and narrowly acuminate with a short costa; seta every rough with low rounded papillæ; capsule inclined to horizontal, oblong-cylindric, curved, urn 3:1, little or not at all contracted under the mouth when dry, operculum three-fourths length of urn; annulus present, narrow; spores maturing in late autumn.

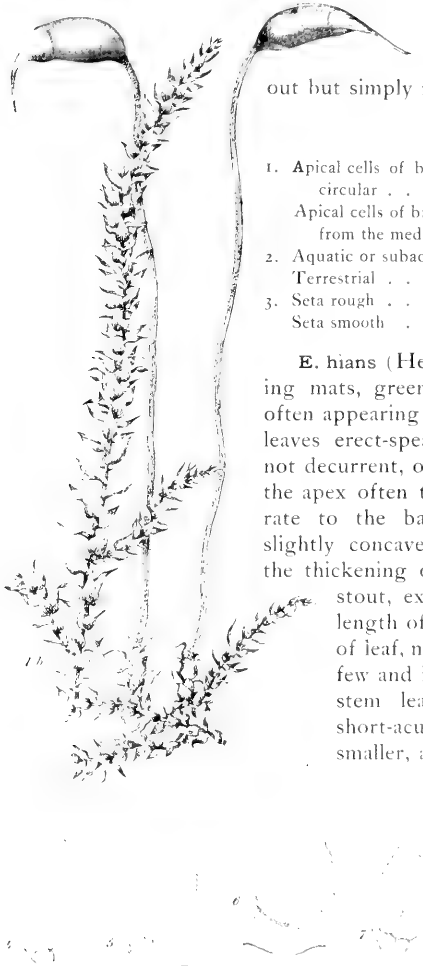


FIGURE 154.
Eurhynchium hians (From Bry. Eur.) Much enlarged.

On the ground in moist shady places throughout our range, frequent but not fruiting freely. The branch leaves vary considerably, especially in the length and slenderness of the apex. The form figured by Sullivant in the *Icones* is not typical of the American forms. In the field this plant has a distinctive appearance due to the arrangement of the leaves and their considerable distance from each other, and when dry it has also a peculiar shining appearance which cannot readily be described but which renders it easy of recognition to one who is acquainted with it.

E. strigòsum (Hoffm.) B. & S. Plants in rather loose mats with a habit much like that of *Brachythecium velutinum* and appearing much like it, except that the leaves are not secund, branch leaves varying greatly in different portions of the branch, those from the middle erect-spreading, ovate-lanceolate, scarcely decurrent, reaching 1 by 0.5^{mm}, acute or often obtuse, sharply serrate above, concave, little or not at all striate; costa extending four-fifths of the leaf, ending in a spine at back of leaf; median leaf cells 7–10:1; quadrate and oval alar cells few; apical cells conspicuously shorter and broader, oblong-rhomboidal, 2–3:1; stem leaves elongated triangular-ovate, more or less long-acuminate, somewhat decurrent, serrate, reaching 1.2 by 0.6^{mm}, apex often twisted half round to the right; leaves of the stolons much smaller, triangular-ovate and abruptly long-acuminate, ecostate; seta smooth, capsule and operculum somewhat shorter than in the last, annulus of two to three rows of cells; spores maturing in autumn.

On the ground, roots of trees and decaying logs in woods and shady places; so far as my experience goes, preferring steep shaded banks of ravines. In our range occurring only in the mountains.

Our common form is:

Var. **robústum** Roell. Plants having the habit of *Brachythecium plumosum*, much more robust than the species, growing in dense tufts or mats, with branches more blunt, leaves from the middle of the branches ovate-lanceolate, reaching 1.2 by 0.5^{mm}, usually acute, quadrate and oval alar cells confined to the extreme angles; stem leaves reaching 1.5 by 0.6^{mm}, longer acuminate, often subfiliform at the apex; capsule and seta rather longer than in the species. This variety is common throughout our range. It is included in the species by all except the most recent American authors. Both variety and species are exceedingly variable in leaf form.

Var. **præcox** (Hedw.) Husnot. Cæspitose with erect blunt julaceous branches, branch leaves crowded, appressed-imbricate when dry, erect-open when moist, cordate-ovate, more or less decurrent, reaching 0.8 by 0.6^{mm}, varying from almost acute to very obtuse and rounded at the apex, serrate, somewhat plicate, quadrate and oval alar cells numerous, apical cells rhomboidal to nearly circular; capsule shorter than in the species, more or less contracted under the mouth when dry.

PLATE LXVII. *Eurhynchium strigosum* (From Bry. Eur.) β. var. *præcox*

This is a very strongly marked and easily recognizable variety in its typical forms, reminding one of a densely tufted *Thelia*, but it graduates by every conceivable intermediate form into the species. The leaves are often more obtuse than is represented in the figure. It grows in rather more moist situations than the species or var. *robustum*. Collected in New York, New Jersey and Pennsylvania.

Occasionally the seta of the last form becomes roughened with scattered papillæ, var. *scabrisetum* Grout.

E. rusciforme (Neck.) Milde (*Rhynchostegium rusciforme* B. & S.). Plants in large robust tufts, usually dark green, dirty green or almost black below; stems prostrate, woody, often very long and denuded of leaves; branches suberect in most cases, or more nearly straight and parallel with the stem, rigid and harsh to the touch when dry; leaves open-erect when dry, scarcely decurrent, reaching 2.4 by 1^{mm}, broadly ovate, slightly concave with plane margins, acute to almost obtuse, denticulate nearly to the base; costa very thick at base, reaching one-half to three-fourths the length of the leaf, often ending in a spine at back; median cells linear, 8–15:1, rather thick-walled, shorter at base and apex; seta smooth; capsule light to dark brown, oblong-ovoid, somewhat contracted under the mouth when dry, beak long and slender, often curved; spores maturing from August 15 to October 15.

FIGURE 155. *Eurhynchium rusciforme* × 2. Leaf and capsule × 10.

Very common in brooks, especially in elevated regions, either submerged or on rocks wet by spray and submerged only during high water. As this species fruits freely it is easily determined if collected in the autumn. In gross appearance it resembles *Hypnum dilatatum* somewhat, but the costate leaves which are not nearly so orbicular and the long-rostrate operculum render it easy to distinguish between them. There is a wide range of variation in size and acumination of leaves, the apex sometimes being much more slender than figured. The habit of the plant is also variable, ranging from the form figured to soft slender almost floating forms.

When I wrote my monograph on *Eurhynchium* (Bull. Torr. Bot. Club, May, 1898), I hesitated about including *Rhynchostegium*, but after a longer acquaintance and more complete study I can see no reason whatever for a separate genus. Certainly as far as American forms are concerned the distinctions between

PLATE LXVIII. *Eurhynchium serrulatum* (From Sulliv. "Icones")

Eurhynchium and *Rhynchostegium* are very hard to find and still harder to define.

E. serrulàtum (Hedw.) Kindb. (*Hypnum serrulatum* Hedw.). Plants growing in wide loose thin mats over humus in woods, chlorophyll green, scarcely glossy, flattened with the appearance of a *Plagiothecium;* branch leaves distant, about 2mm long, plane margined, serrate, slightly concave, somewhat contorted when dry but scarcely striate or plicate, ovate-lanceolate, long acuminate, strongly serrulate above; median cells linear-vermicular, 7–10:1, basal and alar somewhat broader and shorter, no specially differentiated alar cells; costa rather thin, usually reaching well above the middle of the leaf, sometimes shorter; stem leaves cordate-triangular, more abruptly and narrowly acuminate with a much more slender point, slightly serrulate above, alar cells more differentiated; seta smooth; capsules contracted under the mouth when dry and empty, urn about 2mm long, operculum long and narrowly beaked; spores maturing from September 1 to October 15.

Frequent but almost sure to be mistaken for a *Plagiothecium*, unless in fruit or studied microscopically. Sterile it might be mistaken for *B. Starkei* or *B. rutabulum*. From the former it differs in the narrower leaves with the alar cells of its stem leaves much less conspicuous. From certain forms of the latter it would be well nigh indistinguishable without the sporophyte. When the sporophyte is present, the smooth seta and the small lighter *colored* capsule afford a ready means of distinction even if the operculum has fallen.

CIRRIPHỲLLUM Grout

Robust glossy mosses resembling *Eurhynchium* in the long-beaked opercula and other capsule characters, but resembling *Brachythecium* in their general leaf characters; leaves imbricate, very concave, *spoon-shaped*, often cucullate at the apex, abruptly drawn out *into a long-filiform acumination*, costate to the middle or beyond. Branches *julaceous*, usually *turgid in appearance*, due to the concavity of the imbricated leaves.

FIGURE 156. *Cirriphyllum Boscii* × ½, branch × 5, leaves and capsule × 10.

The species I have included here have usually been referred to *Eurhynchium*, but are so distinct in leaf form and structure that they are best treated separately.

C. Bóscii (Schwaegr.) Grout (*Hypnum Boscii* Schwaegr.). This is a beautiful species so clearly marked and easily recognizable as to render a detailed description unnecessary, Typically it grows in loose fluffy golden-green mats over the soil in edges of woods and in thin grass in open fields.

The branches are very turgid by reason of the loosely imbricate, *spoon-shaped leaves, abruptly acuminate, with acumination twisted to the right*, large, reaching 2.5^{mm} in length; median leaf cells 6–10:1. The basal and apical shorter and broader. The seta is smooth and the capsule like the typical *Eurhynchium* capsule, only a little longer than is usual in that genus. The spores mature in autumn. Common in the southern portion of our range extending northward to southern Vermont.

Although easy to recognize when fully and normally developed, young or depauperate specimens which are very difficult to recognize are not infrequently met with. The leaves in such cases are often much less concave and without the distinctive twisted apex.

C. piliferum (Schreb.) Grout is rare and local in the northeastern states. It is slender, glossy yellow-green, with leaves spoon-shaped and a slender acumination one-half the length of the rest of the leaf, median cells 10–15:1, alar abruptly enlarged and inflated: seta rough. It is most likely to be found on the ground and bases of trees in moist woods and shady meadows. It is often closely interwoven with other mosses, from which its peculiar gloss usually suffices to distinguish it.

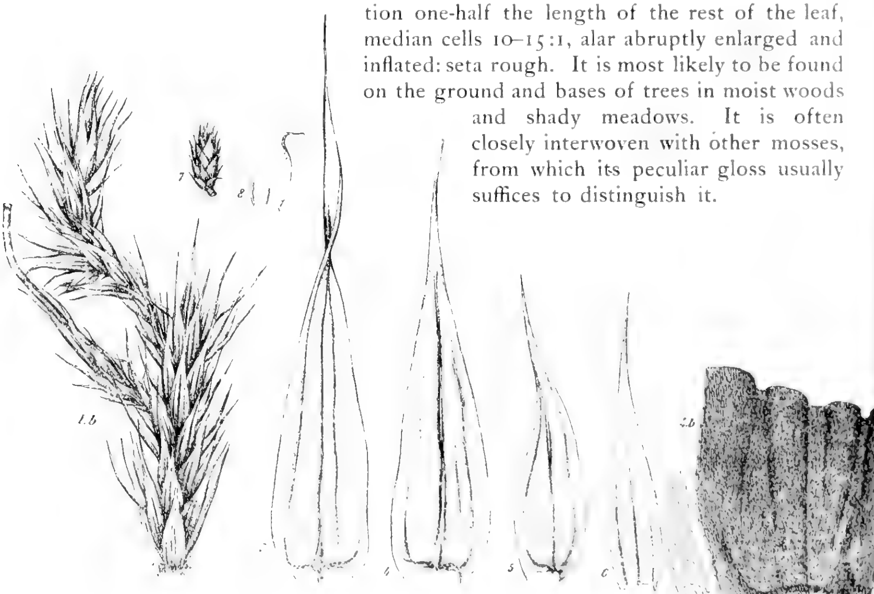


FIGURE 157 *Camptothecium nitens* (From Bry. Eur.)

CAMPTOTHÈCIUM B. & S.

Plants closely allied to *Brachythecium* but for the most part distinct to the casual observer by reason of the *bright golden or yellowish green, silky luster and strongly plicate leaves*, which are usually slender and have as a rule narrower leaf cells; seta rough or smooth. Our only species is:

C. nitens which is rather infrequently found in swampy places in cool or elevated regions. It is a very striking plant by reason of its golden or red-golden color and stems densely covered with a *felt of reddish radicles.* These stems are large, sometimes reaching 10–12^{cm} in length. Leaves elongate-lanceolate reaching more than 3^{mm} in length, gradually and evenly narrowed to the slender apex, *strongly plicate*, nearly entire with margins revolute. A few of the extreme basal cells shorter with very thick porose cell walls, those at the angles somewhat shorter and broader, but not forming a very considerable area; seta smooth, capsules cylindric-arcuate; spores maturing in summer(?). Not frequent and usually sterile.

HOMALOTHECIÉLLA Cardot. (See The Bryologist for January, 1908, p. 7)

Homalotheciella differs from *Euhomalothecium* Card. in its small size and concave nonplicate leaves. From *Brachythecium* it differs in the hairy calyptra and imperfect peristome. The plants have almost the appearance of a *Pylaisia*. The resemblance is all the more striking because the segments of the endostome adhere to the teeth as in *Pylaisia intricata*, (Hedw.) R. & C. One cannot help wondering if the similarity between *Pylaisia*, *Platygyrium* and this species is not due to the fact of their having a similiar habitat. May it not be that their approach in capsule to *Leskea*, *Leucodon*, *Anomodon*, etc., is due to the same cause?

H. subcapillàta (Hedw.) Card. (*Homalothecium subcapillatum* Sulliv.). Plants in light green thin glossy mats on the bark of trees or on fallen trunks, stems creeping; branch leaves loosely imbricate when dry, elliptical-oblong, reaching 0.9–1.2 by 3.5^{mm}, abruptly long-acuminate, more or less serrate above, concave, not plicate, not papillose, costate to the middle or beyond; median leaf cells 9:1, quadrate alar cells numerous, bordering the lower one-fourth of the leaf: monoicous; seta rough, calyptra somewhat hairy; capsule suberect to nearly horizontal, gibbous to slightly curved, slightly contracted under the mouth when dry, 2–3:1, operculum short-beaked, segments of peristome adherent to the teeth forming a hyaline border; spores maturing in autumn.

This species has the habit of a *Pylaisia* or of *Platygyrium*, and like those mosses grows on the bark of trees and fallen trunks but it is easily distinguished from all the *Entodoneæ* by the costate leaves and rough seta. It is widely distributed throughout the United States east of the Mississippi but apparently rather infrequent.

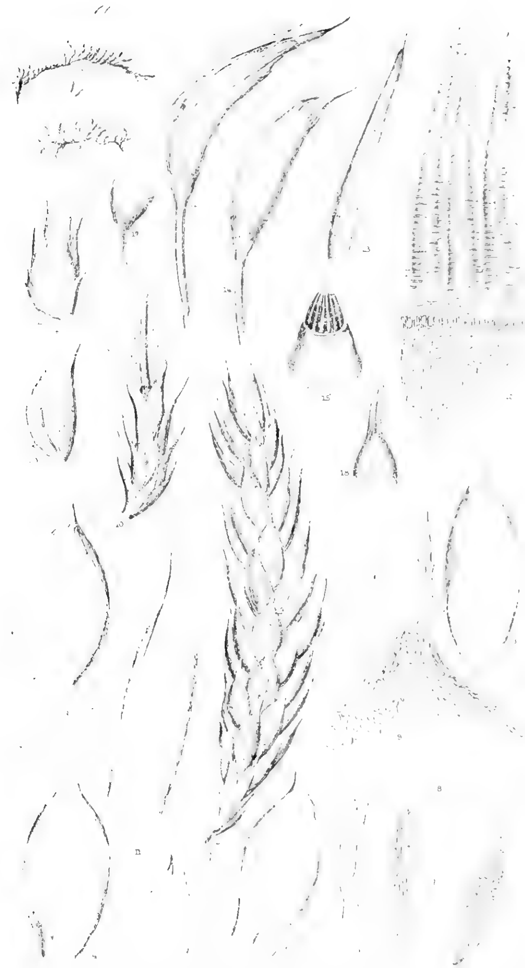


PLATE LXIX. *Homalotheciella subcapillata* (From Sulliv. "Icones")

SUBFAMILY 3. CLIMACEAE

Characterized by the dendroid habit, strongly costate leaves, erect symmetric capsules and well-developed peristome, lacking both cilia and the fine transverse markings on the base of the peristome. We have but one genus.

CLIMÀCIUM Web. & Mohr.

Large handsome mosses with a tree-like habit of growth from underground creeping stems (Fig. 158 a). Sometimes prostrate, or floating in very wet places. Stem and branches bearing paraphyllia. The leaves are all somewhat decurrent but vary greatly in shape and structure. The leaves figured are from the middle of well-developed branches. The leaves of the main upright stems are very large, thin, with little chlorophyll, closely imbricated and clasping. Branch leaves smaller, of a different shape and texture, chlorophyllose. All our species are dioicous. The seta is long and smooth, twisted to the right when dry. Calyptra split on one side, long, reaching to the base of the capsule. Capsule erect, cylindric; operculum conic-rostrate with the beak often oblique; annulus none; peristome double; teeth linear-lanceolate, very long, closely articulate, minutely papillose; segments as long as the teeth, keeled, split between the articulations, often split to the apex when old, united at the base into a continuous narrow basal membrane, minutely papillose.

Mosses of swampy woods and fields; fruiting with comparative infrequency. The systematic position of this genus is as yet doubtful. It certainly does not belong in the *Entodaneæ*, where it has previously been placed. The lack of transverse lines on the peristome teeth indicates that it is either not closely related to the *Hypnaceae* or else is a very highly modified member of that family. It has been placed near the *Fontinalaceae*, but there is much to be said against this view. Perhaps a separate subfamily *Climaceae* of the *Hypnaceae* will be as satisfactory an arrangement as can be made with our present knowledge. There are three species known to North America, one of which, *C. dendroides*, is common in Europe.

KEY

1. Capsules 3 to 4 times as long as broad; median leaf cells 10 times as long as broad. *dendroides.*
   Capsules 5–6: 1; median leaf cells not more than 7: 1 . . . . 2.
2. Plants of a distinctly tree-like habit; median leaf cells 5–7: 1 . . . . *Americanum.*
   Plants growing in dense tufts so that the tree-like habit is obscured, or prostrate and hypnoid in appearance; median leaf cells 2–3: 1 . . . . *Kindbergii.*

C. dendroìdes (L.) Web. & Mohr. Plants, 7–9^{cm} high; branches spreading, flexuous; branch leaves loosely imbricated, 2 x 0.7^{mm}, the upper oblong-lanceolate; lower ovate-lanceolate; denticulate at base, sharply serrate above, obtuse, bisulcate, costate nearly to apex; basal angles sometimes slightly enlarged; *median cells linear-rhomboidal to linear hexagonal, 7-10:1;* alar and apical cells much shorter and broader; stem leaves larger, 2–3^{mm} long, ovate, entire, apiculate. Capsule cylindric, about *4^{mm} long, 3–4:1;* operculum often remaining attached to columella; spores maturing in autumn.

Wet ground, borders of streams, swamps and lakes, especially in the mountains; more common than is indicated by Lesq. & James in the Manual. Ranging through the northern and western part of the continent from New Brunswick to St. Paul Island, Behring sea; south to New Jersey, Colorado and California. Not reported from the north central states.

FIGURE 158. a. *Climacium Americanum* × 1. b. Capsule × 10. c. Branch leaf × 10. d. Branch leaf of *C. dendroides* × 10. e. Capsule of the same × 10.

A form from Oregon with "leaves narrowed at base, less serrate at apex, sometimes subentire" is called var. *Oregonense* by Renauld and Cardot.

C. Americànum Brid. Plants 5–7^{cm} high; branches usually straight and tapering; branch leaves closely imbricate, 2 x 1^{mm}; upper oblong-lanceolate, *broadly auriculate;* lower ovate to ovate-lanceolate, denticulate below, sharply serrate above, more acute than in the last, bisulcate, costate nearly to the apex; leaf cells more nearly uniform than in *C. dendroides;* median cells oblong-hexagonal, 5–7:1; stem leaves as in *C. dendroides;* capsule cylindric, *about 6^{mm} long, 5–6:1;* peristome teeth sometimes slightly perforated: spores maturing in autumn. Distinguished from *C. dendroides* by its more closely imbricated leaves, broadly auriculate branch leaves, longer capsules and shorter leaf cells. Swamps, wet soil and rocks, rotten logs, etc.

This species is exclusively American. It is found in the northern and eastern states, ranging from Canada to North Carolina and probably south to the Gulf.

C. Kindbérgii (R. & C.) Grout. (*C. Americanum Kindbergii* R. & C.) Plants *dark green, almost black*, below rarely lighter green, *growing typically in dense tufts or cushions* in very wet swamps, somewhat tree-like in habit, but growing so compactly together as to obscure the dendroid appearance. On the edges of pools and on sticks and stones in pools the stems are decumbent, irregularly branching, often floating, dendroid secondary stems rarely present.

Stem leaves scattering, ovate; branch leaves ovate-lanceolate, somewhat auriculate, less differentiated than in *C. Americanum*, clasping by enlarged rounded basal angles, sulcate; areolation nearly uniform; median cells oblong-hexagonal, 2–3 : 1. Seta usually much longer and more flexuous than in *C. Americanum;* capsule about the same as in that species, 4–6^{mm} long; teeth of peristome usually more or less perforate.

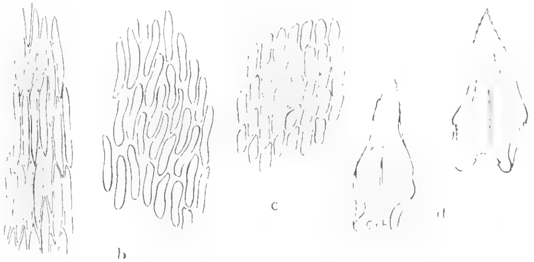


FIGURE 159. a. Median leaf cells of *Climacium dendroides* × 250. b. Same of *C. Americanum* × 250. c. Same of *C. Kindbergii* × 250. d. Two branch leaves of *C. Kindbergii* × 10.

A close study of this form has convinced me that it is a good species closely related to *C. Americanum*, as occasional forms with the short leaf cells and a dendroid habit or auriculate leaves are occasionally met with. The typical form seems most abundant along the coast and in the South; in general this species has the range of *C. Americanum*, but is much less frequent inland than that species. Aquatic forms of the other two species may be confused with this. Usually distinguished at a glance by its color and habit of growth: surely determined by the larger, proportionately broader branch leaves without the conspicuous auricles of *C. Americanum*, yet more auriculate than *C. dendroides*, and specially by its *very short leaf cells.*

SUBFAMILY 4. POROTRICHEAE

Plants dendroid in habit. Leaf cells short and broad. Capsules unsymmetric and inclined, with a perfect hypnaceous peristome. Brotherus in "Die Natürlichen Pflanzenfamilien" puts this subfamily in the *Neckeraceae*, an arrangement with which I am compelled thoroughly to disagree. All the characters, of our species at least, are hypnaceous except, possibly, the areolation. We have one genus

PLATE LXX. *Porotrichum Alleghaniense* (From Sulliv. "Icones.") 1. Plant natural size.

PORÓTRICHUM Brid. (*Thamnium* B. & S.)

and only one species.

P. Alleghaniénse (C. M.) Grout. This is a rather infrequent moss, growing on damp rocks in cool shaded ravines. It is said to be rare, but I believe that a careful search will reveal it almost anywhere in the mountainous regions of our range, although it is a rare thing to find it fruiting. It is distinguished by its dendroid habit, like a small *Climacium* with its branches blown in one direction, and its short rhomboidal to hexagonal leaf cells. The figures in Sullivant's plate are excellent and will enable the student to recognize it without further description. The spores mature in late autumn. It is true of many other mosses, as well as of the *Hypnaceae*, that mosses whose spores mature in late autumn may be found in good fruit until spring, as growth is very slow in the cold months of late autumn and winter.

SUBFAMILY 5. AMBLYSTEGIEAE

Plants of various habits and habitats. Central strand and costa nearly always present (except *Campylium* species). Paraphyllia rarely present (except in *Cratoneuron*). Seta smooth, capsules oblong to subcylindric, cernuous, more or less curved and unsymmetric, usually contracted under the mouth when dry and empty. Leaves acute to slenderly acuminate (except *Calliergon*).

KEY TO THE GENERA

1. Leaves blunt and rounded at apex . . . . *Calliergon.*
   Leaves acute to acuminate . . . . 2.
2. Leaf cells very long and narrow (except forms of *D. aduncus*); leaves more or less falcate-secund . . . . *Drepanocladus.*
   Leaf cells much shorter: leaves rarely falcate-secund (except *Cratoneuron*) . . . 3.
3. Paraphyllia abundant ; plants plainly pinnately branched . . . . *Cratoneuron.*
   Paraphyllia very few or lacking . . . . 4.
4. Leaves squarrose-recurved (except *polygamum* and *riparium*); leaf cells usually more than six times as long as broad . . . . *Campylium.*
   Leaves not squarrose-recurved ; leaf cells usually less than six times as long as broad . . . . *Amblystegium.*

DREPANOCLÀDUS C. M., 1851 (*Harpidium* Sulliv., 1856)

Of all the mosses this genus is probably the most difficult because of the extreme variability of the plants. Even the recognized authorities in the group identify many specimens by telling what they are nearest rather than by referring them definitely to a described form. Nearly all grow in water or very wet places and the amount of water and other conditions of their immediate environment appear to modify their growth profoundly. Sometimes two well marked varieties can be found on the same plant. So variable are the leaves that it is absolutely necessary to take fully developed leaves from the older portions of the stem for purposes of study and comparison. In removing these, great care must be taken to get all of the leaf as the characteristic swollen alar cells often remain attached to the stems.

Although the species are so difficult to define and identify the genus itself is one of the easiest to recognize. *Scorpidium scorpioides* looks exactly like a large species of this genus, but its short and double costa at once differentiates it. *Cratoneuron filicinum* and *C. commutatum* are often mistaken for species of this genus, but their abundant paraphyllia are very easy to observe and at once distinguish them from *Drepanocladus*. I have followed the arrangement of species and subspecies made by Renauld in Revue Bryologique No. 6, 1906, and No. 1, 1907, and have drawn largely upon his descriptions and figures in Husnot's Muscologia Gallica.

I have described very few of the multitudinous varieties, as their identification needs more minute descriptions and illustrations than can find a place in a work of this sort and even with the best of descriptions, authentic specimens are at times almost a necessity in identifying many forms.

Drepanocladus, meaning sickle-branch, must replace the more familiar and less cumbersome *Harpidium* because it is an older name and because *Harpidium* had previously been used for another genus of plants.

Plants slender to very robust, without paraphyllia (there are a few inconspicuous paraphyllia in *D. uncinatus*). Leaves falcate-secund to circinate, often forming conspicuous hooks at the ends of the stem and branches, not papillose, nearly always longly and slenderly acuminate; costa single and well developed, reaching well into the upper $1/3$ of the leaf; leaf cells very long and narrowly linear (shorter in forms of *aduncus*); alar cells in most species enlarged and inflated, forming more or less conspicuous decurrent auricles; basal cells usually shorter and thicker walled, often porose. Capsules inclined to horizontal, subcylindric and curved, usually somewhat contracted under the mouth when dry, with a perfect hypnaceous peristome.

Renauld recognizes the following species of the first order which occur in our range. The key differentiates these species and with them their subspecies and varieties as well. These are not mentioned in the key but are described immediately after the species to which they pertain, that is, all forms described after one of the species mentioned here and before the next such species, belong as subspecies or varieties to the former.

The subspecies are marked with an asterisk (*) to distinguish them from species of full rank. The term group as used here merely indicates a group of varieties with many similar characters.

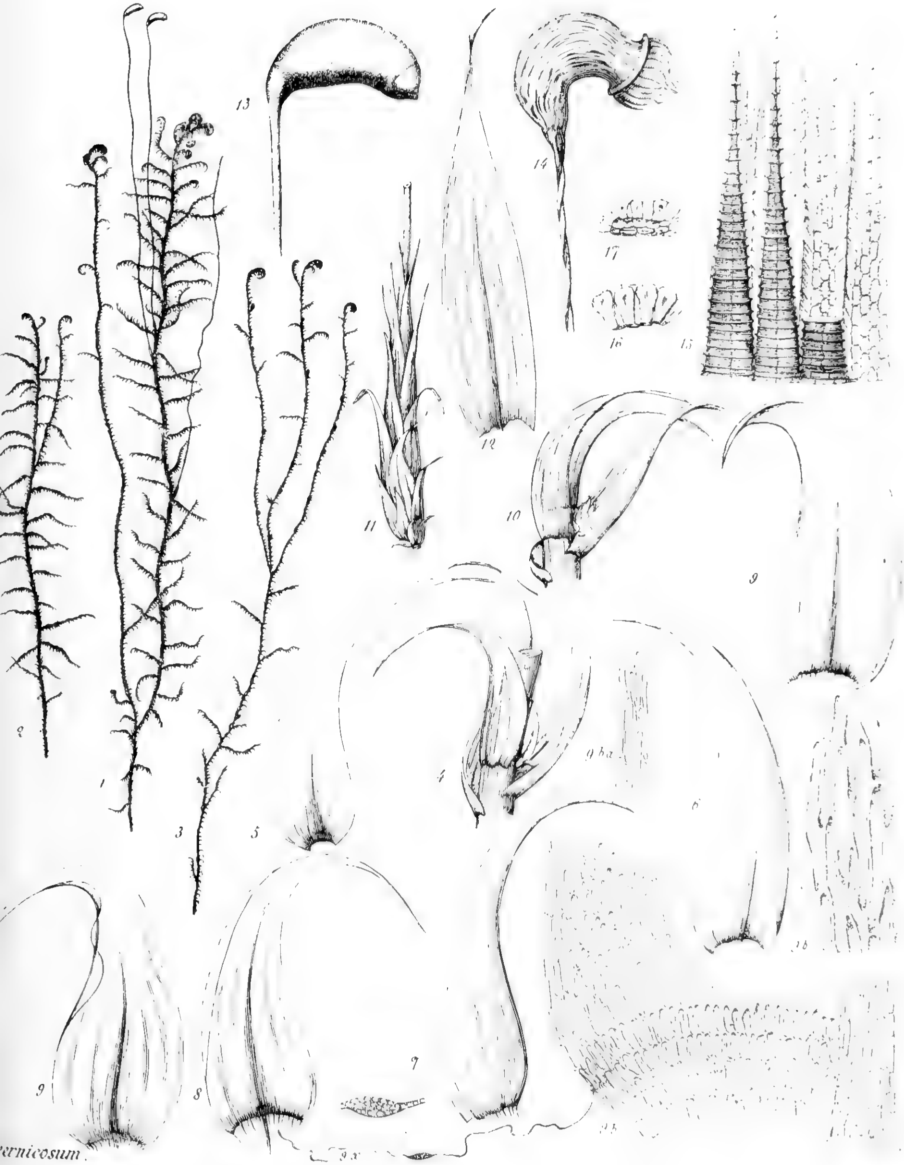


PLATE LXXI. *Drepanocladus vernicosus* (From Bry. Eur.)

KEY

1.	Leaves entire (excl. forms of *revolvens*), somewhat narrowed to the nearly straight insertion, with no enlarged or decurrent alar cells (rarely a few as in Fig. 161), but with a row or two of thick-walled broader and shorter cells across the base (Plate LXXII, Fig. 9b)	2.
	Leaves with alar cells distinctly enlarged and inflated; often decurrent or plainly serrate or both	3.
2.	Plants robust, the older portions usually a deep reddish purple; stems with a central strand; leaves not plicate	*revolvens.*
	Plants as a rule more slender and less deeply colored; central strand lacking; leaves plicate	*vernicosus.*
3.	Leaves entire; alar cells usually greatly enlarged and inflated	*aduncus.*
	Leaves, some or all plainly dentate	4.
4.	Leaves strongly plicate even when moist	*uncinatus.*
	Leaves not plicate; alar cells more or less inflated	*fluitans.*

D. vernicòsus (Lindb.) Warnst. A rather rare species of swamps and bogs, usually slender, 5–10^{cm} long, green to yellowish green; often discolored below, but never deep red or purple; leaves crowded, falcate to circinate, concave and often channelled at apex, finely plicate, at least when dry, entire, not decurrent; costa extending to above the middle; basal and alar cells as described in the key; spores in spring. If a cross section of the stem be made it will be found as shown in Fig. 160 without a central strand, a very unusual thing in plants with strongly unicostate leaves. The outer cells of the stem are small and thick-walled like those immediately underneath, which distinguishes this species from the next. In gross appearance *vernicosus* somewhat resembles some forms of *aduncus* but is easily distinguished by its striate nondecurrent leaves. *D. uncinatus* with nearly entire leaves might be mistaken for this species by a beginner, but the leaves of *uncinatus* are very much more longly and slenderly acuminate.

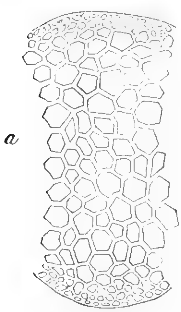


FIGURE 160.
Drepanocladus vernicosus. (Figs. 160 and 161 from Limpricht's Laubmoose). Cross section of stem.

D. revólvens (Sw.) Warnst. is very rare with us but more common westward and northward. It is larger than the last, deep reddish purple below in old well-grown colonies; leaves with acumen *longer and more slender*, costa longer and stronger; stem with a central strand of small thick-walled cells and an outer single layer of large thin-walled cells. Most authorities describe the leaves of *revolvens* as not plicate, I find them much less distinctly so than in *vernicosus* with many leaves entirely free from plicæ. Both this species and the last are dioicous. Stem section as figured in Fig. 161.

Var. **intermedius** (Lindb.) is a more slender pale-yellowish or green plant with shorter acuminate leaves much as in *vernicosus*, except not plicate; basal cells and stem structure as figured. Probably only the variety will be found in our range.

D. uncinatus (Hedw.) Warnst. This is our most common species and in spite of great variability the easiest to recognize. It grows in wet places, over earth, stones and bases of trees, *but is never submerged or red or purple.* Plants rather slender and loosely intertangled, 2–10^{cm} long, rather distantly and irregularly branched or sometimes pinnate; leaves rather close, *regularly falcate to circinate*, hooked at the end of stems and branches, *strongly plicate with numerous folds whether wet or dry*, narrowly elongated-lanceolate, gradually tapering to the very long and slender acumen, usually *more strongly denticulate above* than is indicated in Plate LXXII (rarely some leaves of a plant are entire); costa extending well into the acumen; cells of leaf very long and narrow; basal shorter, often colored; alar varying greatly; somewhat decurrent and enlarged, often with the lower row more abruptly enlarged and differentiated than is shown in Plate LXXII; perichætial leaves long, erect and sheathing: autoicous; spores mature from spring to summer. Easily recognized with a hand-lens by means of the italicized characters.

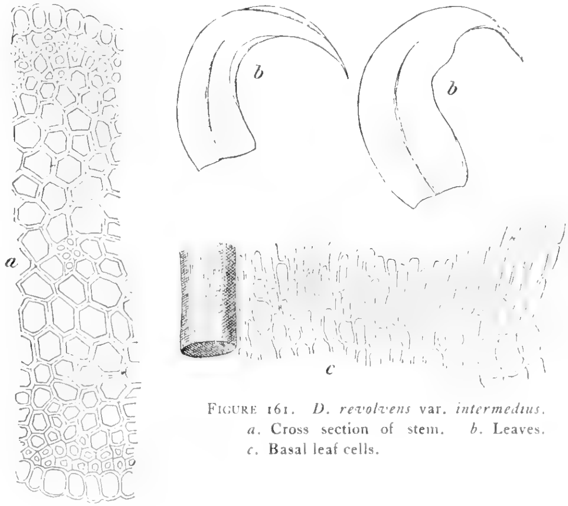


FIGURE 161. *D. revolvens* var. *intermedius*. *a*. Cross section of stem. *b*. Leaves. *c*. Basal leaf cells.

Var. **plumulosus** (B. & S.) Roth is a very slender closely pinnate form with shorter pointed, less denticulate leaves; seta shorter and capsule smaller; frequent.

D. fluitans (Dill.) Warnst. (including subspecies and varieties). This is fairly common in swamps and is frequently found floating in pools. All forms are characterized by *denticulate, non-striate leaves.* Some of the leaves of a plant may be entire but some are sure to be denticulate, especially at apex. Some of the leaves of the subspecies *exannulatus* and its varieties may be slightly striate,

PLATE LXXII. *Drepanocladus uncinatus* (From Bry. Eur.)

but never so much so as to lead to confusion with the other species. With few exceptions the leaves at the end of stems and branches are falcate-secund but are often straight below, all very long acuminate (except some varieties of *exannulatus*), decurrent; costa long, extending into the apex or very rarely somewhat excurrent; leaf cells very long and narrow, more or less inflated at the angles; capsules without annulus.

KEY TO SUBSPECIES AND VARIETIES

1. Alar cells abruptly enlarged and inflated, forming conspicuous auricles reaching nearly to the costa and arranged in a regular series; costa reaching well toward apex; nearly always dioicous . . . . *exannulatus*, 2.
   Alar cells differentiated but not so much enlarged and not in a series; costa shorter as a rule; autoicous . . . . *fluitans*, 3.
2. Leaves very long and narrow with hair-like points . . . . group *rotæ*.
   Leaves with much shorter acumen . . . . group *typicum*.
3. Leaves slender, distant, only slightly secund except at the tips of stems and branches, distinctly denticulate . . . . group *amphibium*.
   Plants robust, often colored below; leaves closer together, strongly falcate-secund, less distinctly serrate as a rule . . . . group *falcatum*.

D. fluitans (Dill.) Warnst. Soft and slender in most of its forms, long and irregularly to subpinnately branched; leaves more or less secund, more markedly so at the ends of stems and branches, lanceolate in most forms and gradually narrowed to a very long slender acumen, distinctly denticulate at apex and often at base; costa reaching well into the acumen; leaf cells very long and narrow, 100–120$^{\mu}$ long, 20–30:1; alar cells enlarged, hyaline or colored, but as a rule not abruptly differentiated, somewhat inflated, forming more or less distinct auricles: autoicous in most cases; spores mature in summer.

There are two principal groups of varieties.

GROUP AMPHIBIUM. Slender and little branched as a rule with leaves only slightly secund except at ends of stem and branches, very narrow, alar cells comparatively little enlarged forming comparatively indistinct auricles; seta very long. Frequently floating in pools and stagnant ponds.

Var. *grácilis* (Boul.) is a very lax, slender, little branched, usually floating form with distant leaves, which are long and slenderly acuminate.

Var. *Jeanbernáti* (Ren.) resembles *gracilis* somewhat in habit but its leaves are very different as shown in Plate LXXIV and are much closer together above. This variety and var. *gracilis* are not uncommon.

Var. *Atlantícus* (Ren.) has been collected on Mt. Mansfield, Vt., and probably occurs elsewhere in alpine or subalpine regions. It seems as though var. *setiformis* (Ren.) ought to be found with us but I have seen no specimens that I could refer certainly to it.

GROUP FALCÀTUM. More robust, often reddish or purplish below; leaves

PLATE LXXIII. *Drepanocladus fluitans* (From Bry. Eur.)

nearly all strongly falcate-secund, hooked at the ends of stems and branches, as a rule faintly denticulate above; costa strong; alar cells not more differentiated than in group *amphibium*. Some forms of this group resemble forms of **exannulatus*, but its leaves are closer together with smaller angular cells.

Var. *falcatus* (Sch.) Roth is apparently not rare at high altitudes. In color and appearance it resembles small forms of *D. revolvens*, from which its denticulate apex and enlarged alar cells will separate it. This variety I find on very wet rocks, but not floating.

***D. exannulàtus** (Guemb.) Warnst. differs from *fluitans* proper in the following characters, as a rule. Tufts more compact and rigid, more pinnately branched, often brown or purplish below; leaves more strongly falcate (excl. gr. *falcatum*) and often somewhat striate when dry, broader at the base with costa longer, reaching well towards the apex, and in nearly all of our forms with very large inflated angular cells as figured in Plate LXXIV, Fig. 16. Dioicous.

Group typicum. Characterized by the relatively very short acuminate leaves. We have the var. *brachydictyon* (Ren.) (Fig. 162) from Mt. Washington with leaves so short and broad as to resemble *D. aduncus* gr. *typicum* but for the denticulate apex, denser areolation and longer costa.

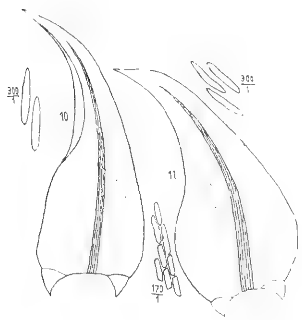


Figure 162. *D. fluitans brachydictyon* (From Musc. Gall.)

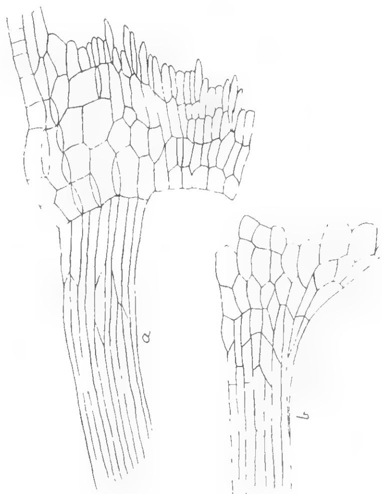


Figure 163. *a*. Basal and alar leaf cells and cuticular stem cells of *D. fluitans*. *b*. Same of *D. aduncus*.

Group rotae. Plants usually brown to purplish below with very longly and slenderly acuminate leaves having the inflated auricular cells very distinctly in a regular series (Plate LXXIV, Fig. 15), the outer very large, long-rectangular

* Mark of subspecies.

and incurved at their lower ends. At high elevations we have var. *falcifolius* (Ren.) with very long and narrow, strongly denticulate leaves, its forma *viridis* (Boul.) is a slender lax form reminding one of *fluitans gracilis*, but distinct by the inflated alar cells.

D. adúncus (Hedw.) Warnst. This species and the preceding are probably the most variable and puzzling mosses we have; both have a similar habitat varying from wet earth and stones to deep pools in which they float. They have numerous parallel forms, which adds to the confusion of intergrading varieties. *Aduncus* and its subspecies and varieties may as a rule be distinguished from *fluitans* by its entire leaves, broader at base, with broader and shorter leaf cells, and areolation noticeably laxer in the lower portion of the leaves. The alar cells are *always* enlarged and inflated, hyaline or colored, and decurrent. Sanio lays great stress upon the gradation between the alar leaf cells and the cuticular stem cells as a means of distinguishing these two species. According to Sanio this transition is very abrupt in *fluitans* but gradual in *aduncus* (see Fig. 163), but Renauld does not attach so much weight to this distinction.

The plants of this species and its subspecies are usually slender (excl. *D. Wilsoni*), sometimes brownish below but rarely reddish, almost simple to rather closely pinnately branched, leaves not crowded, often distant, usually less strongly falcate than in typical *fluitans* (strongly falcate in *Sendtneri*), but more strongly falcate at the ends of stem and branches often giving them a hooked appearance, *not plicate*, broadly ovate-lanceolate to oblong-lanceolate, variously acuminate, usually *wide* and *cordate* at base and *strongly excavate between the decurrent auricles* to form a more or less complete semicircle; costa reaching about 3/4 the length of the leaf (excurrent in *capillifolius*): leaf cells short for the genus, 10–12:1, becoming broader and shorter, "hexagonal-rectangular," toward the base; alar cells as described above: dioicous; annulus present, broad; spores mature in summer.

Forms of *Hygrohypnum ochraceum* are mistaken for *D. aduncus*, but can readily be distinguished by the rounded apex of even the most slenderly pointed leaves.

Group typicum Ren. The Hedwig type of *aduncus* figured in Plate LXXIV gives a good idea of this group, but this form is comparatively rare. The short, *channelled acumen* is a conspicuous character of this group.

EXPLANATION OF PLATE LXXIV. (From drawings by F. Renauld in Husnot's Muscologia Gallica.)

1. Leaves of *Drepanocladus aduncus*, gr. *typicum*, from Hedwig's specimens. 2. Leaf of *D. aduncus polycarpon*. 4. Stem leaves of *D. aduncus Kneiffii*. 3. Elongated leaves of a shape occasionally found on secondary branches of *D. aduncus Kneiffii*. 5. Leaf of *D. aduncus pseudofluitans*. 6. Leaf of *D. fluitans falcatus*. 7, 8 and 16. *D. exannulatus*. 9. Leaf of *D. capillifolius*. 10. Leaf of *D. aduncus gracilescens*. 11. Leaves of *D. aduncus gracilescens forma tenuis*. 12 and 13. *D. fluitans Jeanbernati*. 14. *D. fluitans gracilis*. 15. *D. fluitans falcifolius forma viridis*. Unless otherwise specified in the figures from the Muscologia Gallica the leaves are magnified × 24; portions of leaves × 170; separate auricles × 80; single cells × 300.

PLATE LXXIV.

Var. *gracilescens* (Sch.) is our most common form. In this the stems are short, slender and somewhat pinnately branched above, usually erect; leaves ovate to ovate-lanceolate and abruptly contracted to the short channelled acumen of the group; leaf bases less deeply and more widely excavate between the auricles than in the form figured in Plate LXXIV. Forma *tenuis* Ren. is probably only a starved form of var. *gracilescens*, less pinnately branched, procumbent, with similar but smaller leaves. Both forms may occur in the same tuft or even in the same plant according to Renauld (Fide Dupret).

Var. *aquaticus* (Sanio) is a form that is mostly submerged, more robust (10–15^{cm}), leaves larger, 3.5–4^{mm} long, more distant, longer acuminate and flexuose above; median cells very long, 0.06–0.08^{mm}.

GROUP KNEIFFII has least of the habit of the genus. The stems are slender; leaves more distant than in gr. *typicum* (excl. var. *aquaticus*) not secund or only slightly so, except at the ends of stems and branches (which are not hooked), not falcate, *acumen flat;* upper leaves generally wider and shorter. Much less frequent than the preceding group. Forms simulate *Campylium riparium.* We have vars. *polycarpon* (Bland.) Roth, *attenuatum* (Boul.) and probably *intermedium* (B. & S.) Roth.

GROUP PSEUDOFLUITANS Sanio. Robust, mostly pinnate and aquatic, simulating forms of *D. fluitans*, but with leaves usually broader. Leaves distant, upper not appreciably different from the lower, large, broadly lanceolate to oblong-lanceolate, gradually tapering to a long slender acumen, sometimes subsecund but not falcate; median cells very long; auricles very distinct, occupying nearly the whole width of the narrow base and excavate into almost an exact semicircle.

***D. Sendtnéri** (Sch.) Warnst. is a subspecies that is largely western. It may be confused with *D. aduncus* gr. *typicum* but can ordinarily be distinguished by its more robust habit and crowded, strongly falcate to circinate stem leaves reminding one of *D. fluitans* gr. *falcatum.* The costa is usually longer and stronger than in *aduncus*, and the inflated alar cells darker and thicker walled. In older herbaria this subspecies was often confused with *D. revolvens intermedius.*

***D. capillifòlius** Warnst., distinguished by the long excurrent costa from all other subspecies and varieties of *aduncus*, has been collected near Montreal. The fully developed leaves of the older stems are sometimes the only ones that show the excurrent costa plainly. Frequent on the Pacific slope.

***D. lycopodioides** (Brid.) Warnst. is a very robust species closely allied to *D. aduncus* and having the appearance of small forms of *Scorpidium*, 10–25^{cm} high with leaves 4–5^{mm} long, falcate, but not strongly so, scarcely hooked at the ends of the stem and branches, entire, irregularly plicate and folded when dry. It is certainly rare within our range.

***D. Wilsoni** (Sch.) Roth is the giant of the aduncus group, 15–30^{cm} long, with very large (3–5^{mm}) leaves, distant, falcate oblong-lanceolate and tapering to a long slender point; alar cells comparatively little differentiated. This and its var. *hamatum* which is more regularly pinnate, longer acuminate and more strongly falcate-circinate are found infrequently. The subspecies from New Jersey, and its var. from Willoughby, Vt. to Wisconsin and Minnesota.

Large forms of *D. aduncus*, group *pseudofluitans* approach *D. Wilsoni* in size but have not its markedly falcate leaves.

CRATONEÙRON (Sulliv.) Roth

Plants typically of medium size, rather regularly pinnately branched (Plate LXXV), not glossy, with somewhat the habit of a *Thuidium* and with abundant paraphyllia like that genus but with leaf cells smooth and more elongated; stem without central stand (excl. *C. filicinum*) and often densely radiculose. The structure of the leaf cells is so like that of *Amblystegium* in some cases (cfr. *C. filicinum* and *A. irriguum*) that many authors place some or all of the species in that genus, from which it is readily separated by the paraphyllia. The paraphyllia also separate its various species from *Drepanocladus*, with which it is sometimes included in part. *C. filicinum* is often separated from all the other species by reason of the presence of a central strand in the stems. This is absent in all the other species, although all have strongly costate leaves, a condition noted previously in *Drepanocladus vernicosus* only. The leaves are cordate-ovate to cordate-lanceolate, more or less falcate-secund, decurrent with inflated hyaline or colored alar cells, more or less denticulate to serrate, strongly costate; branch leaves like stem leaves, but smaller and often proportionately narrower. Dioicous; capsule large, cylindric-oblong, arcuate, with operculum conic to conic-apiculate; annulus present, peristome perfect. We have two species, both of which prefer calcareous habitats, growing on soil and stones in moist situations.

KEY

Leaves not circinate nor crisped when dry, scarcely plicate . . . . *filicinum.*
Leaves often circinate, somewhat crisped and plainly plicate when dry . . . . . . *commutatum.*

C. filicinum (L.) Roth. Very variable in habit and size; typically of the size and habit shown in Plate LXXV, but occurring in stouter unbranched forms simulating *Drepanocladus;* paraphyllia numerous, oval, laciniate, and branched: stem leaves cordate-triangular, slenderly acuminate, open-erect to slightly falcate-secund; branch leaves narrower and more falcate-secund; all rigid, little changed in drying, scarcely plicate, with margins plane or nearly so, finely serrate; costa usually percurrent but sometimes passing beyond the apex and sometimes stopping short of it; leaf cells variable in outline; 6–9μ broad and 3–$6:1$, usually obtuse at the ends, gradually becoming wider towards the base, then suddenly

filicinum

PLATE LXXV. *Cratoneuron filicinum* (From Bry. Eur.)

inflated, hyaline or colored, forming clearly defined decurrent auricles; spores in spring; frequent. Some specimens, apparently growing in dry situations, have the auricles less inflated and more deeply colored. Slender forms of *Thuidium paludosum* may be mistaken for this species, but its more plicate leaves with recurved margins and the abundant filamentose paraphyllia easily distinguish it.

FIGURE 164. Leaves of *Cratoneuron commutatum* (From Bry. Eur.)

C. commutàtum(Hedw.) Roth. Variable as in the last, but typically larger, with stem leaves strongly falcate to circinate but sometimes irregularly spreading; leaves somewhat crisped and *strongly plicate when dry;* costa ending well below the apex; leaf cells linear, 8–10:1, at base as shown in Figure 164; spores in early summer; apparently rather rare in our range.

CALLIÉRGON (Sulliv.) Kindb.

Large mosses usually found in swamps and wet places; usually erect when growing in water. Central strand present in the stem. Stem leaves large, not falcate or secund, broadly oblong-ovate to nearly circular, usually very obtuse and cucullate at apex, very concave, little or not at all plicate, with a single strong costa reaching nearly the entire length of the leaf, or ecostate; leaf cells narrowly linear; capsules unsymmetric, inclined to horizontal, with perfect hypnaceous peristomes.

The old genus *Hypnum* included nearly the whole family as here treated and it is very difficult to break it up into separate genera satisfactorily. Though usually treated as a subgenus, *Calliergon* seems to me far better characterized than several other genera of the family that are generally recognized. The first two species placed by Sullivant in Calliergon were *Hypnum cuspidatum* and *H. Schreberi* which much resemble the other species here included, but have their leaves ecostate or nearly so.

KEY

1. Leaves with a single long strong costa . . . . 2.
   Leaves ecostate or with costa short and double . . . . 4.
2. Leaves imbricate when dry; stems almost simple . . . . *stramineum.*

Leaves scarcely imbricated; stems more or less branched . . . . 3.

3. Branches few; enlarged and decurrent angular cells gradually grading into the others . . . . *cordifolium.*

Pinnately and rather regularly branched; enlarged and swollen cells of auricles abruptly differentiated from the others . . . . *giganteum.*

4. Stems green when fully grown; ends of stems and branches cuspidate with the convolute apical leaves; plants of wet places . . . . *cuspidatum.*

Stems red; plants of dryer situations. Very common . . . . *Schreberi.*

C. sarmentosum (Wahlenb.) Kindb. is a very rare species of mountain bogs distinguished by the deep purplish crimson color in the older parts, well defined and large auricles of the mostly apiculate leaves.

C. cordifòlium (Hedw.) Kindb. is our only common species with costate leaves. It is large, 10–20^{cm} in length, sparingly branched with few exceptions; leaves large, 2–5^{mm} long, distant, spreading, soft, somewhat shrinking when dry, somewhat concave, cordate-ovate, rounded at apex and often cucullate, entire, decurrent; autoicous; spores mature May to early summer. Common in swampy places and pools or even shallow, sluggish streams.

C. stramíneum (Dicks.) Kindb. is a rather rare subalpine species, usually found mixed with *Sphagnum* in peat bogs, distinguished from *cordifolium* by the much more slender unbranched stems and smaller more crowded and imbricate leaves, less than 1^{mm} broad, oblong to ovate-oblong with area of differentiated alar cells smaller and not extending inward so far toward the costa; dioicous; spores mature in summer.

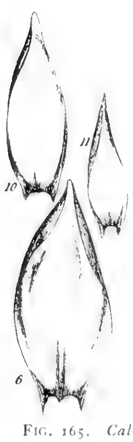


FIG. 165. *Calliergon Schreberi* (From Bry. Eur.) 6. Stem leaf. 10 and 11. Branch leaves.

C. gigánteum (Schimp.) Kindb. is apparently rare and is at once distinguished from the species previously described by its abundant branching which is usually plainly pinnate; it is dark to reddish green below; leaves resemble those of *cordifolium*, but are more crowded, with large decurrent auricles composed of abruptly enlarged, inflated and hyaline or colored cells, and extending almost to the costa. *Cordifolium* has similar auricles but the gradation between the cells of the auricles and those of the leaf is very gradual as will be seen by a reference to Plate LXXVI, Fig. 5b.

C. Schréberi (Willd.), Schreber's Moss, is the bright yellow-green moss that forms dense deep cushions by almost every moist shaded roadside in inland country regions. It is abundant in moist pastures and open woods, and sometimes makes its most luxuriant growth in a Sphagnum bog. It is so common, so conspicuous and so large that every observant person must have seen it and noted its beauty at some time or other. The stems are 10–15^{cm} long, nearly erect and crowded so closely together as to form dense soft cushions into which the foot sinks deeply. The older portions of the stems appear a bright red through the semi-

PLATE LXXVI. *Calliergon cordifolium* (From Bry. Eur.)

transparent leaves, which are broad, obtuse, *incurved at apex* and very concave, closely imbricated, glossy, lightly plicate, entire or slightly crenulate at apex; branch leaves narrower and more pointed; costa double, short and indistinct; median leaf cells linear, 10–15:1; apical and basal shorter and broader, all rather thick-walled and *somewhat porose;* alar abruptly subquadrate, enlarged and hyaline or colored: dioicous; capsules rather sparingly produced as a rule, sub-

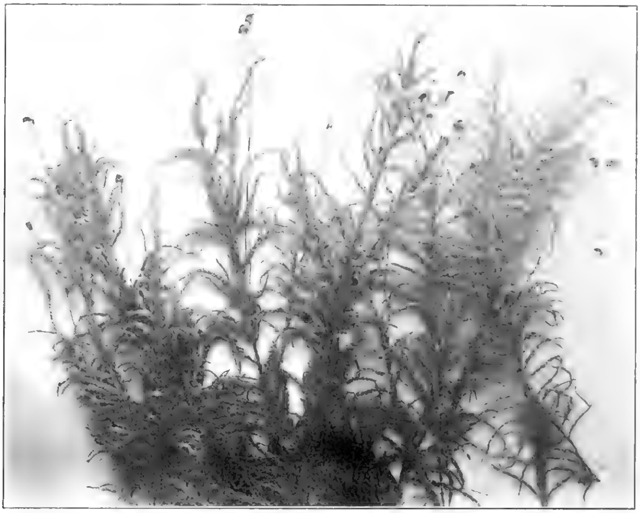


FIGURE 166. *Calliergon Schreberi* × 1

cylindric, arcuate and inclined; *annulus none;* spores in autumn. In dry sterile situations this species sometimes becomes stouter, dark green and much more closely and regularly pinnate than the specimens photographed.

C. cuspidàtum (L.) Kindb. A plant of wet meadows and swamps, more slender than the last, irregularly pinnate; leaves more distant and more spreading below, *but closely convolute at the tips of stems and branches, making them cuspidate; outer layer of stem cells large, thin-walled and hyaline;* leaves broadly elliptic-oblong, *broad and rounded at apex*, concave-cucullate, entire, ecostate or costa short and double; median leaf cells linear-flexuose, 15–20:1; alar suddenly enlarged, thin-walled, hexagonal, hyaline or colored: dioicous; capsule strongly arcuate and *sulcate* when dry and empty; *annulus large;* spores in summer. Easily distinguished from the last by the cuspidate stems and branches and the large outer stem cells. Floating forms may become very robust and beautifully pinnate.

FIGURE 167. *Calliergon cuspidatum* (From Bry. Eur.)

CAMPYLIUM (Sulliv.) Bryhn

Plants growing in moist places, frequently in or near water, usually over earth or stones (except *C. hispidulum*). The genus is closely allied to *Amblystegium*, from which it differs in the longer leaf cells and typically squarrose to squarrose-recurved leaves. The leaves are rarely somewhat secund, never falcate-secund or circinate. Branching usually irregular. Central strand of few cells. Leaves broadly lanceolate to ovate-lanceolate, usually long-acuminate and decurrent; alar cells somewhat differentiated, quadrate to hyaline-inflated. Costa usually single, double or lacking in some species, never percurrent or excurrent. Capsules inclined to horizontal, curved and usually contracted under the mouth when dry and empty. Annulus present; peristome perfect.

KEY

1. Leaves strongly squarrose . . . . 2.
   Leaves not noticeably squarrose . . . . 4.
2. Leaves strongly costate . . . . *chrysophyllum*.
   Leaves without costa or with costa short and double . . . . 3.
3. Plants very slender; alar cells not conspicuously enlarged or inflated . . . . . . *hispidulum*.
   Plants stouter; alar cells conspicuously enlarged and inflated . . . . *stellatum*.
4. Stem leaves cordate-ovate, abruptly slenderly acuminate; dioicous . . . . *radicale*.
   Stem leaves broadly lanceolate, gradually narrowed to a very long slender acumination; monoicous . . . . *polygamum*.

Amblystegium Juratzkanum and *A. Kochii* may be sought in *Campylium*, but their leaves are spreading from the base and not bent, consequently they will lie flat on a slide while the species of *Campylium* most likely to be confused with them will not do so.

Plagiothecium striatellum may be sought here, as it has the appearance of a *Campylium*, but the stem is without central strand, the leaves are serrate and the capsules strongly striate when dry.

FIGURE 168. *Campylium hispidulum* (From Sulliv. "Icones") .10. Perichætial leaf.

C. hispídulum (Brid.) Mitt. Plants slender, interlaced in bright green tufts over roots of trees, decaying wood, etc., near the ground in moist shaded places; stems creeping, freely and irregularly branching; stem leaves reaching 0.75^{mm} long, widely spreading to squarrose, *triangular-heart-shaped*, rather abruptly narrowed to an acumen equaling the rest of the leaf in length, somewhat concave, *subserrulate all around*, *decurrent*, *excavate;* costa very short and double or lacking; median leaf cells 6μ wide and 3–6 times as long; basal cells shorter, subquadrate; alar cells numerous, 9–12μ in diameter: monœcious; capsule cernuous to horizontal; annulus simple; peristome perfect, cilia nearly as long as the segments and somewhat appendiculate; spores in summer. Frequent but not occurring in large quantities as a rule. Distinguished from all our other species by its small size (about that of *Amblystegium serpens*) and slender stems and branches.

I frequently find a form apparently growing in drier places that has its leaves closer together and branch leaves shorter-acuminate and more strongly serrulate and leaf cells shorter than figured by Sullivant. To this form I have tentatively given the name forma **compácta**, type from Hempstead, Long Island, Dec. 1, 1899. Coll. A. J. G.

FIGURE 169. *Campylium chrysophyllum* (From Bry. Eur.)

C. chrysophýllum (Brid.) Bryhn. Plants slender, creeping, irregularly and diffusely to subpinnately branching, forming thin loose mats in some cases, in others cespitose; leaves squarrose-spreading from a somewhat clasping base, occasionally somewhat secund in varietal forms; stem leaves cordate-ovate to cordate-triangular, decurrent, abruptly narrowed to a long, slender, somewhat channeled acumen, $1.3–1.5 \times 0.4–0.5^{mm}$ typically entire or slightly denticulate at base; branch leaves narrower, lanceolate to ovate-lanceolate; costa single, reaching the middle or beyond; leaf cells $5–9\mu$ wide and 4–6 times as long; typically with a group of small subquadrate alar cells as shown in Fig. 169: dioicous; spores in early summer. Common everywhere. Growing over earth and stones in moist places. Varying greatly in robustness and density of tufts, length of costa, length and slenderness of acumen, spreading of leaves, smoothness of margin and size of capsule. In Europe this species is said to intergrade with the next, but intergrading forms in America seem less frequent. We have forms of undoubted *chrysophyllum* with costa very short in some of the leaves and with alar cells somewhat enlarged, also *stellatum* with some of the leaves distinctly unicostate. In these intermediate plants the length of costa often varies greatly on the same plant. It is not impossible that some of these forms are hybrids.

While we have forms of *chrysophyllum* that are practically identical with the European plant, yet by far the greater number of plants that I have examined have branch leaves with a broader and rather shorter acumen which is sinuolate to subserrulate, and leaf cells rather broader in proportion to their length. The very young leaves are often serrate at apex. These forms culminate in var. *brevifolium* and I have designated them as forma **intermedia.** *Hypnum unicostatum* C. M. & Kindb. of Macoun's Canadian Musci No. 840 and No. 132 of my N. American Musci Pleurocarpi, also Austin's Musci App. Nos. 394 and 395 are forma *intermedia*.

Var. **brevifòlium** (R. & C.) (var. *Caroliniànum* Grout). Very robust; leaves more or less falcate, somewhat secund in the type, more gradually and less slenderly acuminate, many plainly serrulate at apex. N. Am. Musci Pl. No. 313 is this variety.

*C. **radicàle** (P. Beauv.) (*Hypnum radicale* P. Beauv. non *Amblystegium radicale* B. & S., *H. Bergenense* Austin, *Hypnum hygrophilum* Jur., *H. chrysophyllum* var. *tenellum* L. & J. non B. & S.).

As may be inferred from the tangled synonymy given above, this plant has had an interesting history (See Bryologist for Nov., 1909). Although it so closely resembles forms of *Amblystegium Kochii* as to be confused with it by good students, I believe Austin was right in regarding it as a close relative of *C. chrysophyllum*. It is a slender, lax, unbranched or little-branched plant, growing in springy or partially inundated places over decaying leaves, etc. The leaves are very distant, not squarrose, merely spreading, not otherwise very different in typical forms from the stem leaves of *C. chrysophyllum*. The leaves differ from those of related *Amblystegia* in being broadly cordate-ovate and decurrent, sub-

*See Fig. 175 for illustration.

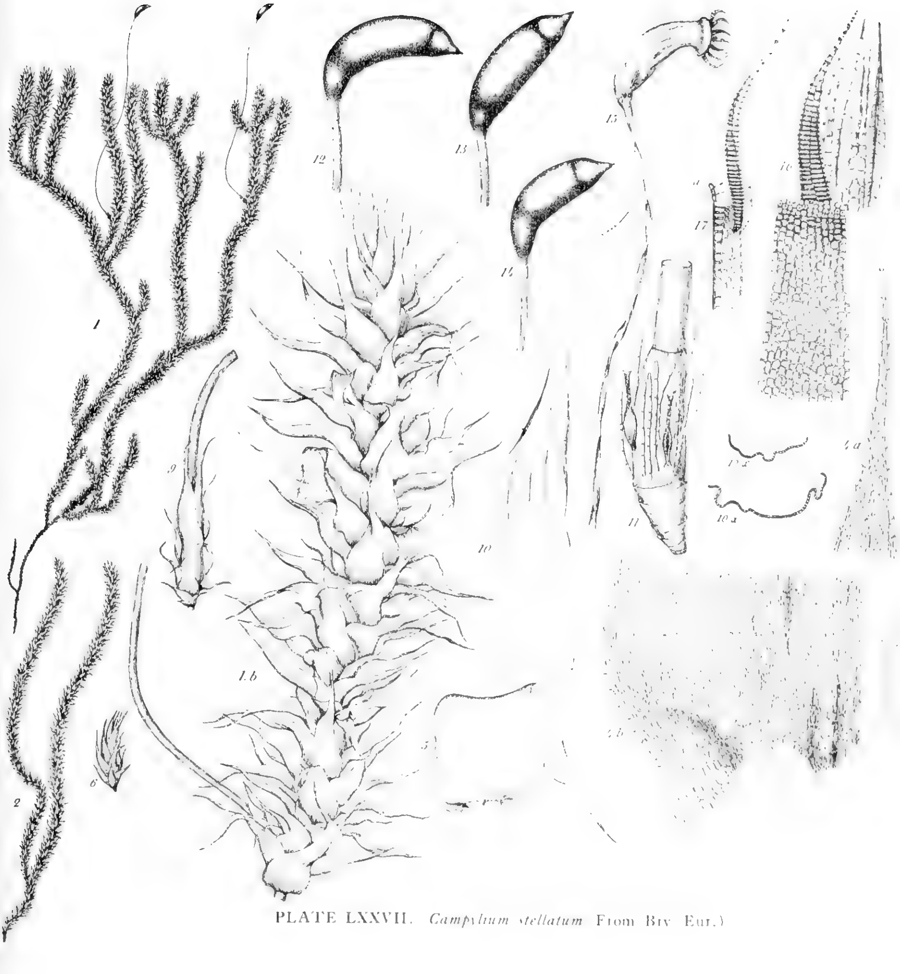


PLATE LXXVII. *Campylium stellatum* (From Bry. Eur.)

clasping at base so that the leaf base does not lie flat when the leaf is removed entire and mounted, and in the longer, thinner-walled, less chlorophyllose leaf cells, those at basal angles being rather abruptly enlarged and hyaline or nearly so, apex often somewhat channelled. The costa is well developed; leaf cells of middle of leaf 6–10:1. The capsules are not at all distinctive and might belong to *Campylium* as well as to *Amblystegium*. From *C. chrysophyllum* it differs chiefly in its lax habit, distant leaves and little-branched plants, resembling in gross appearance *Amblystegium* rather than *Campylium*. Small forms of *Drepanocladus aduncus Kneiffii* are distinguished by their more strongly excavate leaf bases and more inflated alar cells; the leaves are usually less abruptly acuminate. I believe this species is common, as I have picked out many specimens from my collection masquerading under several specific names.

C. stellàtum (Schreb.) Bryhn. This is a much more robust moss than *C. chrysophyllum*, and grows in thick tufts in swamps. Stems stout, erect or ascending, 5–10^{cm} long;

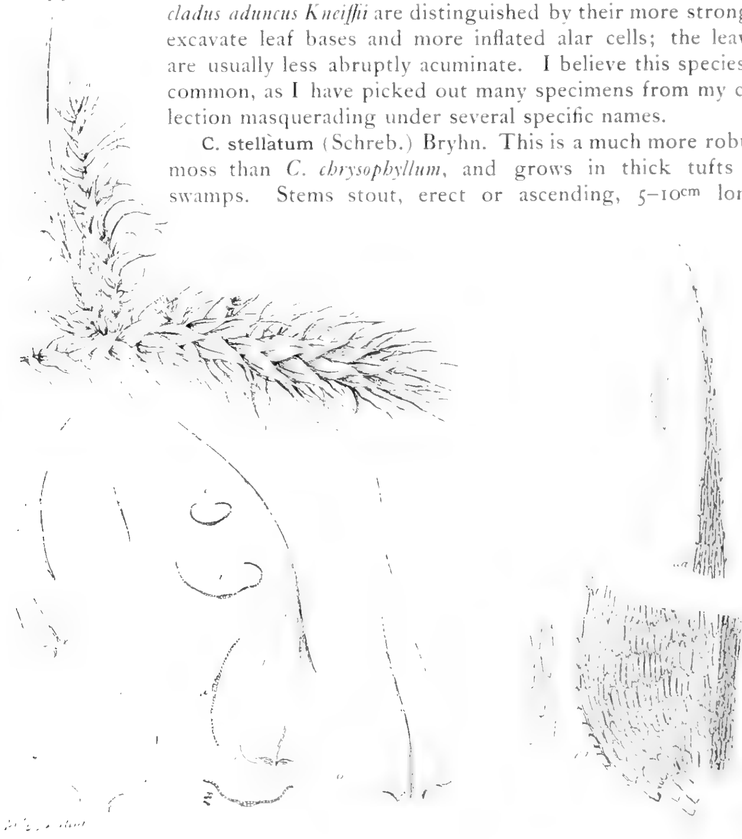


FIGURE 170. *Campylium polygamum* (From Bry. Eur.)

leaves typically entire with apex somewhat channeled, *strongly squarrose to recurved*, without costa or at most with merely a trace of one; inflated alar cells numerous and conspicuous, hyaline or colored: dioicous; spores in summer, but infrequently produced. This species is apparently not abundant but is widely distributed in our range. Forms are found varying toward *C. chrysophyllum* and having a well-developed costa in leaves.

Var. proténsum (Brid.) Roehl is reported from our region, though I am not familiar with it. It is slender, more or less procumbent and creeping; leaves more distant, smaller, more abruptly and more longly and finely acuminate from a distinct cordate-ovate base, with angular cells smaller and fewer (*fide* Dixon).

C. polýgamum (B. & S.) Bryhn is apparently a rare or infrequent species with us. It is rather smaller than the last; leaves narrower, erect-open, *not squarrose, entire, with a long, slender, somewhat channelled acumen;* costa extending well above the middle; *leaf cells narrowly linear*, the alar enlarged and distinct, forming auricles; basal cells enlarged nearly to the costa: autoicous or synoicous: annulus present, cilia well developed; spores in summer. Swamps, wet meadows, etc.

Distinguished from *Amblystegium riparium* by the inflorescence, auricled base and channeled acumen. From forms of *Drepanocladus aduncus*, by its usually narrower leaf base, its scarcely decurrent, not secund leaves, and by its inflorescence.

AMBLYSTÈGIUM B. & S.

Mostly small moisture-loving mosses, growing on various substrata; variously colored, dark green to yellowish, sometimes blackish in the older portions, not glossy. Stems creeping, branching freely and irregularly; central strand present, few-celled. Leaves spreading to erect when dry, mostly equally spreading, but occasionally somewhat secund, more or less decurrent, lanceolate to ovate, acute to long-acuminate, strongly costate, flat or concave, but not plicate, margins plane. Leaf cells short, often less than 5:1 (longer in *A. vacillans* and *A. riparium)*; basal cells shorter and broader and parenchymatous; alar often somewhat enlarged, but not abruptly so, not inflated or forming auricles except *A. filicinum*. Paraphyllia few or more often wanting. Nearly always monoicous. Seta long, smooth; *capsules often large in comparison with the gametophyte*, inclined to horizontal, elongated and *usually strongly curved and constricted under the mouth when dry and empty;* operculum conical, not rostrate; annulus usually present; peristome perfect. The genus as here defined does not include the small species having ecostate leaves. They belong in the *Hypneae*.

The short leaf cells and long capsules, together with the usually small size of the plants, render this genus fairly easy of recognition, but the species, like most aquatic and subaquatic mosses, are exceeding variable and puzzling and also apparently intergrade in many instances.

Brachythecium reflexum might be mistaken for an *Amblystegium*, but when in fruit its short capsule and rough seta will distinguish it. A careful study of the genus has brought me to believe that *Cratoneuron filicinum* is a true *Amblystegium*, (*A. filicinum* (L.) De Not.) because of its close relationship to forms of *A. irriguum*. It is, in most instances, readily distinguished by its abundant paraphyllia and inflated alar cells. I have also concluded that *Hypnum Lescurii* Sulliv. is better treated in a separate genus, *Sciaromium Lescurii* (Sulliv.) Broth., because of its marked character of bordered leaves.

KEY

1.	Leaves with a distinct border joined with the costa at apex (See *Sciaromium*).	
	Leaves not bordered	2.
2.	Paraphyllia abundant, alar cells inflated. (See *Cratoneuron filicinum*.) . . .	
	Paraphyllia few or wanting, alar cells not distinctly inflated	3.
3.	Costa percurrent or nearly so, or excurrent	4.
	Costa ending well below the apex, usually not far above the middle	10.
4.	Costa excurrent	5.
	Costa not excurrent	6.
5.	Plants larger; leaves broad, gradually narrowed to the very stout excurrent costa	*noterophilum*.
	Plants smaller; leaves narrower and acuminate, ending in a much narrower excurrent costa	*irriguum spinifolium*.
6.	Very slender, densely tufted; leaves finely and sharply denticulate; median leaf cells 6–10:1	*compactum*.
	Larger; leaves entire or at most obsoletely denticulate; median cells 3–6:1 .	7.
7.	Stem leaves entire, cordate-ovate to oblong-lanceolate, apex rather blunt; all forms aquatic	9.
	Stem leaves narrower in outline, usually acute with a more slender acumen; growing in water or wet places	8.
8.	Aquatic, submerged except at low water; basal leaf cells usually plainly enlarged; costa very stout	*irriguum*.
	Growing in wet places but not often submerged; basal cells much less differentiated; costa more slender and apex usually more slenderly acuminate.	*varium*.
9.	Stem leaves oblong-ovate to broadly oblong-lanceolate, 1–2^{mm} in length, gradually and evenly narrowed to a rather blunt apex	*fluviatile*.
	Stem leaves ovate to cordate-ovate, usually less than 1.2^{mm} long, more abruptly narrowed to a distinct acumination	*orthocladon*.
10.	Median leaf cells reaching 10:1 or longer	13.
	Median leaf cells less than 8:1	11.
11.	Leaves widely spreading when dry; marginal cells at base of leaf oblong to rectangular	12.
	Leaves not widely spreading; marginal cells at base quadrate or transversely elongated	*serpens*.

12. Stem leaves 1^{mm} in length or less, rarely more, ovate-lanceolate . . . . . *Juratzkanum.*
    Stem leaves more than 1^{mm} in length; leaves broadly ovate-lanceolate to cordate-ovate . . . . *Kochii.*
13. Stem leaves narrowly elongated-lanceolate; apical cells shorter, apex blunt . *vacillans.*
    Stem leaves ovate to ovate-lanceolate; apical cells little if any shorter, apex acute . . . . *riparium.*

The genus as here constituted divides itself pretty clearly into four subgenera. **Euamblystegium** Broth., of which *A. serpens* is the center. Slender plants, not aquatic; leaf cells 2–6:1 rarely longer; costa slender, reaching to the middle of the leaf or a little farther (to the apex in *compactum*).

This group includes *serpens*, *Juratzkanum*, *Kochii* and *compactum*. *Kochii* is usually put with the next group, but its nearness to *Juratzkanum* and its wide leaf cells convince me that it belongs here.

Leptodictyum Schimp. contains *A. riparium* and its allied species *vacillans*, *Floridanum* R. & C., *brevipes*, *laxirete* and *brachyphyllum* (the last three recently described from the West by Cardot and Theriot). M. Cardot admits that all these are subspecies of *riparium* and, to my mind, all except possibly *vacillans* and *Floridanum* are much better regarded as varieties or even mere forms and are not described here. The group is characterized by a generally aquatic or subaquatic habitat, long, narrow leaf cells, 8:1, sometimes 10–15:1, and the costa ending at about the middle of the leaf.

Hygroamblystegium Loeske, which Brotherus makes a separate genus, contains *varium*, *irriguum*, *fluviatile*, *orthocladon*, *noterophilum* and *filicinum*, and is characterized by aquatic habitat (excl. *varium*) and stout, percurrent or excurrent costa; leaf cells 2–4:1, occasionally 6:1, thick-walled; paraphyllia present in many species. I have become convinced that *Hypnum filicinum* L. belongs in *Amblystegium* because it intergrades with *irriguum* so that some forms are next to impossible to locate definitely.

Sciaromium Mitt. includes *Lescurii*. This, with 16 other known exotic species of *Sciaromium*, undoubtedly should be treated as a separate genus, but it was discovered too late to insert in keys.

The different species have a way of being closely interwoven so that one often gets two or three species in the same tuft. It is very necessary to bear this in mind when distributing or comparing material.

A. sérpens (L.) B. & S. *Plants slender, the smallest of our species*, growing in rather thin, more or less densely interwoven mats, irregularly branching, not glossy; leaves moderately close together as a rule, not widely spreading; stem leaves ovate-lanceolate, long-acuminate, reaching 1.2×0.4^{mm}, but usually smaller, branch leaves smaller and lanceolate, both serrulate to entire, narrowed at the insertion and slightly decurrent; costa slender, reaching to the middle of the leaf or somewhat farther; median leaf cells oblong-hexagonal to hexagonorhomboidal, 3–4:1, broader and subrectangular toward the base, *quadrate to transversely elongate at the basal margin:* autoicous; seta 15–30^{mm} long; capsule cylindric, curved and cernuous, contracted below the mouth when dry and empty; annulus of 2–3 rows of cells; spores in spring.

Common on moist substrata, ground, stones and especially decaying wood. Very variable in size; several European varieties are described. We have var. **tenue** (Schrad.) B. & S., which is so distinct as to merit notice. It is exceedingly slender, filiform; leaves distant, shorter and smaller; seta short, capsule small, nearly straight.

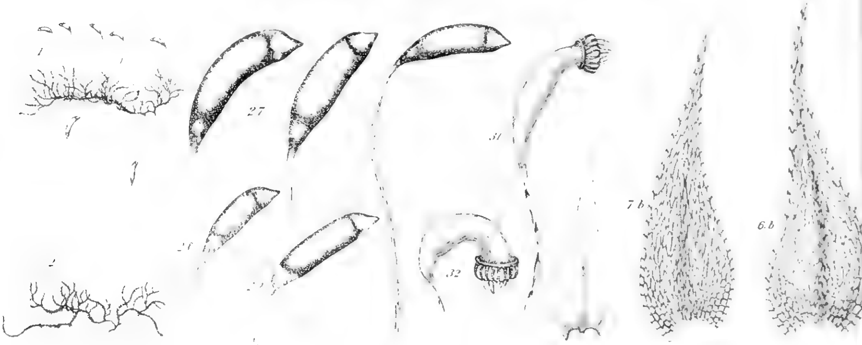


FIGURE 171. *Amblystegium serpens.* (From Bry. Eur.) 1 and 2. Plant natural size. 27 to 32. Capsules. 6*b* and 7*b*. Leaves. The angular cells are usually shorter, and some are broader than long.

The short, broad leaf cells distinguish *A. serpens* from mosses of other genera that may resemble it superficially. Small forms of *A. varium* with costa not quite percurrent and large forms of *serpens* approach each other, but I have never seen *serpens* with the costa as long and strong as in *varium.*

A. Juratzkànum Schimp. is, in my opinion, a large variety of *serpens*, with some nondescript forms included by various authors. Exceedingly variable in size, ranging from forms the size of *serpens* to those difficult to distinguish from *Kochii.* Leaves larger than in *serpens*, *widely spreading both wet and dry*, narrowly long-acuminate, more or less serrulate; cells of the basal margins rectangular, longer than broad, 1.5–2:1. Frequent; probably often overlooked.

While the rather artificial distinction of the length of the alar cells usually holds as between this species and *serpens*, I have seen leaves with one side having cells of *serpens* and the other those of *Juratzkanum. Juratzkanum* is distinguished from *Kochii* by its smaller size and its resemblance to *serpens.*

A. compáctum (C. Muell.) Aust. About the size of *serpens*, light green, yellowish *within the dense tufts*, which may be 25^{mm} deep, but are usually thinner;

leaves erect, open, about 1^{mm} long, narrowly decurrent, *lanceolate to ovate-lanceolate*, gradually long acuminate, *finely denticulate throughout, teeth at base frequently recurved and double as in Fig. 172;* costa percurrent or nearly so, *very thin, frequently bearing delicate brood filaments from the back or apex;* branch leaves narrower and smaller; seta short; capsule small, erect or slightly inclined, nearly or quite symmetric. On decayed wood or at bases of trees in swamps or along streams.

Widely distributed across the northern United States and in Canada and not rare. One of the easiest species to recognize under the microscope. Some densely growing forms of *serpens* simulate its macroscopic appearance.

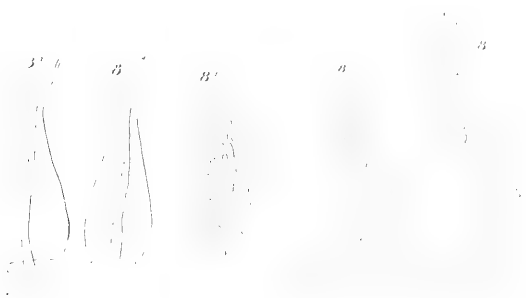


FIGURE 172. *Amblystegium compactum* (From Cheney in Botanical Gazette). 8*a*. Leaves, 8*b*, 8*c*, and 8*d*, apical, basal and median cells, respectively.

A. Kóchii B. & S. Smaller plants resemble *A. Juratzkanum*, the larger *A. riparium*, in appearance; leaves rather distant, *spreading from the point of insertion*, at times almost squarrose, again, in drier situations, erect-spreading, giving the plants the appearance of *A. varium;* stem leaves ovate to ovate-lanceolate, somewhat narrowed at the insertion, long and slenderly acuminate, entire, sinuolate or serrulate, 1–1.5^{mm} long; costa extending $\frac{2}{3}$–$\frac{3}{4}$ the length of the leaf; leaf cells strongly chlorophyllose, *rhomboid-hexagonal, 4–6 : 1, rectangular and hyaline or slightly colored at base but not forming auricles;* branch leaves smaller and more narrowly lanceolate; spores in summer. Common in shaded marshy places.

I have yet to see any plants with leaves as broadly cordate-ovate as are figured in the Bryologia Europea (Fig. 4*b*). A rather narrow-leaved form common in swampy shaded places, on the Atlantic coast at least, has been referred to *Campylium chrysophyllum* and to *C. radicale*, from both of which it clearly differs in its non-decurrent, non-clasping leaf base. Similar European forms are referred to *Kochii* by the best authorities. It has also been referred to *A. Juratzkanum*

and *A. varium* according to specimens in my collection. Plants of *A. varium*, with costa reaching scarcely beyond the base of the acumination, are found and are likely to be referred to *Kochii*, but the costa, even in such cases, is much stronger, the cell walls thicker and the cells themselves rather smaller, especially at the basal margin and near it.

A. vàrium (Hedw.) Lindb. Plants in mats of varying density, thin and loose to almost cespitose, younger portions light green, darker below the surface; stem leaves rather close together, loosely erect-spreading, averaging 1.2 x 0.5^{mm}, reaching 1.4×0.57^{mm} in large plants, broadly ovate to ovate-lanceolate, narrowed at the insertion and somewhat decurrent, rapidly narrowed to a long and comparatively slender acumen, entire or nearly so, slightly concave but lying nearly flat when removed entire; costa strong, tapering, reaching the apex or nearly so, rarely stopping at base of acumen; leaf cells rhomboid-hexagonal, *2–4:1, somewhat rounded at the ends*, toward the base *becoming rectangular, subquadrate at basal margins*, those near the

FIGURE 173. *Amblystegium Kochii* (From Bry. Eur.)

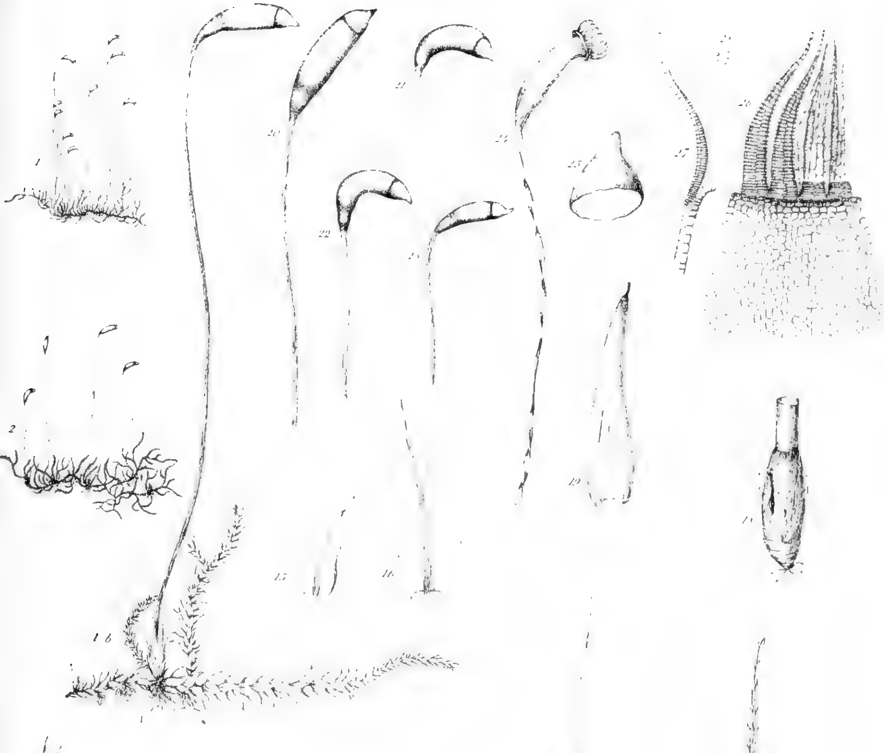


PLATE LXXVIII. *Amblystegium varium* (From Bry. Eur.)

insertion occasionally slightly colored but not opaque; branch leaves much smaller and less slenderly acuminate; spores in spring. Common in moist shaded places, on soil, at base of trees, decaying wood, or even on stones. Variable, especially in size, and often mixed with other species.

Distinguished from *serpens* and *Kochii* as noted under those species. It grades into *irriguum* by such minute degrees that there are indeterminable plants, but in general *irriguum* is known by its less slender apex and stouter less tapering costa.

Forma ovàta Grout, has stem leaves smaller, more concave, round-ovate, abruptly and narrowly short acuminate, with nearly the outline of *Thelia asprella;* quadrate alar cells very numerous extending up $\frac{1}{3}$ the margin of the body of the leaf. Type from near St. Louis, Mo., growing with *Eurhynchium hians* and *Mnium cuspidatum.* Differs from *A. orthocladon* in its more slender costa, more slender acumination and lack of highly colored opaque basal cells and in its very different habitat.

A. irríguum (Wils.) B. & S. Typically aquatic, growing on stones in the bed of streams, also found along the edges of streams, ponds, etc., and in swampy places; *deep olive to blackish green;* stems rather thick and tough *with a few paraphyllia particularly near the insertion of branches;* stem leaves *elongated deltoid-ovate* to ovate-lanceolate, gradually long-acuminate *with apex acute,* 1–1.5^{mm} long, more or less narrowed to the insertion and slightly decurrent; branch leaves smaller and narrower; all rather thick and rigid, sinuolate to entire; costa very thick and strong throughout, percurrent or merging into the

Figure 174. *Amblystegium irriguum.* 1a. Leaves × 42. 1b, 1c and 1d. Basal, median and apical cells of same × 290. 1a. Leaf of var. *spinifolium* × 42. (From Cheney in Botanical Gazette.)

fluviatile

PLATE LXXIX. *Amblystegium fluviatile*, forma *typica*. (From Bry. Eur.)

apex; one or more rows of basal cells enlarged, rectangular, usually thick-walled and colored, cells above these quadrate to short-oblong, becoming rhomboid-hexagonal above, 2–4:1 (Boulay and Dixon say 4–6:1), rather thick-walled and more opaque than in the preceding species; spores in summer. Common, but the typical form appears rare both here and abroad. It grades into *varium* from which it is distinguished as noted under that species. It grades into *orthocladon* which is at best only a subspecies, intermediate between *irriguum* and forma *brevifolia* of *fluviatile*. *Orthocladon* has shorter, broader, pointed leaves altogether different in outline from typical *irriguum*. *Fluviatile* has the costa still stouter, especially at the apex, and the leaves subobtuse and less narrowly acuminate.

Var. **spinifolium** Sch. More robust than the species; stems 3–12^{cm} in length; leaves longer and narrower, reaching 1.8^{mm} in length with a thick long-excurrent costa; upper leaf cells 6–8:1, basal areolation looser. Distinct from *A. noterophilum* by its narrower leaves and costa only about ½ as wide.

There is a floating aquatic moss about the size of var. *spinifolium* and with a similar areolation but with leaves often broadly ovate and sometimes reaching 2^{mm} in length, and with the costa much thinner and vanishing in the apex or below, that probably is this species. In general appearance it resembles var. *spinifolium* because of its large size, but in leaf outline and areolation and numerous paraphyllia it resembles forms of *A. filicinum* (*Cratoneuron*, p. 315). This form differs from *filicinum* in its floating unbranched habit and enlarged basal and alar cells, gradually merging into those above.

My N. Am. Musci Pleurocarpi Nos. 247 and 291 are this form. M. Dupret, the collector, suggests for this form the name forma *Marianopolitana*.

A. fluviátile (Sw.) B. & S. Plants aquatic, floating, with long parallel branches, dark green or blackish; stem leaves oblong-lanceolate to oblong-ovate, *not so much broader below as in most species*, scarcely narrowed to the insertion, not decurrent, *more gradually tapering to a blunt point, entire*, concave and occasionally plicate; *costa very stout, percurrent and merged into the apex, typically nearly or quite as broad above as below;* area of enlarged and rectangular cells at base larger than in the preceding, *these basal cells thick-walled and often colored*, opaque or pellucid; median and upper cells hexagonal-rhomboid, *4–6:1*, or even longer, *very chlorophyllose and more or less indistinct;* capsules very long, narrowly cylindric, suberect, somewhat unsymmetric but scarcely arcuate before dehiscence, after dehiscence more curved, strongly contracted under the mouth when dry; spores in summer.

Boulay separates the species into two forms: Forma **typica** with leaves 2 x ⅔^{mm}, oblong-lanceolate, loosely imbricate, often somewhat plicate, lower cells little colored. This form is apparently infrequent. The Bry. Eur. plate represents Boulay's forma *typica*. Forma **brevifolia**; leaves oblong-ovate, 1–1.4 x ½^{mm} tapering to a wide subobtuse apex, concave, basal cells often deeply colored

FIGURE 175. 1. *Hypnum orthocladon* P. B. *a*. Four leaves × 30, from a specimen in the herbarium of Schwaegrichen from North America and communicated by Palisot. *b*. Two leaves × 30 from a specimen in the herbarium of Schwaegrichen; collected by Muhlenberg in North America. *c*. Two leaves × 30 from a specimen in the herbarium of Schwaegrichen; collected in Cuba by Pöppig. *d*. Lower portion of a leaf × 135. 2. *Leskea varia* Hedw. (= *A. varium*) from Pennsylvania (Muhlenberg). *a*. A leaf × 30. *b*. Lower part of the same × 135. (From an "original" specimen.) 4. *Hypnum fluviatile* Sw. *a*. Two leaves × 30. *b*. Lower portion of one of these leaves × 135. (From an "original" specimen communicated to Hedwig by Schwartz and preserved in the herbarium of the former.) 8. *Hypnum radicale* P. B. from North America (Palisot and Richard). *a*. Three leaves × 30. *b*. Lower portion of one of these leaves × 135. *c*. Cells from the middle portion of the same × 135. (From specimens in the herbarium of Schwaegrichen.) 9. *Hypnum Bergenense* Austin, from Closter, New Jersey. (Austin "original" specimen.) *a*. Two leave × 30. *b*. Middle portion of one of these leaves × 135. 10. *Amblystegium hygrophilum* Sch. from Germany. *a*. Two leaves × 30. *b*. Middle portion of one of these leaves × 135.

These figures and their descriptions are taken from M. Cardot's valuable "Revision of the Types of Hedwig and Schwaegrichen" published in the "*Bulletin de l'Herbier Boissier*," in 1899. The specimens marked as "original" were evidently communicated or furnished by the authors, and though not types in every case certainly should be regarded as authentic. It should be remembered, however, that in those early days of inferior microscopes material was often mixed and the authors of species themselves had mixtures in their types. M. Cardot's figures have been presented as being as near authenticity as anything available. The figure of *H. Bergenense* fails to show the characteristic concavity of the base as shown in Austin's Musci Appalachiani No. 391.

and opaque. According to M. Cardot's figures of specimens supposed to be from the type locality this is probably the typical form (see Fig. 175) and it certainly is the more common form with us. It grades into the form which M. Cardot believes to be *A. orthocladon* (P. B.) and which is clearly intermediate between this species and the last, merging into both with such a series of intergrading forms that it is impossible to tell where one leaves off and the other begins. Almost identical plants have been referred to *irriguum* by Cheney and to *fluviatile* by Renauld. Until the position of these forms can be better determined, I have included them under,

A. orthocladon (P. B.) Kindb. Leaves broadly cordate-ovate, either gradually narrowed to a subobtuse apex or somewhat acuminate in Fig. 175. Stems more freely branching with shorter branches; stem leaves shorter in most all cases; one or more rows of basal cells enlarged, thick-walled and usually opaque and colored; median leaf cells as short as in *irriguum*. Common on stones in brooks in the elevated regions of New England at least, and probably common throughout our range.

A. noterophilum (Sulliv.) Warnst. is a large ($2–15^{cm}$ long) moss, harsh and rigid to the touch, forming close thick tufts when growing out of water, and crowded floating masses in the water; leaves varying from broadly triangular-cordate-ovate in the land forms to long-lanceolate in water forms, reaching 2^{mm} or more in length, but usually shorter, $1–1.5^{mm}$, characterized by the very thick, strongly excurrent costa, which is $\frac{1}{6}$ to $\frac{1}{3}$ the width of the leaf at base; lamina commonly of two layers of cells in the basal and costal regions. Growing in and around springs, especially in calcareous regions. Rare and local. Not likely to be confused with anything except the var. *spinifolium* of *irriguum*, which is a smaller plant, having narrower, more slender-pointed leaves with costa $\frac{1}{2}$ as wide.

A. riparium B. & S. is very close to forms of *Drepanocladus aduncus Kneiffii* and certainly bears a marked likeness to forms of *C. polygamum* as well. It is probable that the structure of these three mosses has been modified by their subaquatic habitat along similar lines so that their true relationship is obscured. (See Bryologist for November, 1909.)

The plants are exceedingly variable in size and habit, typically creeping, with long stems, irregularly branched with rather short, spreading branches, forming loose mats over various substrata near water or even floating in water in some of the varieties, reaching 10^{cm} or more in length; stem leaves long, $2–4^{mm}$, rather distant, widely spreading both wet and dry, often subcomplanate, rarely somewhat secund at ends of stems and branches, broadly ovate-lanceolate to elongated-lanceolate, shortly decurrent, somewhat excavate, but not auriculate, *entire, rarely subserrulate, gradually tapering to a long, slender, flat acumen;* branch leaves like stem leaves, but smaller; costa $\frac{1}{2}–\frac{3}{4}$ length of leaf;

leaf cells linear, about 9μ wide and *8–12 (or rarely 15) times as long*, thin-walled; basal cells 8μ wide and 2–3 times as long, subrectangular and often hyaline; autoicous; capsules oblong-cylindric, inclined and arcuate; spores in spring. Common in wet places.

For distinctions from *C. polygamum*, see under that species. It is distinguished from forms of *Drepanocladus aduncus* by its inflorescence, and non-auriculate leaves with flat acumen.

Var. **longifolium** (Schultz) B. & S. is one of the larger forms, yellowish green to bright yellow, very slender, little branched; leaves more distant, usually subcomplanate, narrowly lanceolate and reaching 5^{mm} long in floating forms, with a very long, tapering and almost filiform acumen. Probably with the range of the species. Floating forms grading between this and the species are common.

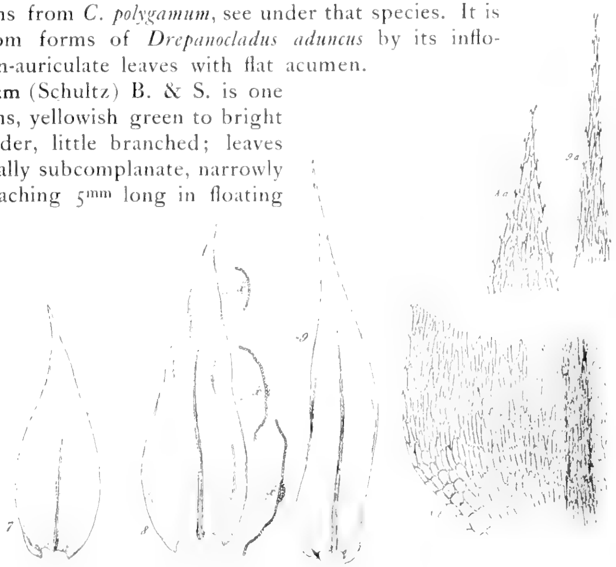


FIGURE 176. *Amblystegium riparium*, leaves and leaf cells. (From Bry. Eur.)

Var. **fluitans** (L. & J.) R. & C. Very robust, $10–20^{cm}$ long, floating in shallow water or at the edges of streams; dirty green or yellowish; leaves 0.8×3.2^{mm}, sometimes reaching 4^{mm} in length and 1^{mm} in width.

Those unfamiliar with these two varieties confuse them because both are floating forms. The very long narrow leaves with long slender acumen distinguish *longifolium*.

The above are our two principal varieties, but the species is so variable that one can scarcely make two collections alike. As in *Drepanocladus*, it is probable that the form is profoundly affected by the amount of moisture present. In spite of all these variations the species is not a hard one to recognize, but the great variations in size are often puzzling. Some of the smaller forms may be confused with *Amblystegium Kochii*, but this last has much shorter leaf cells, leaves more abruptly acuminate and often serrulate above.

A. vacillans Sulliv. is a rare moss closely related to *riparium*, and differing chiefly in the subobtuse apex of the leaves having apical cells rather irregular and conspicuously shorter and broader than in *riparium*. The stem leaves are narrowly lanceolate, long-acuminate, reaching 2^{mm} in length in large plants; branch leaves oblong-lanceolate, less slenderly acuminate; costa extending above the middle, in the perichaetial leaves excurrent. N. H., Vt., N. J., Ontario. The specimens from Georgia and Florida that have been referred to this species, are, I believe, a different thing, for it is scarcely probable that a subalpine species of the New England mountains should be found in the lowlands of the southern states.

FIGURE 177. *Amblystegium vacillans*. (From Sulliv. "Icones.")

SCIAROMIUM Mitt.

Distinguished from *Hygroamblystegium* chiefly by the strongly bordered leaves and entire lack of paraphyllia. In habitat and gross appearance it is the same, also in the cellular structure of the leaves.

S. Lescùrii (Sulliv.) Broth. is our only species. It is a blackish green moss growing on stones in brooks and is common especially in elevated regions in the eastern United States. It often grows associated with *Amblystegium orthocladon* and its leaves are about the same size and shape, so that it can be readily distinguished by a microscopical examination only. The border to the leaves, while plain, is not conspicuous and may be overlooked easily in some cases. Sullivant's figure will supply all needed details of structure. Spores mature in spring.

FIGURE 178. *Sciaromium Lescurii*, leaf and leaf cells. (From Sulliv. "Icones.")

SUBFAMILY 6. HYPNEÆ

Central strand lacking or thin and few-celled; leaves often strongly falcate-secund, without costa or with costa short and double (except *Hygrohypnum sp.*); leaf cells linear-flexuose in most species (rhomboidal to linear-rhomboidal in *Amblystegiella);* capsules oblong to cylindric, typically inclined to horizontal, and unsymmetric to strongly curved, but nearly erect and symmetric in some few species; peristome perfect except in some of the species with erect capsules. This subfamily differs from the last in the slightly developed costa and longer leaf cells. *Hygrohypnum* is a connecting link.

KEY TO THE GENERA

1.	Branching often regularly pinnate to plumose; leaves strongly falcate-secund; costa short and double or lacking; alar cells usually strongly differentiated	7.
	Branching irregular; leaves apparently in two rows, complanate costa as in Hypnum	*Plagiothecium* and *Hypnum pratense.*
	Leaves neither complanate nor strongly secund, or if strongly secund, with a strongly marked costa	2.
2.	Leaf cells short, 2–5:1	*Amblystegiella.*
	Leaf cells usually narrowly linear-flexuose	3.
3.	Costa usually pronounced; aquatic	*Hygrohypnum.*
	Costa faint or lacking	4.

4. Epidermal cells of capsule strongly collenchymatous; operculum beaked . . . . *Raphidostegium.*
   Epidermal cells of capsule not collenchymatous . . . . 5.
5. Alar cells little differentiated . . . . *Plagiothecium* species.
   Alar cells strongly differentiated, inflated . . . . 6.
6. Leaves spreading to squarrose as in *Campylium:* capsules striate. *Plagiothecium striatellum.*
   Leaves imbricated; capsules not striate, long-cylindric . . . *Hypnum Haldanianum.*
7. Aquatic; plants very large and tumid; leaves usually obtuse or apiculate . . . . *Scorpidium.*
   Often growing on wet soil but not aquatic; smaller; leaves acuminate and acute . . . . *Hypnum.*

HYGROHÝPNUM Lindb.

Aquatic or subaquatic mosses growing on stones in and near the beds of brooks, especially in mountainous regions, often forming extensive mats, more or less filled in below with sand and gravel. Stems mostly creeping or prostrate, with ascending branches; central strand present, usually few-celled. Leaves in most species usually concave, more or less falcate-secund, comparatively *short and broad, soft in texture* and *often obtuse at apex*, rarely acutely acuminate, sometimes apiculate, mostly entire or slightly denticulate at apex; costa double, of varying length, or single and forking, sometimes reaching above the middle; *alar cells plainly differentiated, hyaline*, colored, or subopaque in the various species, often remaining on the stem when leaves are stripped off for examination. Capsules inclined and unsymmetric, rather short and thick; peristome perfect.

Nearest to *Drepanocladus*, from which it is distinguished by its habitat in running streams and its broader concave more obtuse leaves. *Scorpidium* is distinguished from this genus by its gigantic size and rugose leaves; *Calliergon* by its habitat and general appearance. Aquatic *Raphidostegia* are very close to some species of *Hygrohypnum* and Limpricht and Brotherus put *Hypnum Novæ-Caesareæ* Austin in this genus, but in general the alar cells of *Raphidostegium* are more strongly developed, the costa is shorter or wanting, and the operculum rostrate. Certain *Brachythecieæ*, such as *B. plumosum* or *Eurhynchium rusciforme* have a similar habitat and appearance, but are easily distinguished by the acute leaves, strong single costa and rough seta.

KEY

1. Alar cells large and conspicuous, clear, hyaline or colored, forming distinct decurrent auricles; outer layer of stem cells much enlarged. (See Fig. 161) . . . . 2.
   Alar cells thick-walled, less distinctly inflated, granulose to subopaque, often colored; outer layer of stem cells not enlarged . . . . 3.
2. Alar cells hyaline and thin-walled; costa usually reaching the middle of leaf; dioicous. *ochraceum.*
   Alar cells usually colored and thick-walled, except the outer row or two, which are usually thin-walled and often hyaline; costa double, short and faint; monoicous . *eugyrium.*

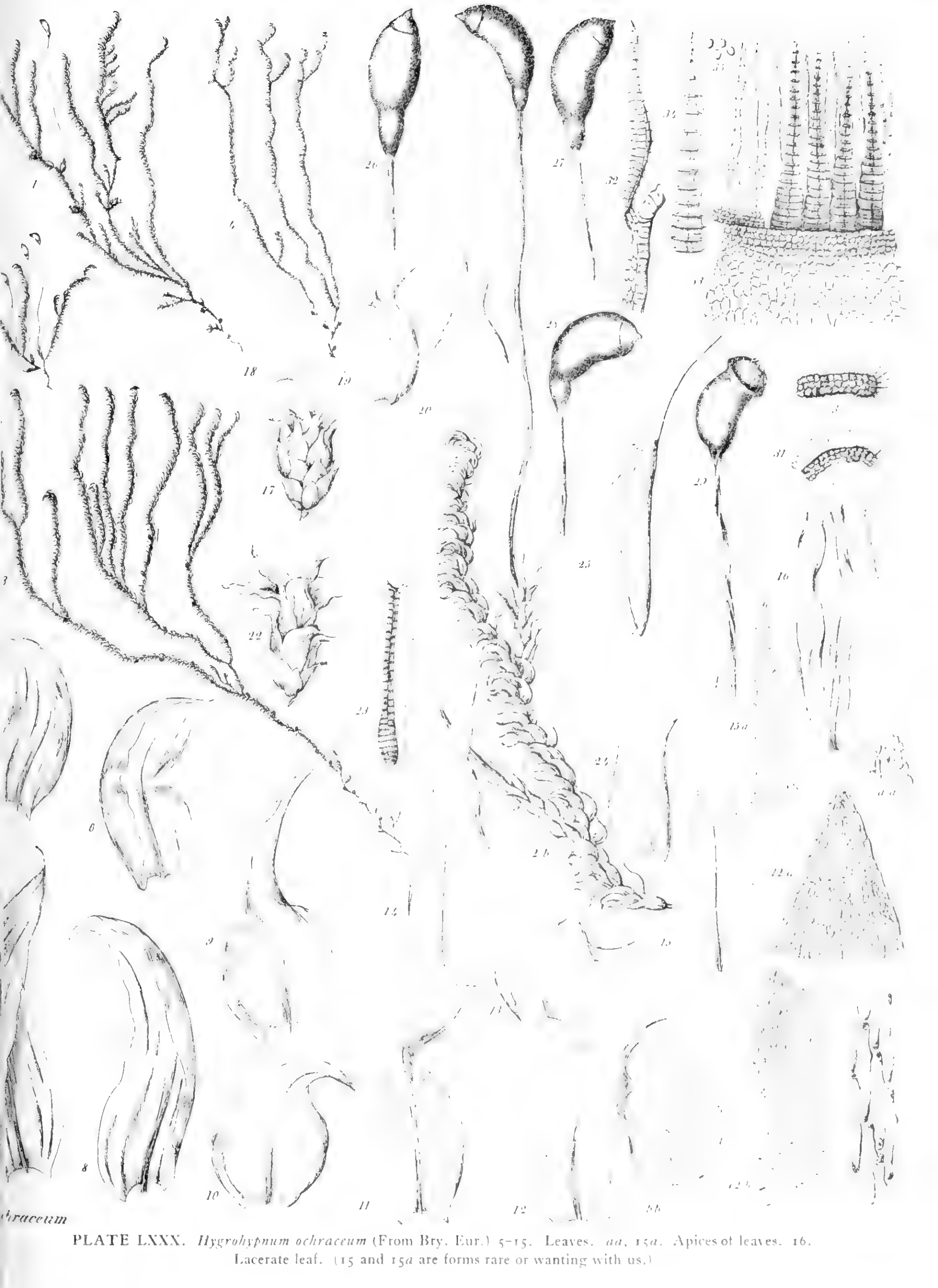


PLATE LXXX. *Hygrohypnum ochraceum* (From Bry. Eur.) 5–15. Leaves. *aa*, 15*a*. Apices of leaves. 16. Lacerate leaf. (15 and 15*a* are forms rare or wanting with us.)

3. Leaves serrulate all around . . . . *montanum.*
   Leaves entire or denticulate at apex only . . . . 4.
4. Leaves entire; costa single, often forking in *palustre* . . . . 5.
   Costa short and double; leaves denticulate at apex . . . . *dilatatum.*
5. Plants minute; stem leaves oblong-ovate, obtuse, flat . . . . *Closteri.*
   Plants larger; leaves concave . . . . *palustre.*

H. ochràceum (Turn.) Loeske. Plants large for the genus; stems usually 5–10^{cm} long, soft and flaccid, pale green with often a yellowish tinge; *outer layer of stem cells large and thin-walled;* leaves subsecund or more usually *strongly falcate-secund*, oblong-ovate to oblong-lanceolate, concave, *slightly plicate*, often split when old, narrowed to a longer or shorter *obtuse or subobtuse acumination*, entire except at

FIGURE 179. *Hygrohypnum eugyrium* (From Bry. Eur.). 6–8. Leaves of stem and principal branches. 9–14. Leaves of other portions of the plants.

the slightly denticulate apex, varying greatly in comparative length and breadth; costa variable, *usually single and reaching the middle or beyond*, sometimes bifid or even trifid and occasionally very short; median leaf cells linear-flexuose, 8–14:1, shorter at apex; basal cells broader and shorter; *decurrent alar cells suddenly enlarged, inflated and hyaline, thin-walled*, frequently a single row of 5 or 6 hyaline cells runs up the basal margin: dioicous; spores in spring or early summer. Our most common species and exceedingly variable, yet some of the leaves on a plant are almost sure to show the strong costa and obtuse denticulate apex, and all show the hyaline alar cells, which, in most specimens, are more abruptly enlarged to the decurrent auricles than is indicated in the figure. We have varietal forms in which the leaves are not at all falcate or secund or are complanate, but I consider them mainly habitat forms. Almost any mountain stream in northern or central North America will yield this species.

H. eugyrium (B. & S.) Loeske. Plants forming wide dense sand-filled mats on rocks in mountain streams; leaves more or less secund, loosely imbricated and *very concave*, giving the branches a turgid appearance, oblong-ovate, short-acuminate and usually acute, narrowed but not rounded at base, entire or slightly denticulate at apex; *costa double, short and faint;* median leaf cells linear, 8–10:1, shorter at apex; *alar cells suddenly enlarged and inflated, the inner thick-walled and usually colored, the outer thinner walled* and *often hyaline:* monoicous; spores in spring. Not rare, but apparently most of our plants are

Var. **Máckayi** (Schimp.) Broth., leaves less strongly falcate-secund, broadly oblong, less acuminate.

H. dilatàtum (Wils.) Loeske. Plants resembling in gross appearance small forms of *Eurhynchium rusciforme.* Easily distinguished from all our other mosses having a similar habitat by its *broadly oval to almost circular, short-acuminate to apiculate leaves*, slightly denticulate at apex, with costa short and double, rarely single and longer. The leaf cells are linear-flexuose, 10–15:1; alar cells enlarged, subquadrate to elongated

FIGURE 180. *Hygrohypnum dilatatum* (Figs. 1–5 from Bry. Eur. 4*b*, alar cells). In the other figures is represented a plant ×3, and leaves and capsule ×10.

hexagonal, frequently colored; spores in summer. Common in mountain brooks on stones. This is the *Hypnum molle* of the Bryologia Europea and many other authors. The true *Hypnum molle* Dicks. probably does not occur in our range although it is found in the western mountains. Its leaves are narrower proportionately, widely ovate, short-acuminate and obtuse; leaf cells 5–8:1.

H. palústre (Huds.) Loeske. Exceedingly variable, and very rare in our range, more frequent in the Rockies and westward, common in Europe. Slender to robust, dark to yellowish green, forming rather loose mats on stones in and near streams; branches, in some forms, hooked or curved at the ends; leaves sometimes closely imbricated all around the stems rendering them julaceous and shining, sometimes more or less falcate-secund, concave with margins incurved, especially toward the apex, ovate-oblong, variable toward apex, acuminate and obtuse or acute, or rounded and obtuse or apiculate, never with a long slender acumination, entire throughout, 1–1.5^{mm} long; costa usually single and forking, reaching the middle of leaf or beyond, but in some cases it may be short, faint and double; median leaf cells 5–10:1; quadrate alar cells few, plainly enlarged but comparatively rather small and opaque as a rule. Much of the material found in N. American herbaria consists of aberrant forms of *H. ochraceum*, distinguished at once by the outer layer of stem cells if other characters fail.

H. Clósteri (Aust.) (*Amblystegium Holzingeri* R. & C.). Plants very slender; stems denuded of leaves below; stem leaves oblong-ovate, *costate*, *scarcely acuminate*, *obtuse*, *not secund* or scarcely so; branch leaves of the *almost flagelliform branches* broadly ovate-obtuse, flat and often scarcely costate. It might be taken for a minute form of *molle* but for the strong costa of the stem leaves and *absolutely entire leaf margins*. Mountain brooks, probably throughout our range; rare.

H. montànum (Wils.) Broth. is an alpine or subalpine moss found in the mountains of New England and in Canada and Newfoundland. It is a small species growing in wide mats on wet rocks; central strand lacking; leaves falcate-secund to subsquarrose, broadly ovate-lanceolate, acuminate and acute, *serrulate nearly or quite to base*, margin reflexed below; costa short and double or lacking; leaf cells 6–10:1, shorter at base and apex. I find some leaf-like paraphyllia present, though other authors say nothing about them. I consider this one of the most distinct species of the genus, in spite of the fact that Sullivant stated that it is close to *palustre*.

SCORPÍDIUM (Schimp.) Limpr.

S. scorpioìdes (L.) Limpr. Aquatic, *very robust*, one of the largest of mosses, *reaching 3^{dm}* in length, divisions little branched or with short branches; forming large soft masses of a dark or brownish green, often reddish, sometimes nearly black; *branches and branchlets curved at ends*, *very turgid by reason of the* *very concave imbricated leaves;* leaves more or less *falcate-secund;* stem leaves $2-4 \times 1.4-2^{mm}$, *not plicate but rugose when dry*, broadly ovate-oblong, narrowed to the insertion, *not decurrent*, abruptly narrowed to an obtuse or apiculate apex, entire (occasionally acute or acuminate and slightly denticulate at apex); costa faint, short and double, or even lacking; median leaf cells narrowly linear-flexuose, 15:1, thick-walled, a few at the insertion shorter and wider, a few at extreme angles somewhat inflated and thinner-walled: dioicous: seta very long, $4-6^{cm}$; capsule *strongly curved from an erect neck, plicate* and contracted under the mouth when dry; peristome perfect; annulus very large; spores in late summer. Bogs throughout our range, but not common. Distinguished from *Calliergon* by its aquatic habitat, great size and dark color. *Drepanocladus Wilsoni* approaches it in size, but in *D. Wilsoni* the leaves are costate and slenderly acuminate.

HÝPNUM L.

Plants usually more or less regularly pinnately branched, often plumose in appearance. Leaves *falcate-secund* and in most species apparently arranged in two rows, giving the stems a *somewhat flattened appearance on one side* (usually the upper) *and a bristly appearance on the opposite side.* Leaves in most cases long-acuminate; costa short and double, or lacking entirely; leaf cells linear-flexuose, 4–20:1, shorter at base; alar cells more or less plainly differentiated, often enlarged, hyaline or colored. Paraphyllia present in all our species, few or found only in axils of branches in some cases. Central strand in stem usually present, but-few celled. Capsules subcylindric, more or less curved and cernuous; peristome perfect (excl. *H. tenuirostris*).

Most of the mosses of this genus have a very similar appearance, due to the leaf arrangement described above and the regularly pinnate and two-ranked branching. Exceptions are *Haldanianum* with its irregular branching; leaves equally spreading, not falcate. *H. patientiæ*, *H. pratense* and forms of *H. cupressiforme* are irregularly pinnate. The species grow on all sorts of habitats but many have a marked preference for decaying wood. *H. imponens* is one of our most common and typical species. Its capsule, however, is more nearly straight and erect than in most species.

KEY

1. Alar cells inflated, pellucid, hyaline or colored. (Forms of *cupressiforme* may be sought here) . . . . 2.
   Alar cells scarcely inflated, often small and quadrate, (*fertile*, and *curvifolium* may be sought here) . . . . 11.
2. Leaves not falcate or secund . . . . 3.
   Leaves secund, usually strongly falcate-secund . . . . 4.
3. Leaves ovate, short-acuminate; inflated alar cells numerous, forming distinct auricles . . . . *Haldanianum*

Leaves ovate-lanceolate, long and slenderly acuminate, not auricled; differentiated alar cells few, not much enlarged . . . . *pratense.*

4. Leaves entire or serralate above only . . . . 5.
Leaves strongly serrate above; inflated alar cells very conspicuous . . . . 9.

5. Inflated alar cells numerous and conspicuous; capsules plicate when dry . . . *Patientiæ.*
Inflated alar cells rather few . . . . 6.

6. Not regularly pinnate; habit of *Plagiothecium* . . . . *pratense.*
Regularly pinnate . . . . 7.

7. Stems reddish; capsules cylindric, little curved and suberect . . . . *imponens.*
Stems not noticeably reddish; capsules curved and inclined . . . . 8.

8. Plants small, yellowish; capsules not plicate . . . . *fertile.*
Plants larger, dark green; capsules plicate when dry . . . . *curvifolium.*

9. Leaves in two rows, appearing more or less complanate; capsules curved and inclined; cilia of peristome one or two . . . . 10.
Leaves not appearing complanate; capsules erect and symmetric or nearly so; cilia none or rudimentary . . . . *tenuirostris.*

10. Plants larger, bright glossy yellow-green; urn of capsule twice the length of operculum . . . . *recurvans.*
Plants smaller, usually darker green, growing at high altitudes; urn about the length of operculum . . . . *delicatulum.*

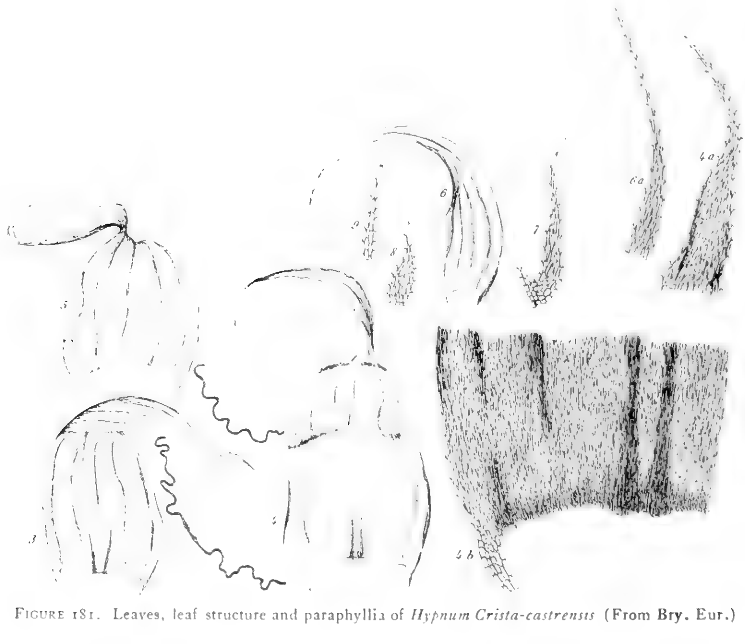


FIGURE 181. Leaves, leaf structure and paraphyllia of *Hypnum Crista-castrensis* (From Bry. Eur.)

11. Plants very large and beautifully plumosely branched; leaves plicate . . . . . *Crista-castrensis.*
Plants smaller, less plumose; leaves not plicate . . . . 12.
12. Stems reddish; quadrate alar cells not very numerous . . . . *imponens.*
Stems not noticeably reddish; quadrate alar cells numerous . . . . 13.
13. Leaves cordate at base . . . . *molluscum.*
Leaves not cordate at base . . . . 14.
14. Leaves entire or serrulate above . . . . *cupressiforme.*
Leaves serrate above, serrulate nearly or quite to base . . . . 15.
15. Capsules 2.5–3^{mm} long, curved and somewhat contracted below the mouth when dry . . . . *reptile.*
Capsules 1–1.5^{mm} long, symmetric and not contracted below the mouth; plants of high altitudes only . . . . *pallescens.*

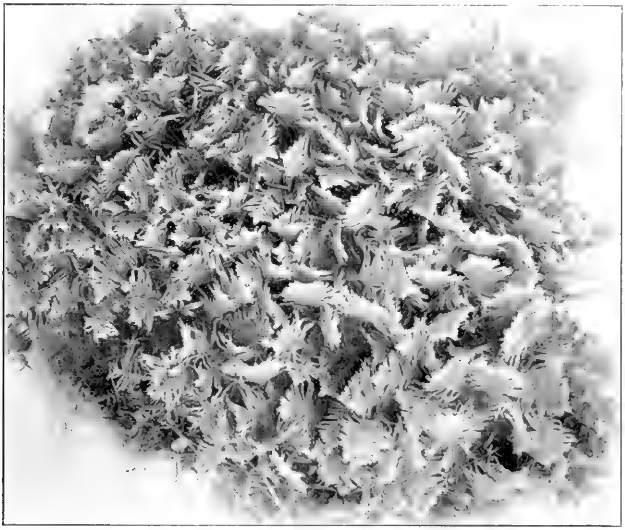


FIGURE 182. *Hypnum Crista-castrensis* (slightly reduced)

SUBGENUS PTILIUM

H. Crista-castrénsis L. Plants robust, rigid and *plume-like; bright yellow-green above*, darker and brownish below; recognizable at once by the strikingly regular and plumose branching, *the branches about equal in length, except at the triangular end of frond; paraphyllia numerous; leaves plicate;* stem leaves crowded, thin, shaped as figured, 2.5–2.7^{mm} long, entire at base, *sharply serrulate above;* median leaf cells linear-vermicular, 10.20:1; basal shorter; alar broader and clear, well represented in the figure; branch leaves smaller, narrower, 1.8×0.4^{mm}: dioicous; capsules large, horizontal, curved; spores in late summer or autumn. Common in mountainous regions on earth, rotten wood, etc., but reaches its full development in deep mountain woods.

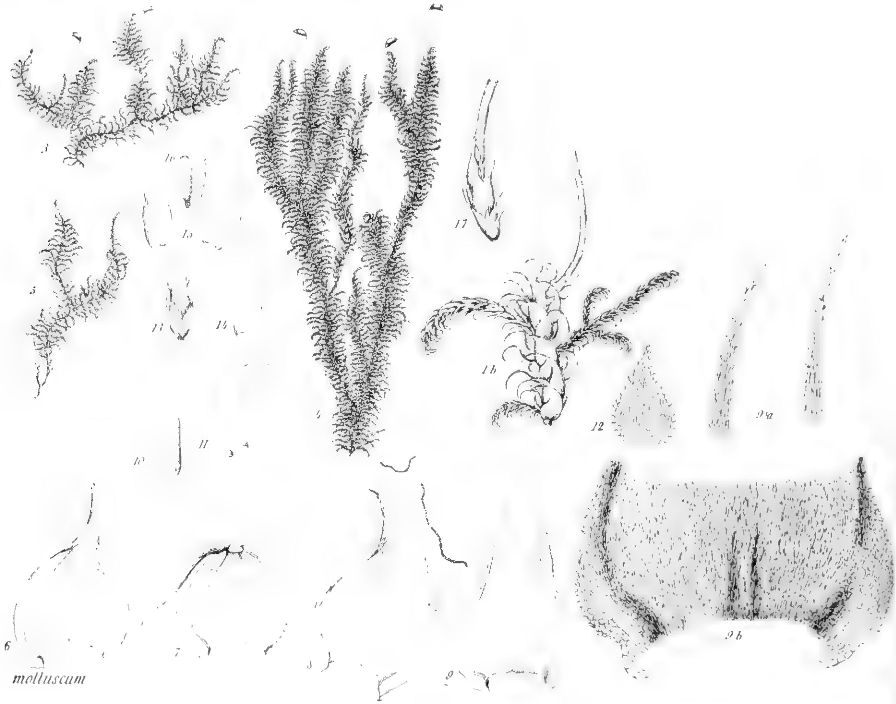


FIGURE 183. *Hypnum molluscum.* (From Bry. Eur.)

SUBGENUS CTENIDIUM

H. mollúscum Hedw. Plants typically bright golden green, closely and regularly pinnate, plumose, but smaller and less perfectly plumose than the last, especially in imperfectly developed forms; stems reaching 10^{cm} in length, prostrate or suberect in dense tufts, growing *on earth* or sometimes on stones, especially in regions where lime is present in the soil or water; leaves *falcate-secund to circinate;* stem leaves $1{:}8$-2.5^{mm} long, *cordate-triangular and auriculate at base*, slenderly long-acuminate, *often somewhat plicate*, and crisped and undulate near apex when dry, giving the plants a soft feathery appearance; margins plane *and strongly serrate, especially at base*, decurrent; costa short and double or lacking; leaf cells 8–15:1, *the projecting corners making the leaf somewhat rough as in Bryhnia;* basal cells broader; alar cells irregularly *quadrate-hexagonal, not much enlarged*, hyaline or colored, chlorophyllose in young leaves; branch leaves much smaller and narrower; paraphyllia few, at base of branches: dioicous; capsule short, horizontal, curved; operculum long and narrowly acute; spores in summer, infrequent. The L. & J. Manual says, "Mostly in mountain regions," but I find it rare in the mountains of New England and common in the vicinity of New York City. Probably common throughout the southern part of our range. Hardly any of our American material is identical with the common European *molluscum*. It is much less closely pinnate, branches not hooked at the end, with leaves more distant and less falcate. It is often a dark olive-green and is probably near var. *fastigiatum* Bosw.

SUBGENUS STEREODON

H. impònens Hedw. Forming rather thin but densely interwoven mats of a darker green than in *molluscum;* stems *reddish-brown*, prostrate, rather regularly pinnately branching, but rarely completely pinnate to the end; *paraphyllia numerous, broad, often ciliate;* stem leaves scarcely decurrent, broadly ovate at base and gradually lanceolate-acuminate above, 2 x 0.6mm, *serrulate below, serrate above*, with margins usually *narrowly recurved below;* costa short and double or lacking; median leaf cells linear-vermicular, reaching 10:1, broader at base and colored, often a bright brownish orange; alar cells subquadrate, a few at the extreme angles slightly inflated, clear but colored, all forming *small but distinct* auricles of a rich orange-brown: dioicous; perichætial leaves *plicate;* capsules cylindric, *nearly erect*, slightly curved; spores in

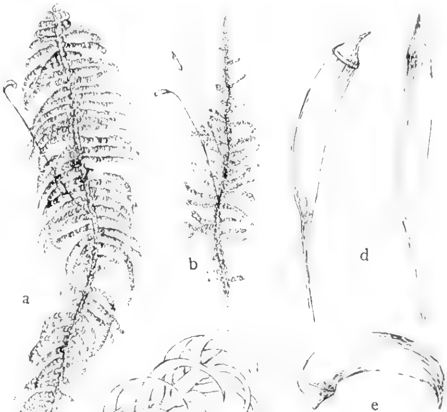


FIGURE 184. *a. Hypnum Crista-castrensis* × 1. *c.* Branch × 10. *e.* Capsules × 10. *b. H. imponens* × 1. *d.* Capsules of same × 10.

autumn or early winter. One of our commonest Hypnums, growing almost exclusively on rotten wood with us, abundant from Canada to Florida in moist shady places. Often confused with the next, with forms of which it appears to

FIGURE 185. *Hypnum imponens.* Leaf, leaf structure and paraphyllia (From Bry. Eur.). See also Figs. 184 and 186.

intergrade, but the area of auricular cells is much smaller in this species and the extreme alar cells more inflated, this taken with the italicised characters makes ordinary forms easy to distinguish.

H. cupressifórme L. Closely related to the last but typically easily distinguished; very variable, especially in size, and in some varieties likely to be confused. *Paraphyllia fewer and narrower;* stems *greenish*, less regularly *pinnate*, less rigid and stouter in appearance; stem leaves *entire, or serrulate above only*, narrower, slightly decurrent, plane at margins or nearly so, area of subquadrate alar *cells much larger, granular and as a rule not* distinct as figured unless cleared, little inflated at extreme angles, *but a few cells are larger and clearer*, leaf bases usually not colored except at the angles: dioicous; perichætial leaves *not plicate;* spores in late autumn or early winter. Growing on stones, bases of trees, earth, etc. Common in Europe, but local with us. It seems not rare along the coast from Massachusetts to New York. It or its varieties occur from Newfoundland to Minnesota and southwards to the limit of our range at least. It is rarely sent for determination and the specimens are mostly depauperate and sterile. Hardly any two specimens are alike, there being great differences in size and differences in regularity of branching and in color, and in length, curvature and acumination of the leaves. We have

Var. **filiforme** Brid. with very long slender parallel branches forming thin smooth patches and having very small leaves, "very regularly and neatly imbricated in two rows, falcate-secund or hamate, usually denticulate." Some of the material referred to this variety is

Var. **resupinatum** (Wils.) Schimp. Branches filiform, erect or ascending; leaves straight or only slightly curved, narrow, oblong-lanceolate; alar cells sometimes large: capsule erect and symmetric or nearly so; operculum rostrate.

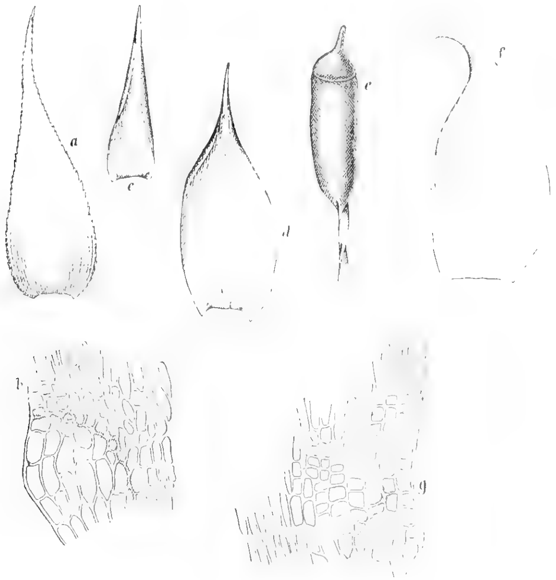


FIGURE 186. *Hypnum cupressiforme* (after Limpricht). *a*. Stem leaf × 22 and *b*, alar cells × 150 of var. *ericetorum*. The alar cells are typical of *H. imponens*. *d*. Stem leaves × 22 of var. *subjulaceum*. *f*. Stem leaf × 22, *g*, alar cells × 150, and *e*, capsule × 15, of var. *elatum*. These alar cells are typical of the species.

Var. **ericetorum** B. & S. Approaching very closely to *H. imponens* in general appearance and structure of alar cells. Of this I have seen no American forms that were typical of the variety but only those approaching it.

Var. **ubjulaceum** Molendo. A form usually growing on cold barren substrata. Stems and branches subjulaceous, leaves closely imbricated, broadly ovate, abruptly narrowed to a slender acumination, less curved than in the species.

H. molluscum and *H. reptile* are the only two of our Hypnums that have an equal area of subquadrate alar cells; the cordate leaf base of the former and the small size and sharp serration of the leaves of the latter will prevent confusion. *H. curvifolium* often appears much like forms of *cupressiforme*, but its few subquadrate alar cells and its subcordate leaf base are good distinctions. Forms of the species resemble *Amblystegiella adnata*. For distinctions see that species.

H. curvifòlium Hedw. Resembles *H. imponens* in general appearance, but is rather larger and *more widely complanate-secund*. Branching typically regularly pinnate but often irregularly pinnate, branches unequal; leaves *very regularly and evenly falcate-secund in two rows, giving a characteristic plaited appearance to the plants;* stem leaves entire or serrulate above, concave with plane margins, *oblong-ovate to elongated triangular-ovate*, long-acuminate with acumen channeled, not so abruptly

FIGURE 187. *Hypnum curvifolium*. 6, 7, and 8 from Sulliv. "Icones." In the others, plant × 2, tips of branches × 4, and capsules × 4.

narrowed as in the two preceding species; base abruptly narrowed to the insertion, *subcordate* and *slightly decurrent, the decurrent cells enlarged, thin-walled and hyaline; a few alar cells subquadrate*, the median linear-vermicular, very narrow, basal more or less colored; costa entirely lacking or short and double: dioicous; perichætial leaves *plicate;* capsules *strongly plicate* when dry and empty; spores in spring. Growing in large mats on various substrata around brooks in cool wet places. Common in elevated regions. There is a great variation in robustness and in width and serration of leaves, but in fruit the plicate capsules furnish a character that will at once distinguish it from all closely related species except the next. When sterile the basal angles of the leaves are not likely to be confused with any other species.

H. Patiéntiae Lindb. Often confused with *H. curvifolium* but usually larger, *more yellowish-green, more erect and irregularly branched.* Stem leaves strongly falcate-secund and not so strongly complanate and lacking the plaited appearance, entire except at extreme apex, $2-2\frac{1}{2}^{mm}$ long, narrowed at insertion *but not cordate*, with very conspicuous *decurrent auricles composed of inflated hyaline thin-walled cells:* dioicous; perichætial leaves plicate; capsules *plicate* as in *curvifolium*, sparingly produced; spores in spring. Common on the ground in swamps and wet places. Referred to in the L. & J. Manual in the note under *curvifolium*. This species is almost as variable as *cupressiforme*, varying from pale lax prostrate forms with the habit of *pratense*, to robust, suberect, little branched forms with the appearance of a *Drepanocladus*. Commonly yellowish green and often very light colored, but I have collected specimens growing in water that were almost black. The leaves may be broad and short with almost the outline of a *Hygrohypnum*, almost symmetric and nearly flat, or in other forms much narrower, concave, long-acuminate and somewhat plicate. The basal angles may be almost as rounded as in *curvifolium* or may have the outline of *pratense*. But in all these forms are found the large hyaline inflated alar cells and plicate capsules. Sterile forms approach *pratense* so closely in some cases as to render determination uncertain, but these forms are infrequent.

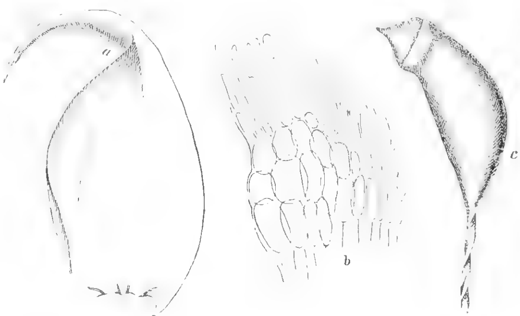


FIGURE 188 *Hypnum Patientiae* (after Limpricht)

Var. **elatum** Schimp. is the extreme of the erect robust plant with the *Drepanocladus* habit and narrow slenderly acuminate leaves.

Var. **demissum** Schimp. is the lax yellowish creeping form with the habit of *pratense*.

H. praténse Koch. Bright green, complanate-flattened with a *Neckera* or *Plagiothecium* habit; leaves slightly concave, often nearly flat, frequently serrulate at apex, less falcate and less secund than in *Patientiæ;* enlarged alar cells few, less inflated and less distinctly marked off, more often colored: dioicous; perichætial leaves plicate; capsules not plicate, rarely produced; spores in spring. A moss of swamps, not abundant but apparently widely spread.

H. fértile Sendt. Resembles small forms of *H. imponens*, but is of a *lighter, more yellowish green. Plants regularly and evenly pinnate;* stem leaves not plicate or decurrent but *subclasping* at base, strongly secund, *falcate to subcircinate*, 2×0.5^{mm}, oblong-lanceolate, *very long- and narrowly acuminate*, narrowed at insertion; margins slightly reflexed near the base, serrulate at apex, costa short and double or lacking; median leaf cells linear-flexuose, reaching 15:1; *differentiated alar cells very few, those at the extreme angles just below where the narrowing begins are thin-walled, inflated and hyaline*, about as many cells immediately bordering these are small subquadrate and subopaque: monoicous; perichætial leaves plicate; capsules curved and somewhat contracted under the mouth when dry; spores in early summer. On decaying wood in cool, elevated wooded regions, not common. A beautiful little species about the size of *H. reptile* from which it is easily distinguished by its color and its alar cells. From *imponens* it is distinguished by these and by its more curved capsules. Its alar cells are more like those of *curvifolium* than any other species, but the two are not likely to be confused because of the difference in size and the much broader leaves of *curvifolium*.

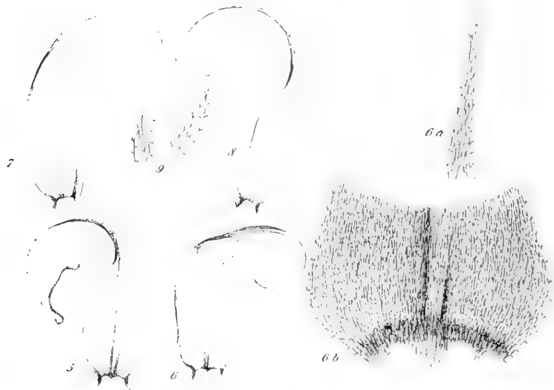


FIGURE 189. *Hypnum fertile* (From Bry. Eur.). Alar cells not well figured

H. réptile Mx. Plants small, dark green, more or less regularly pinnate but so *closely interwoven that the pinnate branching is not as conspicuous as in the preceding species*, approaching *Amblystegiella adnata* in appearance as the branches appear *almost julaceous* from the upper side, but the bristly points of the falcate-secund leaves are easily seen on the under side in most cases; stem leaves long and slenderly lanceolate-acuminate from an ovate base, slightly and narrowly decurrent, about 1x0.5^{mm}; *margins revolute and serrulate below*, strongly serrate above; median cells linear-rhomboidal to linear-flexuose, 6–10:1, quadrate alar cells *very numerous and subopaque* much as in *cupressiforme*, *not hyaline or inflated*, all basal cells shorter and more or less colored: monoicous; perichætial leaves plicate; capsules about *2.5^{mm} long*, *subcylindric* and somewhat inclined, shrinking most at the under side of the mouth so that the *operculum points almost at right angles to the lower portion of the capsule; spores in midsummer.* Common on the bases of trees, stones and decaying wood in shaded places in elevated regions, less frequent at low levels. At about 2,500 feet its place is more or less taken by the next. The abundant midsummer fruiting of this species makes it easy to recognize, although the leaves vary a good deal in width and slenderness of acumen. There are forms which intergrade with the next but they are not abundant. Depauperate lowland forms are confused with *Amblystegiella adnata*, but *H. reptile* has much more slenderly acuminate leaves, always serrate, and a plainly beaked operculum.

H. pallescens (Hedw.) B. & S. is an alpine development of the preceding. It grows on the bark of trees at high altitudes, and is less regularly pinnate; leaves *more slenderly acuminate*, less serrate with a *smaller area of quadrate alar cells* and *capsules about ½ the* length of those of *reptile*, *nearly symmetric and erect, not shrinking under the mouth when dry;* spores in late summer. This can usually be distinguished at sight by the thinner mats of a more silky appearance, due to the slender, less closely imbricated leaves, by the branches often curved at the ends and by the short symmetric capsules. According to Mrs. Britton, *Hypnum Jamesii* (Sulliv.) L. & J. is a synonym of this species.

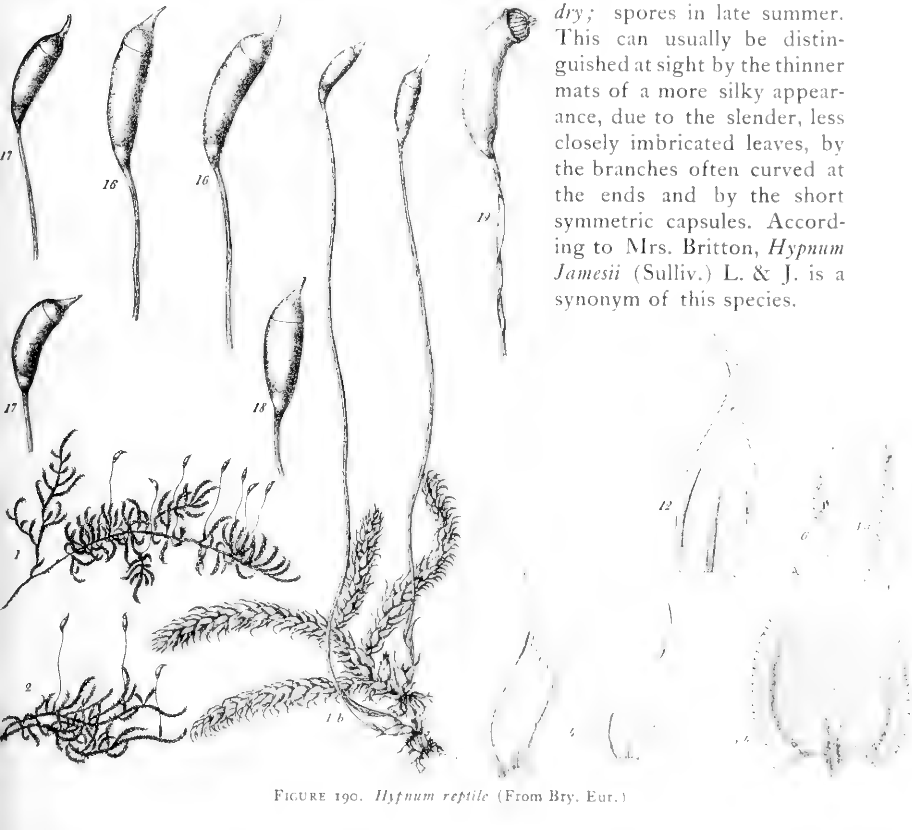


FIGURE 190. *Hypnum reptile* (From Bry. Eur.)

SUBGENUS HETEROPHYLLIUM

H. Haldaniànum Grev. Plants in loose wide mats usually dark or brownish green with the habit of *Brachythecium oxycladon*, irregularly branching; leaves not falcate or secund, loosely and nearly evenly imbricate; paraphyllia large and numerous; stem leaves *not decurrent*, *broadly ovate-lanceolate to oblong-ovate*, rather rapidly narrowed to a *short but slender acumen*, very concave; margins *plane and entire;* median cells linear-flexuose, 12-18:1; *area of enlarged and inflated alar cells large and forming distinct auricles bordered above by a line of smaller sub-opaque* quadrate cells: monoicous; capsules *long cylindric*, with lid 2.5–3^{mm} long, *suberect or inclined*, somewhat curved; lid short-beaked; spores in late fall and winter. Common on decayed wood in cool shaded places, more abundant in elevated regions. Its straight leaves make it look more like a *Brachythecium* than any of the other species, but otherwise it seems clearly to belong here.

FIGURE 191. *Hypnum Haldanianum* (Leaves and leaf structure from Bry. Eur.)

SUBGENUS PSEUDO-RAPHIDOSTEGIUM

H. recurvans (Mx.) Schwaegr. Plants *yellowish green*, *very glossy*, rather irregularly branched; leaves strongly falcate-secund except in slender or depauperate forms; stem leaves ovate-lanceolate, slenderly long-acuminate, not decurrent, somewhat concave; margins usually somewhat reflexed below, *very sharply serrate above;* costa lacking or short and double; median cells linear-flexuose, basal broader and shorter and usually somewhat colored; *at the extreme angles are four to eight very much enlarged and inflated hyaline or colored cells,* three or four above these along the margin smaller and subquadrate: dioicous; perichætial leaves strongly spinose-dentate above, not plicate; capsule oblong-ovoid, curved and oblique, *lid long-beaked,* about ½ *length of urn; annulus present;* spores in November and December. Common on decayed wood and soil at base of trees in moist shaded places; more abundant in elevated regions, varying a great deal in general habit and robustness.

FIGURE 192. *Hypnum recurvans.* For markings on teeth see Plate 81.)

This species and the two following have usually been put in *Rapidostegium* but Brotherus places them with the preceding species and I am inclined to agree with him. The strongly beaked opercula, inflated alar cells and spinose-serrate leaves distinguish these three from all the rest of this genus.

H. laxepatulum L. & J. (*H. delicatulum* (James) in key). At high elevations *recurvans* grades into this species, a smaller, darker, less glossy moss, growing in thinner mats, having the leaves less constantly falcate-secund, seta shorter, operculum as long as the shorter urn, annulus lacking.

Mrs. Britton states that cilia are present as in *recurvans* even in the type specimen. Intermediate and puzzling forms are not rare. The markings of peristome teeth and the structure of alar cells is practically the same in both species.

H. tenuiróstris (B. & S.) (*H. cylindricarpum.* L & J. Manual) is a rather rare moss of cool or elevated regions extending north to Connecticut, central New York and northern Pennsylvania; more abundant southwards, often confused with *laxepatulum* when sterile, but the leaves, though falcate-secund and serrate in much the same way, are not at all complanate as in the preceding two species and are more narrowly lanceolate; the margins are strongly reflexed to base of acumen, and above the inflated alar cells are several small subopaque cells which are *quadrate, usually some transversely elongated* as in *Amblystegium serpens.* Leaves of *laxapatulum* and *tenuirostris* can be found that are very much alike, but a great majority of the leaves of the latter have a conspicuously large number of these subopaque cells, some of which are broader than long. The stems are also very brittle and it is difficult to get leaves off so as to show the alar cells satisfactorily. In fruit there can be no confusion for the capsules are erect and symmetric; annulus lacking and cilia of peristome rudimentary or lacking.

PLATE LXXXI. *Hypnum laxepatuium* (From Sulliv. "Icones."

RAPHIDOSTÈGIUM (B. & S.) De Not.

Mostly slender mosses with irregular branching; paraphyllia lacking; leaves symmetric and equally spreading or somewhat secund, narrowed to the insertion, *not decurrent*, concave, not plicate; *margins entire or nearly so (except in Novæ-Cæsareæ)*, strongly reflexed in most cases; costa lacking or short and double; leaf cells linear-flexuose, shorter and broader at base; *at basal angles 3–8 large inflated pellucid, hyaline or colored cells*, very conspicuous: capsules small, oblong-ovoid, more or less unsymmetric and inclined (excl. *R. adnatum*); lid beaked, peristome usually perfect. Cell walls of outer layer of capsule strongly collenchymatous (i.e. strongly nodulose at points of intersection), in all our species except *Novæ-Cæsareæ*. This genus differs from *Hypnum*, subgenus *Pseudo-Raphidostegium*, in the lack of paraphyllia, less falcate and scarcely secund or serrate leaves, and in the characteristic cell walls of the capsules. All southern, reaching our range as a northern limit. The leaves described in this genus are from the middle of the branches.

KEY

1.	Plants growing on trees, of *Pylaisia* habit; capsules erect and symmetric or nearly so	*adnatum*.
	Plants growing on rocks and stones, capsules inclined to horizontal	2.
2.	Leaves suborbicular, serrate	*Novæ-Cæsareæ*.
	Leaves oblong-ovate to oblong-lanceolate; entire or slightly serrulate	3.
3.	Plants large; leaves 2–2.5^{mm} long	*Marylandicum*.
	Plants smaller; leaves 1.5^{mm} long or less	*Carolinianum*.

R. adnàtum (Mx.) B. & S. (*Hypnum microcarpum* L. & J. Manual). Plants in rather small thin mats, green to golden green; stems prostrate; branches rather short, suberect, *often curved at ends;* leaves rather closely imbricate when dry, *narrowly oblong-lanceolate, short-acuminate;* margins broadly reflexed, entire or nearly so; median cells linear-fusiform, somewhat flexuose; just above the inflated alar cells is a group of quadrate to subrectangular cells, little or not at all inflated: monoicous; capsules small, oblong-ovoid, erect and symmetric or nearly so; annulus lacking; peristome teeth with a much heavier median line than in most cases; cilia single and short; spores summer to autumn. Common in the South and extending northward to northern Pennsylvania, New Jersey and Rhode Island. Distinguished by its habitat on the bark of living trees and its *Pylaisia* habit and erect capsules.

I can find no plants of this genus growing on trees and having curved strongly inclined capsules, neither can I find plants growing on stones that have erect and symmetric capsules. I am convinced that the form with inclined and unsymmetric capsules described by Sullivant as var. *anisocarpon* (*H. admixtum*

PLATE LXXXII. *Raphidostegium adnatum* (From Sulliv. "Icones"). The inflated alar cells are not correctly represented and the fine lines on the peristome should be transverse instead of longitudinal.

Sulliv.) belongs rather to *R. Carolinianum*, from which I can see little to separate it except characters due wholly or in part to its habitat on stones in woods instead of wet rocks in or near streams. Our plant certainly is not the same as Wright's from Cuba, specimens of which I have had the privilege of seeing through the courtesy of Mrs. Britton. The leaf cells in Wright's plant are narrower and the capsule walls are not collenchymatous.

R. Carolinianum (C. M.) J. & S. Larger than the last, darker green, dirty green below, growing on wet rocks; branches less erect, often little or not at all curved; *leaves broader, acute rather than acuminate*, more often serrulate at apex, less secund and with margin more broadly reflexed all the way around; capsules *curved* and *inclined, constricted under the mouth when dry;* cilia one or two: spores in summer. Common in the southern states, extending north to Canada but apparently rare north of New Jersey. This species is very close to the European *R. demissum* (Wils.) De Not., but Mrs. Britton thinks the two are distinct, as she has been unable to find on American plants the stomata with four guard cells which, according to Limpricht, are characteristic of *demissum*. She also records other slight differences.

Var. **admixtum** (Sulliv.) also grows on stones but in drier situations, usually in moist woods. The plants are usually lighter green, with branches shorter and more erect and more curved at the ends when dry; leaves more closely imbricated when dry, smaller and usually narrower. In dry situations the plants resemble *adnatum* in appearance but always have cernuous curved capsules, at the other extreme it grades imperceptibly into *Carolinianum*. Massachusetts to Florida, apparently more abundant near the coast.

R. Marylándicum (C. M.) J. & S. *Much larger than the preceding*, dark green, growing on wet rocks in cool shaded places, especially mountain ravines, somewhat resembling *Brachythecium plumosum* in appearance and habit, but rather more prostrate; stems reaching 1^{dm} in length, but usually shorter; leaves often somewhat secund, especially at ends of stem and branches; *leaves oblong-ovate*, acute to short-acuminate, *about* 2.5×1^{mm}, very concave, *margins less reflexed* and leaf cells *more narrowly linear and longer* than in the preceding; basal shorter and strongly colored; *inflated alar cells very large;* capsules scarcely larger than in the last, very small for the size of the gametophyte; strongly contracted under the mouth when dry. Common in the mountains from Virginia southward, extending north to the White Mountains. Easily confused with *Hygrohypnum eugyrium* when sterile.

R. Nòvæ-Cæsarèæ (Aust.) R. & C. Plants small, yellowish green; stems prostrate, slender, little branched; leaves often somewhat secund, suborbicular, acuminate, serrate at apex; very concave, margins somewhat reflexed below; median cells linear-flexuose; alar inflated; but less strongly so than in our other species; dioicous; capsules collected but once, horizontal; operculum beaked;

FIGURE 193. *Raphidostegium Novæ-Cæsareæ.* (From Sulliv. "Icones.")

capsule walls not collenchymatous. On wet rocks in cool ravines. Pennsylvania and New Jersey and southward in the mountains; rare and not abundant in regions where it occurs.

PLAGIOTHÈCIUM B. & S.

Mostly loosely tufted glossy mosses, growing on moist stones and earth, roots of trees and decaying wood, irregularly branching; stems and branches appearing flattened by reason of the complanate leaves (except in *Roeseanum*, *pulchellum*, and *striatellum*). The twisting to the sides makes some of the leaves unsymmetrical, (except in the species named above) but otherwise they are symmetrical. Stems and branches often ending in flagella or stolons; paraphyllia lacking. Stem and branch leaves usually much alike, ovate to ovate-lanceolate or oblong-lanceolate, little concave, margins usually plane; differentiated alar cells few (except in *striatellum* and *latebricolor*); median cells long, linear-flexuose to linear-rhomboidal; costa lacking, or short and double, or forking. Capsules oblong-ovoid to cylindric, usually inclined and more or less unsymmetric (except *latebricolor* and *lætum*).

P. striatellum, because of squarrose leaves and inflated alar cells, is likely to be sought under *Campylium*. *Hypnum pratense* forms are apt to be sought under *Plagiothecium* because of the complanate leaves. The two subgenera are, by many authors, treated as separate genera, and there are good reasons for so doing, but in a work of this kind conservatism is believed to be most helpful.

KEY

Mostly very slender plants, light yellowish green to whitish, glossy; leaves little or not at all decurrent; median leaf cells narrowly linear, alar little or not at all differentiated; capsules not plicate (except in *turfaceum*) . . . . . . *Isopterygium.*

Usually larger, darker green; leaves decurrent; leaf cells wider; alar clearly differentiated; capsules often plicate . . . . *Euplagiothecium.*

ISOPTERYGIUM MITT.

1. Leaves complanate . . . . 2.
   Leaves not complanate, entire . . . . *pulchellum.*
2. Leaves entire, scarcely a trace of serration on any leaf; cortical cells of stem very large; plants of cold ravines, growing mostly in moist crevices of ledges. *Muellerianum.*
   Leaves (some or all) more or less serrate . . . . 3.

3. Leaves strongly serrate in the upper half . . . . 4.
Leaves serrulate at or near apex only . . . . 7.
4. Plants very slender, usually growing on decayed wood or humus, sometimes on soil. 6.
Plants largest of the subgenus, resembling *Euplagiothecium*, growing on earth and stones . . . . 5.
5. Plants dark green; leaves distant, apex usually bluntish as in *Eurhynchium hians*. *geophilum*.
Plants lighter green, usually yellowish and glossy; leaves closer, not blunt . . . *deplanatum*.
6. Leaves short-acuminate; capsule not striate; operculum rostrate . . . . . . *Groutii*.
Leaves long and slenderly acuminate; capsules somewhat striate when dry and empty; operculum conic . . . . *turfaceum*.
7. Plants light yellowish green; costa very faint or none; growing chiefly in the lowlands from Long Island southwards . . . . *micans*.
Plants not yellowish, often dark green; costa evident, often reaching the middle of the leaf; growing in cool ravines and on mountains . . . . *elegans*.

EUPLAGIOTHECIUM

1. Leaves not complanate, squarrose-spreading; capsule strongly striate . . . . . *striatellum*.
Leaves complanate (excl. *Roeseanum*) . . . . 2.
2. Plants very slender, with habit and appearance of *Isopterygium*; capsules erect and symmetric; peristomes without cilia . . . . *latebricolor*.
Plants more robust, with the habit of *P. denticulatum* . . . . 3.
3. Leaves slenderly acuminate; capsules erect and symmetric; peristomes without cilia. *lætum*.
Leaves acute to somewhat acuminate; capsules more or less inclined and unsymmetric; peristome perfect . 4.
4. Not complanate or only slightly so . . . . *Roeseanum*.
Conspicuously complanate . . . . 5.
5. Plants dingy or yellowish green; leaves shrunken when dry; dioicous; operculum rostrate . . . . . . *sylvaticum*.
Plants bright green; monoicous; operculum conic . . . . 6.
6. Edges of leaves strongly incurved and clasping the base of the leaf above, Fissidens-fashion. Plants of swamps . . . . . . *Ruthei*.
Leaves not as above or to only a slight degree; plants of all regions. *denticulatum*.

FIGURE 194. *Plagiothecium Muellerianum* (From Sulliv. "Icones"). 7 and 8. Stem sections

P. Muellerianum Schimp. In crevices of moist ledges in cool ravines or on shaded mountain sides will be found flattened strands of this yellow-green moss; these often taper into flagella or stolons; tufts seldom of any considerable size; leaves ovate-lanceolate, nondecurrent, concave, *entire*, plane-margined and *rather abruptly apiculate-acuminate;* leaf cells very long and narrow, 20:1, *alar cells not differentiated; cortical cells of stem very large and thin-walled, 3–4 times as wide as basal leaf cells*, easily seen without sectioning: dioicous; capsules rare; spores in autumn. Widely spread in mountain regions but apparently local. Easy to recognize even in the field.

FIGURE 195. *Plagiothecium elegans* (From Sulliv. "Icones").

P. elegans (Hook.) Sulliv. Small and delicate, about the size of the last or somewhat larger and growing in somewhat similar but more moist situations and usually in larger masses, glossy green, often with axillary gemmiferous branchlets; cortical cells of stem not enlarged, thick-walled; leaves complanate, oblong-ovate to oblong-lanceolate, *at first gradually narrowing, then rapidly contracted to a rather short slender acumen*, rounded at base and narrowed to the insertion, not decurrent, plane-margined; *costa prominent for the subgenus, short and double or occasionally reaching nearly the middle of the leaf;* leaf cells linear-flexuose, 20:1: dioicous; capsules *ovoid, nearly symmetric, inclined to pendent*, contracted under the mouth when dry; spores in spring. Local throughout our range.

The smaller form, with leaves ovate to ovate-lanceolate, slenderly acuminate-apiculate, concave, serrate above, usually without gemmiferous branches, which Austin distributed as var. *gracilens* is said by Mrs. Britton to be the type form instead of the more common form described above. The leaves figured are more evenly narrowed than most forms I have seen.

P. micans (Sw.) Paris. Plants small and slender like the two preceding species, growing in thin mats, *yellowish green to whitish green*, glossy; stems prostrate, irregularly branching; stem leaves thin, distant spreading, ovate-lanceolate, 1–1.3^{mm} long, *gradually long-acuminate, somewhat serrulate above;* costa usually lacking; basal cells shorter and broader, a *well-marked line of short broad cells at insertion of leaf* which often fails to come off with the leaf; cortical cells of stem fully as wide as median leaf cells; a very few quadrate cells at basal angles; branch leaves less slenderly acuminate and more strongly serrulate: monoicous; *seta long and slender, seta and capsule light reddish brown;* capsules small, *short-ovoid*, more or less contracted under the mouth when dry and empty; operculum *conic-apiculate to short-rostrate; annulus lacking;* spores in January. On rotten wood and soil at base of trees from Long Island southward, principally near the coast, abundant in the southern states. The leaves of *P. micans* vary considerably in slenderness and length of leaf cells. I do not find the perichætial leaves as sharply serrate as figured by Sullivant.

FIGURE 196. *Plagiothecium micans* (From Sulliv. "Icones")

Var. **fulvum** (Hook. & Wils.) Paris. A large form with stems and branches longer, much wider and more complanate, approaching in size and appearance forms of *P. denticulatum*, but lighter colored, or more brownish when old, is found in the southern portion of our range, though more abundant farther south. It is found in swamps and sphagnum bogs and is sometimes floating.

PLATE LXXXIII. *Plagiothecium turfaceum* (From Sulliv. "Icones")

P. Groútii Card. & Ther. is closely allied to the last and perhaps best considered as a subspecies. It is more slender; the stem leaves are broadly ovate-lanceolate, 0.7–0.9^{mm} long, rather abruptly narrowed to a short serrate acumen; operculum beaked with beak as long as rest of operculum. Depressions in base of chestnut tree, Hempstead, Long Island, N. Y.

P. turfàceum Lindb. Much resembles *P. micans*, but is a more northern plant extending northward into Canada. It is light green to yellowish green, grows on decayed wood or humus, and has cortical cells of stem fully as wide as median leaf cells; basal cells shorter and broader; but it is easily distinguished from *micans* by the leaves *strongly serrate above*, serrulate below, usually without differentiated alar cells; also by the longer capsule *slightly striate* when dry and empty, *having a neck that shrinks conspicuously in drying*, even when full of spores, and by a *large double annulus* and a conic operculum; spores in summer. Not rare, but apparently little collected. Some of our forms are scarcely complanate and therefore often puzzling.

P. pulchéllum (Dicks.) B. & S. is a rare species with us. It is about the size of *turfaceum*, but is a *bright glossy green with a metallic luster;* stems prostrate; branches nearly or quite erect, resembling the pile of a very coarse velvet; *leaves not complanate, often slightly secund, narrowly ovate-lanceolate, slenderly acuminate*, scarcely concave, slightly rounded at base and narrowed to the insertion, *entire*, plane margined, ecostate; leaf cells 15–20:1, about *two rows at base shorter and broader but alar not differentiated:* monoicous; capsules variable in length, usually inclined and somewhat unsymmetric, slightly contracted under the mouth when dry and empty; spores in early summer. On decayed wood mainly, also on roots of trees and rocks.

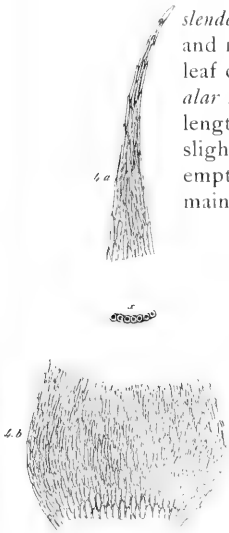


FIGURE 197. *Plagiothecium pulchellum* (From Bry. Eur.)

FIGURE 198. *Plagiothecium geophilum* (From Sulliv. "Icones")

P. geóphilum (Aust.). Larger than the three preceding species, *dark green;* leaves complanate and *rather distant*, somewhat narrowed to the insertion and rounded at base, oblong-lanceolate, *gradually and evenly narrowed to the rather blunt apex, serrate in the upper half;* margins plane; costa short and double, *but stronger than in most Plagiothecia;* leaf cells rather shorter than in preceding forms; alar scarcely differentiated: capsules ovoid, inclined, unsymmetric; *operculum beaked; annulus large and double.* Rare, growing on moist banks and stones in or near water, apparently a plant of lowlands. Some or all of the leaves are blunt at apex as figured and the apex strongly resembles in appearance that of *Eurhynchium hians*, but many of the leaves are much more slender at apex. The larger size, darker color and characteristic leaf apices distinguish *geophilum* from all the preceding species. The leaf apices and color distinguish it from the next.

FIGURE 199 *Plagiothecium deplanatum* (From Sulliv. "Icones"

P. deplanàtum (Sch.) Grout. Bright *shining golden green;* leaves complanate, *close and overlapping much more than in the last*, in outline much like those of *elegans* but larger, oblong-lanceolate to ovate-lanceolate, gradually long-acuminate in some cases, in others abruptly narrowed above, *concave, serrate above*, not decurrent, plane-margined; median cells linear-flexuose; costa lacking or nearly so: dioicous; rarely fruiting; capsule unsymmetric and inclined, contracted under the mouth and *somewhat plicate when dry; annulus lacking;* operculum short-beaked. In thin mats over clayey ground and stones. Rather infrequent; capsules rare. Distinguished from all the other species of the subgenus, except *geophilum*, by its size. These two species approach *Euplagiothecium*.

Forms referred to this species vary a great deal and it is probably a composite. One of these forms issued as No. 174 *(P. deplanatum)* in my N. Am. Musci Pleur. seems to approach *P. densifolium* (Lindb.) Limpr., while others approach *P. Silesiacum* (Seliger) B. & S., though to my mind entirely distinct. Dr. Best drew up a comparison in parallel columns between ordinary *deplanatum* and my No. 174, which I here reproduce with some slight changes. Dr. Brotherus regards No. 174 as *deplanatum*.

P. DEPLANATUM	N. AM. MUSCI PLEUR. NO. 174
Yellowish green.	Deep dark green.
In thin mats; stems and branches densely radiculose on the under surface. Plants generally smaller.	In denser tufts; stems and branches not densely radiculose on under surface. Plants generally larger.
Leaves smaller, nearly symmetric, gradually acute to short acuminate.	Leaves larger, longer, distinctly asymmetric, rather abruptly long and slenderly acuminate.
Median cells loose, rather wide, 8–12:1; alar cells quadrate-oblong, not clearly differentiated.	Median cells close, narrow, 10–15:1; alar cells small, quadrate, thick-walled, clearly differentiated.
Central strand absent or rudimentary.	Central strand distinct.

P. denticulàtum (L.) B. & S. One of our most common mosses, found everywhere, exceedingly variable and possibly a composite species, as several European authors have split off other species besides those mentioned below. It grows in wide loose *glossy-green* mats; much larger than any species of *Isopterygium*, except possibly the last two; branches ascending, branch leaves neither distant nor crowded, complanate, somewhat spreading, *little shrunken in drying*, usually slightly concave and asymmetric, 1.5–2.5^{mm} long, oblong-ovate, acute to short-acuminate, broadest at base and decurrent with one or both margins narrowly recurved, entire, or usually with a few teeth at the extreme apex; costa variable, sometimes lacking, sometimes double or forked and reaching $\frac{1}{3}$ the length of the leaf; median cells linear-rhomboidal, 120–160μ x 10–15μ, thin-walled, full of chlorophyll, gradually becoming broader and shorter toward the base; basal cells subrectangular and pellucid, *alar hyaline and decurrent: monoicous; capsule* about 2^{mm} long, cylindric with a distinct neck, inclined to subhorizontal, curved to nearly symmetric, often striate when dry and empty; *operculum long-conic*, occasionally short-beaked; *annulus large;* spores in summer. On the ground, roots of trees, stones, etc., in damp shaded places. The amateur will collect this on every trip, thinking he has something different each time. The plants vary in size, in color, in shape of leaves and in arrangement and position of leaves, size and curvature of capsules and length of beak of operculum.

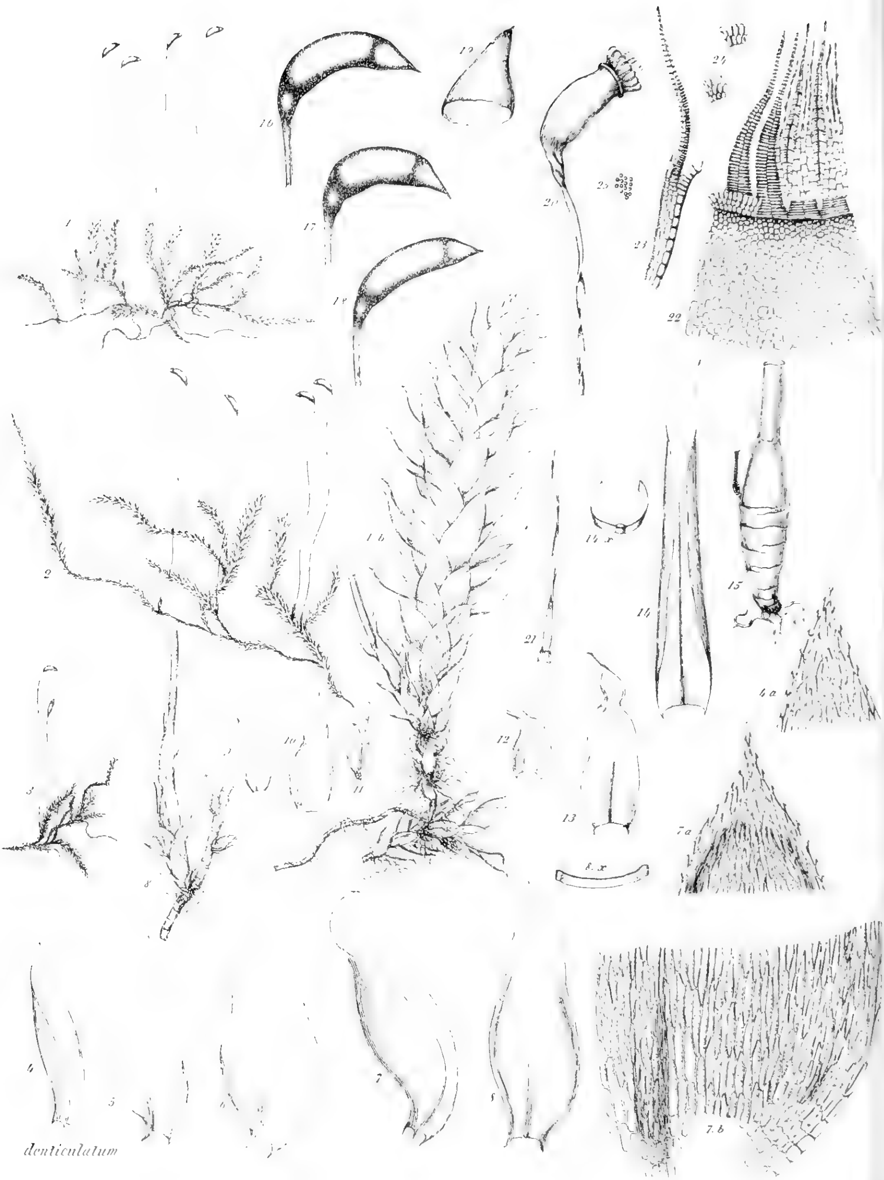


PLATE LXXXIV. *Plagiothecium denticulatum* (From Bry. Eur.)

Forma *propagulifera* Ruthe, leaves strongly unsymmetric, very strongly decurrent, *bearing 3–4-celled brood bodies on the back of the leaves.* Long Island swamps, probably elsewhere in similar situations.

Var. **Dónii** (Smith) Lindb. (*Hypnum obtusifolium* Brid.) Very glossy, leaves soft, ovate, blunt or rounded at apex, often apiculate, concave. Alpine or subalpine, not common.

Several other varieties are described, based on the variations mentioned above. In crevices in wet cliffs and ledges in cool shaded mountain regions I find a small smooth soft shining form that is probably var. **tenellum** B. & S.

P. sylváticum (Huds.) B. & S. Schimper says of this species that it is distinguished from *denticulatum* by its softer, less glossy leaves, shrinking when dry; by its dioicous inflorescence, long-cylindric striate capsule, beaked operculum and narrower annulus. Limpricht and Roth say that the capsules of *sylvaticum* are striate and of *denticulatum* not striate. Husnot says of both species, capsules smooth or striate. Abbé Boulay, one of the most careful of observers, says the same. Spruce and Dixon say that a striate capsule is always found on a monoicous plant. I do not believe inflorescence is a valid character for distinguishing species unless plainly correlated with other characters. I have examined several plants of a tuft and found them all female, only to examine another and find on it both antheridia and archegonia. Boulay says that he finds in the same tuft male plants, female plants, and others which are bisexual. I find both monoicous and dioicous plants with striate capsules. If we add to Schimper's description, as given above, that the plants of *sylvaticum* are usually larger, duller or more yellowish green; leaves shrinking when dry so as not to overlap, or barely overlapping, we should have a description of a plant that every one would recognize as *sylvaticum*. As Husnot puts it: "If *P. denticulatum* and *sylvaticum* always presented the characters I have indicated, their distinction would not be difficult; but one often finds plants that lack one or more of these characters. The characters indicated as separating the two plants are exceedingly variable, even in the case of the inflorescence." To my mind *sylvaticum* is but a poorly delimited subspecies of *denticulatum* with all manner of common intergradations. *Roeseanum*, *lætum* and *Rothii* I consider in the same light.

P. Roeseànum (Hampe) B. & S. (*P. Sullivantiæ* Schimp.) is another subspecies of *denticulatum* closely related to *sylvaticum*. Dioicous; scarcely complanate, sometimes nearly julaceous, often brittle, leaf cells narrower, 15:1; beak of operculum shorter.

P. lætum B. & S. Monoicous; smaller than typical *denticulatum*, leaves slenderly long-acuminate, less strongly decurrent; capsules erect or nearly so, peristome without cilia.

P. Rùthei Limpr. A fine large moss growing in low-lying coastal swamps of Long Island and probably elsewhere; leaves complanate with both sides of each leaf incurved and clasping the base of the leaf above, asymmetric, about 2.5^{mm} long; costa extending $\frac{1}{3}$–$\frac{1}{2}$ the length of the leaf.

The *Fissidens* habit of the leaves gives the plants a peculiar easily recognizable *facies* when fresh, different from any monoicous forms I have seen inland, but approached by forms of *denticulatum* growing in similar situations in neighboring localities. The leaves often bear brood bodies. Reported from Minnesota by Holzinger.

P. latebrícola (Wils.) B. & S. Slender, resembling *Isopterygium* in appearance, in dense tufts of a light glossy green, yellowish when dried; branches numerous, short; leaves more or less complanate, concave, spreading, somewhat subsecund at end of branches, about 1^{mm} long, ovate-lanceolate, rather slenderly acuminate, *decurrent, entire*, ecostate or nearly so; median cells linear-flexuose, 10–15:1; basal broader and shorter; *decurrent alar cells large, clearly defined, rectangular, hyaline; numerous oblong-cylindric several-celled* (about 4) *brood-bodies are borne abundantly on the tips of* the leaves and sometimes on other parts of the plant: dioicous; capsules small, *erect and symmetric;* peristome teeth distantly articulate, cilia lacking or rudimentary; annulus small; spores in late autumn or summer. Swamps, about roots of trees, on decaying wood, hummocks of fern, etc. Distinguished from all the species of *Isopterygium* by its enlarged and decurrent alar cells.

FIGURE 200. Leaf and leaf apex and base of *Plagiothecium striatellum* (From Bry. Eur.)

P. striatéllum (Brid.) Lindb. Growing in rather dense dark green tufts; branch leaves, in American specimens, *squarrose-spreading*, giving the plants the habit of a *Campylium*, long-acuminate from an ovate base, or sometimes elongated triangular-ovate, narrowed and strongly decurrent at insertion, *serrulate*, especially above; costa short and double or lacking; median leaf cells linear-flexuose, *rather short for the genus, 5–10:1;* basal shorter and broader; *alar suddenly inflated, hyaline or colored, forming very distinct decurrent auricles:* monoicous; capsules inclined and curved, *always plainly striate when dry;* spores, May-June. Common in swamps. In general appearance this species resembles *Campylium* rather than *Plagiothecium* but the abundant striate capsules easily distinguish it from any of our *Campylia*.

AMBLYSTEGIÉLLA Loeske

Usually treated as a section of *Amblystegium*, but differing from the true *Amblystegia* in the smaller size, lack of central strand and in the slightly developed costa, which is either wanting or very faint. Nearly all our species, except *adnata*, have a tendency to become stoloniferous and the leaves on the stolons are much smaller than the normal leaves. Therefore, well-developed leaves should be sought for study.

KEY

1. Plants of the size and habit of *Hypnum reptile;* leaves reaching more than 1^{mm} in length . . . . . *adnata.*
   Plants minute; leaves not over 0.6^{mm} in length . . . . . 2.
2. Plants growing on bases of hardwood trees; leaves reaching 0.6^{mm} in length . . . . *subtilis.*
   Growing on stones, especially limestone; leaves usually less than 0.5^{mm} . . . . . 3.
3. Leaves narrowly triangular-lanceolate, not narrowed to insertion; alar cells at margin all longer than broad; median 5–10:1 . . . . . *minutissima.*
   Leaves narrowed to insertion; median cells shorter, alar quadrate . . . . . 4.
4. Quadrate alar cells conspicuous: monoicous; capsules curved and inclined . . . . *confervoides.*
   Quadrate alar cells few, or lacking in some leaves: dioicous; capsules erect or nearly so . . . . . *Sprucei.*

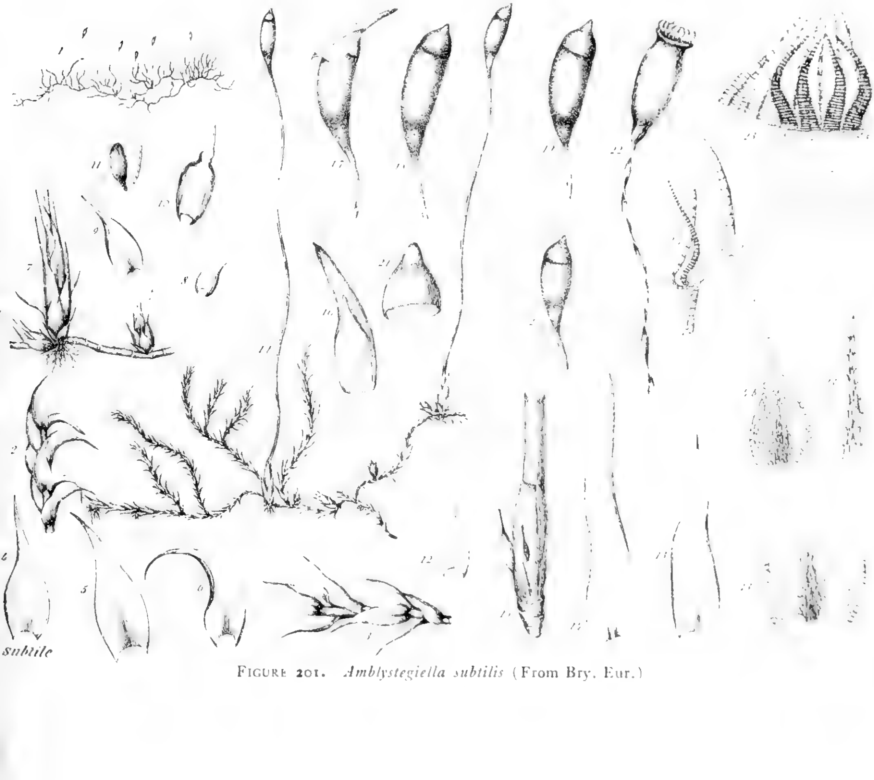


FIGURE 201. *Amblystegiella subtilis* (From Bry. Eur.)

A. súbtilis (Hedw.) Loeske. Plants small, in thin closely woven dark-green mats; leaves rather distant, lanceolate to linear-lanceolate, slenderly long-acuminate, narrowed to the insertion, not decurrent, entire, appressed when dry, 0.25–0.6^{mm} long; costa short and faint or lacking; median cells oblong-hexagonal, 2–3:1; *alar cells quadrate to transversely elongated:* monoicous; capsule *oblong-cylindric, nearly or quite symmetric and erect;* annulus present; *cilia rudimentary or lacking;* spores from August to September. On bases of hardwood trees in cool swampy places; not rare.

A. confervoides (Brid.) Loeske is the only other one of our minute species

FIGURE 202. *Amblystegiella* (after Cheney). 1. *A. confervoides: a*, leaf; *b*, cells from alar region; *c*, median cells of American plant; *c'*, median cells of European plant; *d*, apical cells from American plant; *d'* apical cells from European plant. 2. *A. Sprucei: a*, leaf; *b*, alar cells; *c*, median cells; *d*, apical cells. 3. *A. subtilis: a*, eaf: *b*, alar cells; *c*, median cells; *d*, apical cells. 4. *A. minutissima: a*, leaf; *b*, alar cells; *c*, median cells; *d*, apical cells. 5. *A. adnata: a*, leaf; *b*, alar cells; *c*, median cells; *d*, apical cells. Leaves by 43 diameters and leaf cells by 290 diameters.

occurring with any frequency. It is a smaller plant than the last, growing on moist stones or ledges. Its leaves will average about ⅔ the length of those of *subtilis*, are ecostate and nearly or quite entire; quadrate or transversely elongated cells numerous; capsules *curved and inclined; peristome with cilia;* spores in summer. By reference to Cheney's figures it will be seen that he illustrates two forms: the "European" form with cells more elongated and apex more slender, and an American form with shorter and more irregular leaf cells and broader acumination. My N. Am. Musci Pleur. No. 317 has the leaf cells of the "European" form and a leaf apex as slenderly acuminate as Cheney figures for *A. Sprucei*, though not more slender than the *confervoides* of the Bry. Eur. Also the margin is plainly denticulate and the quadrate alar cells less numerous than figured. This form approaches *A. Sprucei*, but is plainly not that species because of the well developed area of quadrate alar cells and the curved capsules with well developed cilia in the peristome. No. 820 of Macoun's Canadian Musci and a plant collected near Montreal by Dupret are the extreme form with the short acuminate leaves and short leaf cells figured by Cheney in *1a*, *1b*, *1c* and *1d*. In the various European authors consulted I can find no description which will fit this form; indeed, at first sight it is difficult to believe it is the same species as is commonly described by Europeans. For this form I propose the name, forma **brevifolia**.

A. Sprùcei is about the size of *confervoides* and grows on similar substrata. The leaves are *somewhat serrulate* and the apical cell usually long and narrow; the quadrate or rectangular alar cells are fewer, none transversely elongated and few as broad as long; median cells 6–8:1; perichætial leaves spinose-denticulate above: dioicous; *capsules erect* or nearly so; *peristome without cilia*. Rare.

A. minutíssima (Sulliv. & Lesq.) Nichols, is a very rare species differing from all the above in that the leaves are broadest at base, not being narrowed to the insertion, narrowly triangular-lanceolate, with no quadrate cells at the marginal angles. As figured by Sullivant the marginal alar cells are twice as long as broad; the median cells are 4–8:1: monoicous; capsules minute, 0.5^{mm} long, ovoid, symmetric or slightly curved, turbinate when dry and empty; annulus and cilia present. "On limestone rocks in shaded ravines."

Leskea tectòrum var. *flagellifera* Best, is likely to be confused with the preceding species, especially *A. confervoides*. It is apparently more common than was known when I wrote up *Leskea*. The leaves of the flagella are ovate, *acute to short acuminate;* median cells *scarcely longer than broad, and irregular in shape.* At the angles is a large area of cells, quadrate, triangular, transversely elongate, etc. Cheney's figures of *confervoides*, except $1c^2$ and $1d^2$, would fit this Leskea pretty well, but usually some fairly well-developed plants with costate leaves can be found in the tufts to identify them.

A. adnàta (Hedw.) Nichols. *Larger* than the preceding *with the facies of*

Hypnum reptile; growing in wide thin closely adherent mats of a dark green to yellowish green; stems creeping, closely branched; *leaves crowded*, erect-spreading, oblong-ovate, *broadly short-acuminate*, margins often recurved below, concave, *entire* or nearly so, about 1^{mm} long; median cells subrhomboidal, 4–7:1; *apical shorter;* alar quadrate, *very numerous*, sometimes extending $\frac{1}{3}$ the length of the leaf; *the entire areolation unusually regular*; costa faint or lacking: monoicous; perichætial leaves dentate; capsule oblong-cylindric, inclined and curved; annulus present; operculum *conic*, *not* rostrate; peristome perfect; spores in summer. Common on stones and bases of trees. Distinguished from *Hypnum reptile* by its terete branches and entire *short-acuminate* leaves, from *A. subtilis* by its larger size and more numerous quadrate alar cells, curved capsules and perfect peristome.

Plants growing on stones sometimes have the leaves as broadly ovate and abruptly short-acuminate as figured by Cheney (Fig. 202), with the quadrate alar cells very numerous and the cells of the upper one-third of the leaf rounded diamond-shaped as figured by Sullivant (Fig. 203). On trees the leaves are often more gradually narrowed to a longer acumen, becoming obong-lanceolate as figured by Sullivant. In this form the quadrate alar cells are much less numerous and the median and upper cells more elongated, much as figured by Cheney.

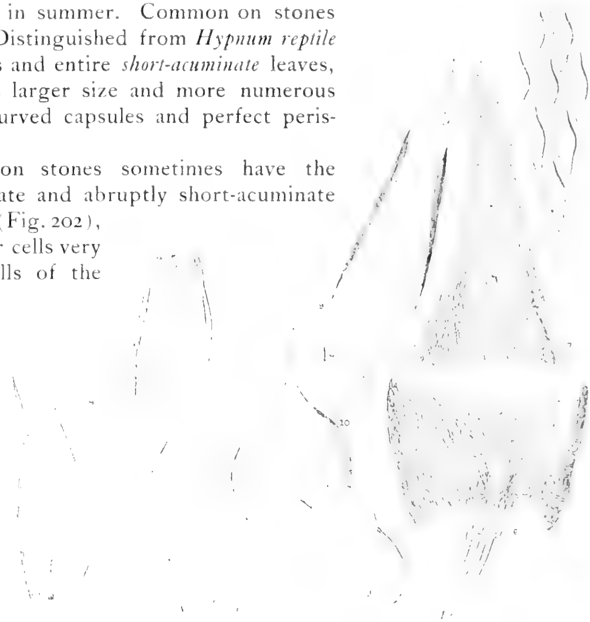


FIGURE 203. *Amblystegiella adnata* (From Sulliv. "Icones")

Raphidostegium Carolinianum admixtum has leaves very similar to those of some forms of this species, but the differentiated alar cells are less in number, with the lowest strongly inflated. *Platygyrium repens*, when sterile, is often difficult to distinguish from *A. adnata*, but the more slender acumination and longer leaf cells of *Platygyrium* will usually be sufficient for identification. Some of the forms intermediate between *A. adnata* and *Hypnum reptile*, or between *A. adnata* and *Platygyrium*, cause one to wonder if they are not hybrids.

Some of the slender varieties of *Hypnum cupressiforme* with nearly symmetrical leaves simulate *A. adnata*, but the leaf apex in that species is often serrate, usually more slender and the upper leaf cells more elongated.

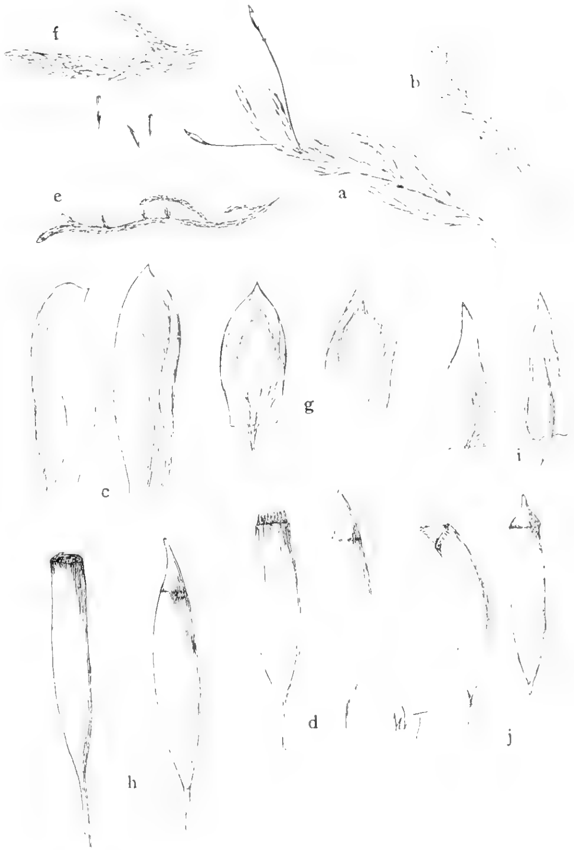


FIGURE 204. a. *Entodon cladorrhizans* × 1. b. Branch × 5. c. Leaves × 20. d. Capsules × 10. e. *E. seductrix* × 1. f. Branch × 5. g. Leaves × 20. h. Capsules × 10. i. Leaves of *Brachythecium acuminatum* × 20. j. Capsules of the same × 10.

SUBFAMILY 7. ENTODONTEAE

Plants of large or medium size, none minute, typically hypnaceous; leaves not papillose, often concave or plicate or both; costa lacking or short and double; median leaf cells linear; alar quadrate (in our forms): seta smooth; *capsule erect, straight, not conspicuously contracted under the mouth* when dry; *peristome with cilia rudimentary or wanting*, segments often narrow and basal membrane sometimes nearly lacking.

This group has contained a heterogeneous collection of mosses of various relationships, their association being based upon the erect capsule and incomplete peristome. I have shown elsewhere that a degeneration of the inner peristome is associated with erect capsules even though it may not (as I think it is) be a result as well. There is no more reason why *Homalothecium* or *Climacium* should be placed in this subfamily than there is for doing the same with *Brachythecium acuminatum* or even *Plagiothecium latebricola*.

KEY TO GENERA

1. Plants robust, glossy yellow-green; leaves symmetric but very concave . . . . *Entodon.*
   Plants slender, dark green, rarely glossy . . . . 2.
2. Leaves somewhat falcate, ends of branches curved when dry . . . . *Pylaisia.*
   Leaves not falcate, branches not curved . . . . . *Platygyrium.*

ÉNTODON C. M. (*Cylindrothecium* B. & S.)

Growing in wide intricate *glossy* yellow-green mats; stems densely leafy, *turgid with the very concave leaves* or in most species *somewhat flattened.* Leaves nearly entire or very slightly serrate at apex, very concave, not *striate or plicate when dry*, ecostate or with costa very short and double; leaf cells linear, *enlarged and quadrate at the basal angles:* capsules cylindric, erect and symmetric; operculum conic to conic-rostrate, annulus usually large and conspicuous, remaining attached longer than is usually the case; peristome with *cilia rudimentary or wanting and segments narrow*, basal membrane usually very narrow.

Their brilliant color and flattened habit (julaceous in *E. seductrix*) render this genus easy of recognition. The leaves are so much nearer together than in most other flattened forms, that one is not likely to put them with forms like *Plagiothecium.* In fruit *Brachythecium acuminatum* is our only moss likely to be misplaced in this genus.

KEY

1. Leaves gradually narrowly acuminate; segments of endostome adhering to the teeth . . . . *brevisetus.*
   Leaves merely acute or apiculate; segments free . 2.
2. Leafy stems and branches rounded (terete) . . *seductrix.*
   Leafy stems flattened . . . . 3.
3. Plants robust; capsules $3–5^{mm}$ long, 5–6:1, peristome teeth not papillose above . . . . *cladorrhizans*
   Plants more slender; capsules 2.5^{mm} long, 4:1, teeth papillose . . . . *compressus.*

FIGURE 205. *Entodon seductrix* (From Sulliv. "Icones")

E. sedúctrix (Hedw.) C. M. is readily known from all other species of *Entodon* by its cylindric julaceous stems and branches, although it varies greatly in many respects. It grows in wide glossy yellow-green mats; branch leaves imbricate-appressed, oblong-elliptical to ovate, about 1.2–0.7^{mm}, short-apiculate, entire or very slightly denticulate near apex; costa short and double; median cells linear, quadrate alar cells numerous: monoicous; capsule cylindric, *3–3.5^{mm} long, 5–6:1; annulus of two or three rows of small cells* obscured by the base of the teeth; *teeth of peristome short and very characteristic*, as illustrated in Fig. 205; *deeply inserted and with few articulations above;* segments linear, about the length of the teeth. Sullivant's figure of the mouth of the capsule shows the annulus cells as a part of the capsule wall, but two or three rows of these have the structure of annulus cells. The spores mature in autumn or early winter. Common, especially in the southern part of our range, on rotten wood, soil, bases of trees, etc.

Var. **lanceolàtus** Grout. Stem leaves ovate-lanceolate, acute; branch leaves broadly lanceolate, tapering gradually to the serrate acute apex; median cells 12:1; capsule 3–5^{mm} long, about 8:1. On rotten wood, Hanging Rock, Ill.

Var. **minor** (Aust.) Grout. Entire plant much reduced, dirty green: leaves, seta and capsule shorter than in type; capsule 1.5–2^{mm} long, its length about 3 times its diameter. Ohio (Sulliv.); near Augusta, Ga. A portion of No. 388 of Sulliv. and Lesq. Musc. Bor.-Am., in Columbia Herb., issued as *Cylindrothecium compressum* Br. and Sch. is this variety.

Var. **Demètrii** (Ren. & Card.) Grout. *Cylindrothecium Demetrii* Ren. & Card. Stems irregularly divided and branched, strongly complanate-foliate, slender, having almost exactly the facies of *E. compressus;* leaves ovate, gradually acute, very entire; peristome teeth often irregularly perforate. On stones at top of well, Emma, Mo.

E. cladorrhìzans (Hedw.) C. M. This is our only other common *Entodon;* readily recognizable by its *glossy yellow-green color and broadly flattened appearance;* branch leaves oblong-ovate, reaching 1.5 by 0.8^{mm}, acute, nearly entire, very concave; quadrate alar cells numerous. The peristome teeth have about the usual number of articulations for a hypnaceous moss, *not papillose;* annulus large; spores maturing in autumn. Typically growing on rotten logs, sometimes found on soil or roots of trees.

FIGURE 206. Peristome of *Entodon cladorrhizans.* (From Sulliv. "Icones")

E. compréssus (Hedw.) C. M. has much the same appearance as the last, but is very *much more slender;* branch leaves only 1.1 by .5^{mm}; *capsules shorter and peristome teeth densely papillose above with minute papillæ.* With much the same habitat and range as the last but rather rare and infrequent. Not reported north of Rhode Island.

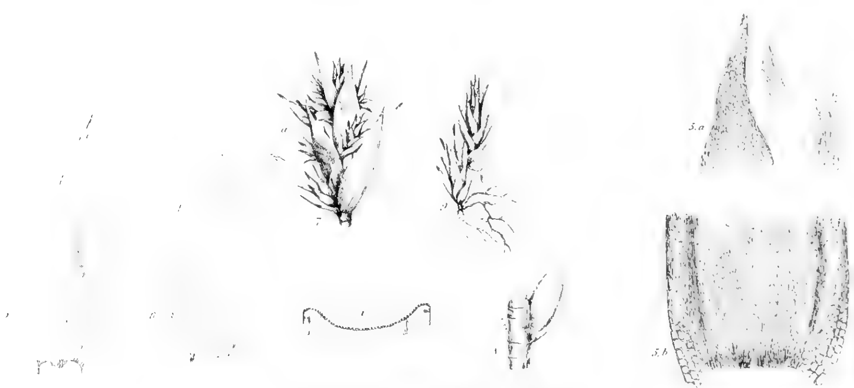
E. brevisètus (Hook. & Wils.) J. & S. is a rare species with the characteristic habit of the genus but with *the leaves long-acuminate* and the segments of *the inner peristome adherent to the teeth after the manner of Pylaisia Schimperi.* Extending over the most of our range, but rarely found. There seem to be some indications that it prefers a limestone country. The incomplete formations of the inner peristome in this species and in two species of *Pylaisia* are of great interest, as showing a step in peristome degeneration in an erect capsule between the condition in which the segments are narrow and cilia lacking, as in most Entodons, and the condition of complete suppression as in *Leucodon.*

FIGURE 207. *Entodon compressus* (From Sulliv. "Icones")

PLATYGÝRIUM B. & S.

P. rèpens (Brid.) B. & S. The microscopic structure of this plant is so like that of *Entodon* that I placed it in that genus in my monograph (Bull. Torr. Bot. Club 23:227), but the dark-green scarcely glossy appearance and the small terete branches much more closely resemble *Pylaisia* than *Entodon.*

From *Pylaisia* this species is distinguishable by the fact that the leaves are not at all falcate-secund and the branches are little if any curved at the ends. The ends of the branches often bear gemmæ in the axils of the leaves. The



repens

FIGURE 208. *Platygyrium repens* (From Bry. Eur.)

leaves are 0.7–1.2 by 0.3–0.4^{mm}, oblong-ovate to oblong-lanceolate, closely imbricate when dry, acute to acuminate, slightly concave with margins entire and reflexed below, not striate or plicate; costa lacking or short and double; apical cells rhomboidal, median linear, 8:1; quadrate alar cells numerous and extending up the margins: capsule erect, 4:1; annulus large; peristome teeth hyaline-margined; segments linear with scarcely any basal membrane; spores in early autumn. Common on bark of trees, decaying logs, and stumps.

The novice might possibly mistake sterile plants for *Amblystegiella adnata*, but the plants are larger, less pinnately branched and otherwise different in general appearance, with much longer median leaf cells and more slenderly acuminate leaves.

PYLAISIA B. & S. (Not Desv.)

A genus of tree-growing mosses sometimes found on fallen trunks, usually easy of recognition by reason of their slender branches, curved when dry and almost hooked at the ends by reason of the falcate-secund leaves and also by their small erect and cylindric capsules, having very degenerate inner peristomes; cilia lacking (or very rudimentary in *polyantha*) and often having the segments adherent to the teeth. The leaves are ecostate or with costa short and double, concave, entire or slightly serrulate above. The annulus is much narrower than in *Platygyrium* or *Entodon* (except *E. seductrix*).

KEY

1.	Segments of endostome free from the teeth	2.
	Segments of endostome wholly or partially adherent to the teeth	3.
2.	Operculum conic; quadrate alar cells few	*polyantha.*
	Operculum short-beaked; quadrate alar cells numerous	*subdenticulata.*
3.	Segments partially adherent; spores 18–24$^{\mu}$	*Schimperi.*
	Segments wholly adherent; spores 25–70$^{\mu}$	*intricata.*

P. polyántha (Schreb.) B. & S. This is a moss with a typical hypnaceous peristome except for the rudimentary cilia and the absence of the fine transverse lines at the base of the teeth. The American plant is very close to the European *P. polyantha*, but it differs constantly in the shorter broader and more abruptly-acuminate leaves. The length of the leaf of the European plant averages 1.5^{mm}, while the average length of the leaf in the American form is only 1^{mm} in length. In examining hundreds of American specimens I found but one leaf measuring 1.4^{mm} in length. It grows in glossy yellowish green intricate mats; stems 2 to 10^{cm} long, rarely longer, creeping; branches 0.5 to 1^{cm} long, erect or ascending; branch leaves somewhat falcate-secund, loosely imbricate when dry, broadly ovate-lanceolate, 1–1.3 x 0.4–0.5^{mm}, more or less long-acuminate, entire, slightly concave, ecostate, or costa very faint, short and double; leaf cells linear-

PLATE LXXXV. *Pylaisia Schimperi* (From Sulliv. "Icones") rhomboidal; median cells 8:1; *quadrate alar cells few;* stem leaves broader, more abruptly acuminate: capsule oblong-cylindric, 2.5^{mm} long, 3.5–4:1; operculum *conic to conic-apiculate;* annulus very narrow and easily detached, of one row of cells; teeth of peristome linear-lanceolate, closely and regularly articulate, submoniliform and slightly granular above; *segments as long as teeth, linear-lanceolate,* more or less split when old, granular-roughened; spores in autumn and winter. Apparently widely distributed in Canada and along the northern border of the United States in mountainous regions, but rather infrequent and local.

P. subdenticulàta Schimp. is a rare and little known species closely related to forms of *P. polyantha;* distinguished by the smaller size, beaked operculum, absence of cilia in the peristome and by the numerous quadrate alar cells.

P. Schímperi R. & C. (*P. intricata* B & S.) Growing in thin dark green mats; leaves ovate-lanceolate, reaching 1.1 by 0.4^{mm}, more or less long-acuminate, nearly entire; *quadrate alar cells numerous, bordering the lower one-third of the leaf:* capsule about 2^{mm} long, ovoid to ovoid-cylindric; *segments of the peristome adherent to the teeth for the lower two-thirds, split below and united above between the points of the teeth;* spores maturing in autumn. Common and specially addicted to trees in the open, apple trees, shade trees and the like.

P. intricàta (Hedw.) R. & C. (Not B. & S.) (*P. velutina* Schimp.) Less common than the preceding, which it resembles; growing on trees in cool woods, *lighter colored* with leaves narrower (0.8–1.2 by 0.3^{mm}); less appressed when dry. In addition to the distinctions given in the key, the *number of quadrate alar cells is much smaller,* so that the species can be distinguished by this character alone.

The mix-up in names between the last two species is due to the fact that the plant named *intricatum* by Hedwig was what almost all recent authors have called *velutina.* (Fide Cardot.)

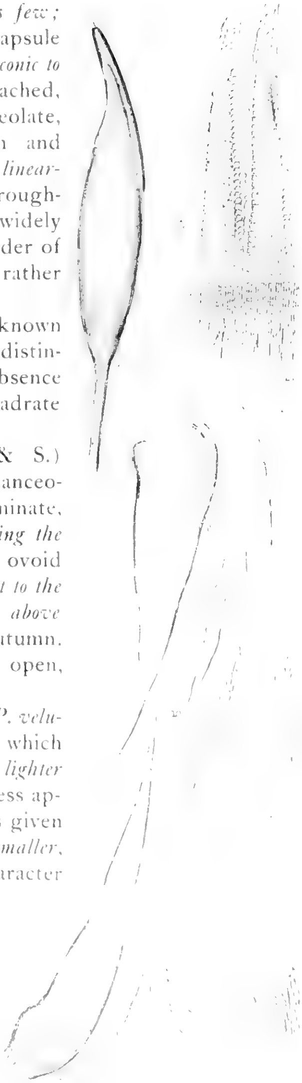


FIGURE 209. *Pylaisia intricata* R. & C. (From Sulliv. "Icones".)

Family 23. Fabroniaceae

Smallest and most delicate of the Pleurocarpi except *Amblystegiella.* Mostly plants of warmer regions, growing in rather thin tufts, often glossy. Stems without central strand, creeping, producing many erect and simple or somewhat divided branches; paraphyllia lacking; branches densely leafy; leaves *soft*, rarely or not at all complanate or secund, *closely imbricate when dry, not decurrent or plicate*, ovate to ovate-lanceolate, acuminate, entire in some species, ciliate-dentate in others; costa lacking or single and extending ½ length of leaf; leaf cells thin-walled (except *Habrodon*), median linear-rhombic to hexagonal; basal and alar often quadrate to short rectangular; none papillose: capsule erect and symmetric, cylindric to ovoid, often strongly contracted under the mouth when dry and empty; peristome single or double, the outer 16 teeth often united in pairs and reflexed as in *Orthotrichum;* segments of inner peristome, when present, narrowly linear. Rare in our range, usually on trees.

KEY TO THE GENERA

1.	Leaves ciliate-dentate	*Fabronia.*
	Leaves entire	2.
2.	Leaves costate; leaf cells thin-walled . .	*Anacamptodon.*
	Leaves ecostate; leaf cells thick-walled . .	*Habrodon.*

ANACAMPTODON Brid.

A. splachnoides (Froelich) Brid. Our only species, dark green; leaves ovate-lanceolate, acuminate, entire; leaf cells rhombic-hexagonal, quadrate to rectangular at base: seta 5–8^{mm} long; annulus lacking; *peristome double; teeth approaching each other in pairs and reflexed when dry; segments filiform with no basal membrane;* spores papillose, maturing in June. *Moist cavities in*

FIGURE 210. *Anacamptodon splachnoides* (From Bry. Eur.)

decaying wood, especially *knotholes* in living trees. Widely spread but extremely local and occurring in limited quantities. In some of our forms the leaves are not so long-acuminate as figured, being scarcely more than acute.

FABRÒNIA Raddi

Very small and delicate, leaves often ciliate-dentate. The only species likely to be found in our range is

F. octoblépharis (Schleich.) Schwaegr. Leaves as figured: peristome single with teeth united in pairs as in *Orthotrichum*. Central states to Minnesota and southwards, rare. There are several species of *Fabronia* in the southern states.

FIGURE 211. Leaf of *Fabronia octoblepharis*. (From Bry. Eur.)

HÁBRODON Schimp.

H. perpusíllus (DeNot.) Lindb. (*H. Notarisii* Sch.). Habit and mode of growth of *Fabronia;* leaves spreading when moist, closely imbricate when dry, ovate to ovate-lanceolate, ecostate, entire or slightly crenulate, leaf cells thick-walled; median fusiform; basal and marginal quadrate to subrectangular, more or less rounded by the thickening of the cell walls: inner perichætial leaves erose-dentate; capsules ovoid; annulus broad; peristome single, of narrow deeply inserted teeth. Trunks of trees, Central states, very rare. The minute size of the plants prevents confusion with species of the *Leucodontaceæ* having a somewhat similar leaf structure.

Family 24. Leucodontaceae

Tree-growing mosses, rarely found on rocks, often julaceous and glossy; main stems slender, creeping, irregularly branching; secondary stems numerous, horizontal to drooping and outwardly curved, paraphyllia lacking in most species; leaves of secondary stems ovate to ovate-lanceolate, concave, costate or ecostate, entire or nearly so, closely imbricate when dry, spreading when moist, not papillose; leaf cells short, roundish-oval to fusiform in the middle portion of the leaf: perichætial leaves long-sheathing, seldom much shorter than the seta and often extending beyond the capsule; capsules erect and symmetric, mostly ovoid; peristome simple.

KEY TO GENERA

1. Secondary stems little branched; calyptra not hairy . . . . *Leucodon*.
   Secondary stems freely branching, often subpinnate; calyptra hairy . . . . *Forsstræmia*.

LEÙCODON Schwaegr.

The various species of *Leucodon* grow almost exclusively on the bark of deciduous trees, very rarely are any found on dry rocks. The Leucodons are seemingly able to do without moisture for considerable periods, as they rarely or never grow at the base of trees, but at a height of five or six feet and above. The main stems are long, slender, branching, almost filiform, with minute leaves and abundant rhizoids. The secondary stems are numerous, suberect, horizontal, or hanging downward and curved outward, usually julaceous and nearly simple; paraphyllia lacking; leaves many ranked, concave, with margins recurved below, ecostate, entire or slightly serrulate at apex, closely appressed when dry, spreading when moist; leaf cells thick-walled; several rows of marginal cells roundish-quadrate; the lower median linear-fusiform, gradually changing to oval at the apex; basal cells often brownish or reddish yellow. Dioicous.

FIGURE 212. a, b, c. Apices of leaves of *Leucodon julaceus*, *L. sciuroides* and *L. brachypus* respectively × 250. d, e, f. Upper-median, median-basal, and alar cells respectively of *L. brachypus* × 250. g. Secondary stem of *L. sciuroides* having flagella × 3. h. Flagellum of *L. sciuroides* × 50. i. Leaves of *L. sciuroides* × 10. j. Leaf of *L. julaceus* × 10. k. Leaf of *L. brachypus* × 10.

Calyptra cucullate, smooth, often attached below the capsule by the connate base; capsules exserted or emergent, erect and symmetric; peristome apparently simple; teeth 16, articulate and papillose, bifid or occasionally trifid; inner peristome reduced to a narrow inconspicuous membrane. We have three species, only one of which, *L. sciuroides*, is European.

KEY

1. Leaves ovate-elliptical, abruptly short-acuminate . . . . *julaceus.*
   Leaves ovate to ovate-lanceolate, gradually longer-acuminate . . . . 2.
2. Seta much shorter than perichætial leaves; secondary stems well-developed, rarely flagellate . . . . *brachypus.*
   Seta longer than perichætial leaves; secondary stems less developed, often bearing numerous flagella . . . . *sciuroides.*

L. julàceus (Hedw.) Sulliv. This species is typically southern, extending north to southern New England and corresponding latitudes of the eastern United States. The secondary stems are typically shorter than in the other two species, the branches very terete, julaceous when dry; the leaves closely appressed and imbricate, not at all secund, ovate-elliptical, abruptly short-acuminate, very concave, scarcely plicate, serrulate at apex; upper median leaf cells markedly shorter and broader than in the other two species: capsule long-exserted as in *L. sciuroides;* annulus none; teeth bifid at apex. Easily recognized by its perfectly terete stems and smaller, scarcely plicate, abruptly acuminate leaves.

L. sciuroídes (L.) Schwaegr. Forming tufts or mats of brownish green, lighter green at the tips of the secondary stems, which are terete and julaceous, more or less drooping and curved upwards at the ends, rarely 5^{cm} long, usually not over 3^{cm}, frequently producing such a great number of flagelliform small-leaved branches as to cause the plant to appear deformed; leaves of secondary stems slightly secund, ovate-lanceolate, somewhat decurrent, long and slenderly acuminate, entire, plicate with several folds: seta about 8^{mm} long; capsule exserted; annulus present; teeth entire or split toward the base. Very rarely fruiting.

Easily distinguished from *L. julaceus* by the different shape of its leaves. It fruits so rarely that it has to be differentiated from *L. brachypus*, which it closely resembles, by its leaf apices. The acumination of the leaves is longer and more slender than that of *L. brachypus* and is also entire. The upper median cells are also usually a little more elongated. The secondary stems also are much shorter than those of well-developed *L. brachypus.* Probably common in northeastern United States and eastern Canada, but not often collected or else confused with *L. brachypus.* Collectors should be on the lookout for it. In examining leaves for serration, several should be examined, as the leaves of *L. brachypus* and *L. julaceus* are sometimes nearly entire.

L. bráchypus Brid. Secondary stems averaging longer and larger than in the preceding species, less frequently branched; leaves more strongly secund, plicate but with fewer folds than in *L. sciuroides;* the acumination is serrulate and not nearly so slender and pointed as in *L. sciuroides;* seta 3–4^{mm} long, wrapped up in the perichætial leaves, which over-top the emergent capsule; annulus lacking; teeth bifid at apex; spores in winter.

FIGURE 213. a. Plant of *Leucodon brachypus* × 1. b. Leaf of *L. brachypus* × 20. c. Sporophyte of *L. brachypus* × 10. d. Leaf of *L. julaceus* × 20. e. Sporophyte of *L. julaceus* × 10. f. Capsule of *L. julaceus* × 10.

Has about the same ranges as the last, but extends farther south. Abundant and frequently fruiting in the mountain regions of northeastern United States. It extends to Georgia along the mountains. A form from Stone Mountain, Georgia (J. K. Small), is much more slender than the usual northern form.

FORSSTRŒMIA Lindb.

(*Leptodon* of L. & J. Manual)

Much like *Leucodon*, but distinguished in all our species by the abundant branching of the secondary stems and by the hairy calyptra. Many species have strongly costate leaves and most are less glossy than *Leucodon.*

F. trichomítria (Hedw.) Lindb. is the only species at all frequent within our range. Its leaves are difficult to distinguish microscopically from those of *Leucodon brachypus* or *L. sciuroides*, but the duller color, subpinnate branching and more loosely imbricated leaves will usually enable one to recognize it in the field; spores in winter. Other structural details are shown in plate 86. Rather infrequent and local.

Var. **immérsa** (Sulliv.) Lindb. is a common southern form which may possibly be found in the southern part of our range. The leaves sometimes show traces of a costa and the capsules are *immersed in the perichætial leaves.*

F. Ohioénsis (Sulliv.) Lindb. is a rare species of the Central States, more slender than the last; costa reaching the middle of the leaves and seta plainly longer than the perichætial leaves.

Cryphæa glomeràta B. & S., a common plant of the southern states, though more slender than any of the species of this family mentioned above, has a similar leaf structure and might be sought here. The leaves are costate and the costa of the *inner perichætial leaves is excurrent:* capsules immersed; *seta hardly perceptible;* annulus large; *peristome double.* On trees.

PLATE LXXXVI. *Forsstrœmia trichomitria* (From Sulliv "Icones")

Family 25. Neckeraceae

Mostly growing on rocks and trees. Primary stems creeping and defoliate; secondary stems erect, horizontal, or pendent, irregularly to pinnately branching; leaves large, ovate-lanceolate to lingulate or cultriform, acute, obtuse or apiculate, ecostate or with a slender costa; leaf cells not papillose, short, rhombic to linear, quadrate to roundish on the margins. Calyptra smooth or hairy; capsule erect and symmetric, immersed or emergent, rarely with seta longer than perichætium; peristome single or double.

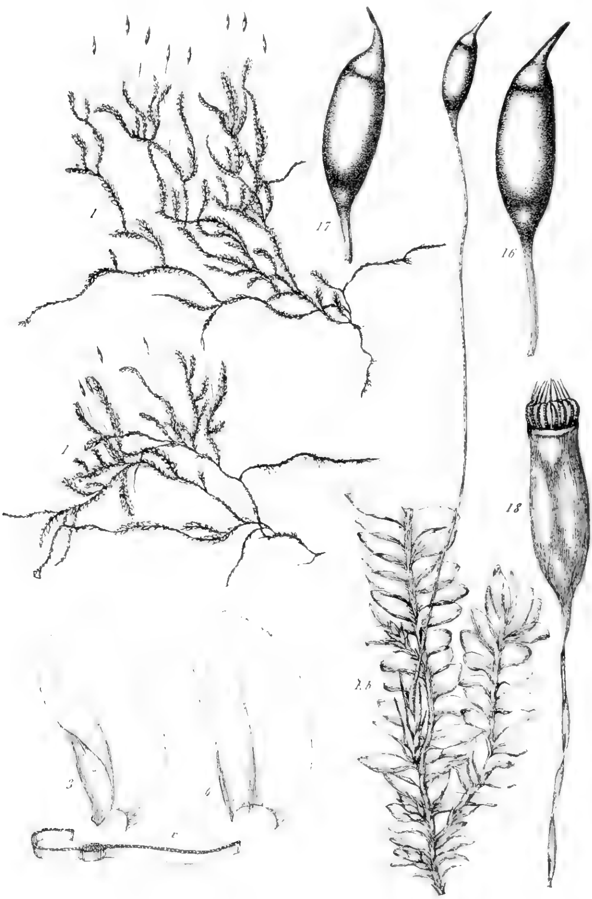


FIGURE 214. *Homalia trichomanoides.* (Schreb.) B. & S. (From Bry. Eur.)

KEY TO GENERA

Leaves cultriform, costate in our species . *Homalia.*
Leaves ecostate . . . *Neckera.*

HOMÀLIA (Brid.) B. & S.

Leaves costate and capsule long-exserted.

H. Jàmesii Schimp. Very loosely tufted, often straggling, shining yellow-green; *branches very strongly complanate-foliate*; leaves cultriform, minutely serrulate above the middle; costa faint, reaching half way or more; lower median leaf cells linear-fusiform; *apical and marginal broadly rhomboidal, as broad as long:*

monoicous; capsules exserted on a fairly long seta; peristome double; *segments narrow, as long as teeth or longer;* cilia rudimentary or none; annulus present; spores in autumn, rather infrequently produced. Our plant is very close to the European *H. trichomanoides*, differing in minor character only, so that the figure of that species answers equally well for our own *Jamesii*. *H. Macounii* C.M. is in all probability a synonym of *H. Jamesii*.

This species is an extremely pretty moss and is frequent on moist rocks in the mountains. By reason of its strongly flattened branches it resembles a *Fissidens* or an hepatic, but a microscopical examination will readily show the difference. It often grows on the underside of overhanging rocks in cool moist ravines; here it is often found in single strands, producing a very pretty effect.

NÉCKERA Hedw.

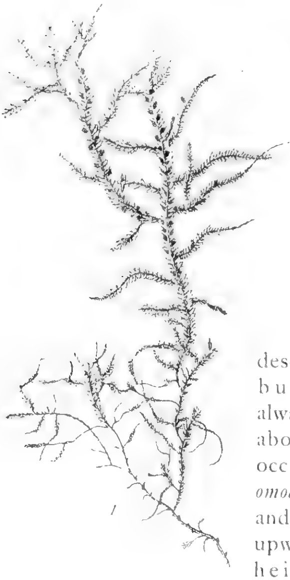
Plants usually large (excl. *gracilis*), growing on trunks of trees or rocks; primary stems creeping, often stoloniferous; secondary stems erect to pendent, often pinnately branched, usually complanate-foliate; stems and branches sometimes flagelliform; leaves often transversely undulate, ovate-lanceolate to oblong or lingulate, frequently unsymmetric, ecostate or nearly so; leaf cells broadly rhomboidal at apex and upper margins, changing to linear-oblong or linear-flexuose at base; capsules immersed or exserted; peristome double, the inner a short membrane with short segments or with segments longer and narrowly linear, cilia wanting; annulus lacking.

KEY

1.	Leaves ovate-lanceolate, undulate, acute	*pennata.*
	Leaves oblong, not undulate, rounded at apex, often apiculate	2.
2.	Plants nearly or quite as stout as in *pennata*	*complanata.*
	Plants filiform	*gracilis.*

FIGURE 215. *Neckera pennata* × 1; leaves × 10; capsules, with and without perichaetial leaves × 10

N. pennàta (L.) Hedw. Plants large; secondary stems 7–10^{cm} in length; branches obtuse or rarely attenuate; leaves ovate-lanceolate, acute to acuminate, strongly undulate, entire or slightly denticulate above; costa short and faint; capsules abundant, immersed; teeth of peristome often united at tips and more or less irregularly divided; segments short and imperfect, as figured under var. *oligocarpa*; spores in summer.



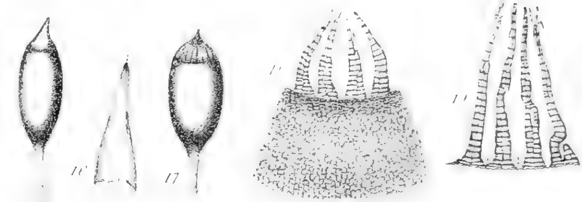


FIGURE 216. *Neckera pennata oligocarpa* (From Bry. Eur.)

This species is found almost exclusively on the trunks of deciduous trees in cool moist woods. It is rarely found on ledges or cliffs. It is a common plant in the habitat described above, rarely growing near the base of a tree, but nearly always growing above the region occupied by *Anomodon* or *Leskea* and extending upward to a height of from 25–50 feet according to the height of the trees and the density of the woods. This species is easily recognized by its flattened branches, wavy leaves, and immersed capsules.

Var. oligocárpa (Bruch). Plants smaller with branches attenuate to flagelliform as figured: capsules like the species. Rare; found in cool shaded places, usually in mountains.

N. complanata (L.) Hueb. is a rare subalpine species, rarely, if ever, fruiting in America. The oblong leaves not undulate, and rounded at apex and apiculate, distinguish it at once from *pennata*. The capsules when produced are

FIGURE 217. *Neckera complanata* (From Bry. Eur.)

long exserted as figured. The branches are often flagellate and the branch leaves are often narrower than the leaves figured.

N. grácilis (James) Kindb. (*Homalia gracilis*, James) is a very rare moss growing on cool shaded rocks. It is almost *filiform*, *freely and irregularly branching;* stems and branches flagellate; the best developed leaves are oblong to cultriform, rounded at apex and more or less apiculate; leaf cells *much shorter than in our other species* of *Neckera*, the lower median being oblong-hexagonal to rhomboidal, 2–5:0.

Family 26. Fontinalaceae. Water Mosses

Aquatic, *floating*, usually slender, *attached at base of stems* only, often very long, dark to blackish green, especially below. Central strand lacking in the stems. Leaves ecostate in *Fontinalis*, costate in *Dichelyma*, mostly decurrent, entire or slightly denticulate at apex; leaf cells rhomboid-hexagonal to linear-flexuose, broader and shorter at base of leaf and often at apex also. Seta short; *capsule immersed in the perichætial leaves or shortly exserted*, *without neck or stomata;* annulus lacking; peristome double, the outer composed of 16 teeth, *the inner of 16 linear divisions more or less completely united by cross strands at regular intervals, forming a regular net* or trellis through the meshes of which the spores gradually escape.

Although mosses belonging to several other families are aquatic, the mosses of this family are most emphatically entitled to the name of Water Mosses, as the members of the family are either submerged all the time or attached to objects that are submerged at high water.

KEY TO THE GENERA

Costa lacking, leaves mostly symmetric . . . . *Fontinalis*.
Costa present, leaves mostly falcate-secund . . . . *Dichelyma*.

FONTINÀLIS Dill.

Stems usually *denuded of leaves below*, *long slender and floating*, freely branched, usually blackish green, except the latest growth; *leaves ecostate*, sometimes nearly flat, but usually strongly concave to nearly tubular. (The young undeveloped leaves at the ends of the shoots are always convolute.) Median leaf cells linear, often long and narrow; alar cells subrectangular to subhexagonal, forming more or less distinct auricles. Dioicous; capsules *sessile*, *little exceeding the perichætial leaves*; outer peristome teeth long, sometimes united at apex.

All our species are submerged, some grow attached to stones and sticks in swift brooks, others in ponds and sluggish streams. Rarely, if ever, are they found in stagnant water. By reason of the peculiarities named the genus is easy to recognize, but the species are often difficult or impossible to distinguish without authentic specimens for comparison as there is relatively very little difference in the areolation of the leaves. I have treated somewhat in detail our five most common species, but we undoubtedly have within our range as many more generally recognized species, but these are either rare or very difficult to distinguish. Some of these rarer species I have treated by comparing with the common species which they most strongly resemble and with which they are most likely to be confused.

I have used to a very great extent the monograph of the family by M. Jules Cardot and hereby acknowledge my indebtedness to him, although I must confess that his eyesight for specific distinctions seems to be considerably more acute than mine. The difficulty of identifying sterile and poorly developed forms is emphasized by the fact that all the older American exsiccati are badly mixed.

KEY

1.	Plants very large, leafy stems triangular, $5-7^{mm}$ in diameter; leaves keeled	*gigantea.*
	Plants much smaller, not evidently three-cornered, leaves concave but not keeled .	2.
2.	Plants very slender and rather rigid; leaves oblong-lanceolate to narrowly lanceolate.	3.
	Plants much stouter; leaves broader, oblong-lanceolate to ovate	4.
3.	Stem and branch leaves markedly different; stem leaves $4-6^{mm}$ long, very long and slenderly acuminate	*Sullivantii.*
	Stem and branch leaves little different, $2-3^{mm}$ long, much less slenderly acuminate.	*dalecarlica.*
4.	Leaves distant, loosely erect-spreading, usually plane or slightly concave above, somewhat acuminate, acute or somewhat obtuse, soft	*Lescurii.*
	Leaves less spreading, closer, concave and often cucullate above, less slenderly acuminate, more broadly obtuse, more rigid	*Novæ-Angliæ.*

F. gigántea Sulliv. is very common in cool brooks in most places. It is most distinct by reason of its large turgid three-cornered stems and branches, which sometimes reach 3^{dm} in length. The deeply concave and keeled leaves reach 8^{mm} in length; median cells 6–15:1; alar subrectangular, somewhat inflated; for peristome, see Plate V, Fig. 17; spores in summer. (See Plate LXXXVIII.)

F. Lescùrii Sulliv. Plants soft and loose; stems $3-4^{dm}$ long, much denuded at the black base; leaves distant, erect and open or loosely imbricated, soft, concave and clasping at base, usually plane above, rather slenderly acuminate for the genus, ovate-lanceolate to oblong-lanceolate, acute or subobtuse, usually a little denticulate at the apex, $3.5-7^{mm}$ long; median cells 12–15:1, the upper shorter; alar enlarged, oblong, inflated, forming distinct auricles: upper perichætial leaves broadly ovate, rounded obtuse, longer than the capsule before maturity; peristome teeth reddish orange, of 20–28 lamellæ, papillose; trellis of inner peristome imperfect, slightly appendiculate. Not rare in cool brooks and ponds, but less frequent than the other species described, except *Sullivantii.* South in the mountains to Alabama. Often difficult to distinguish from the

PLATE LXXXVII. *Fontinalis Lescurii* (From Sulliv. "Icones") next, from which it differs chiefly in the softer, less concave leaves, more slenderly acuminate and less obtuse, and in the more papillose peristome teeth with more (20–28) lamellæ.

F. Novæ-Angliæ Sulliv. Plants firmer than in the last, of about the same size, leaves rather closer, more closely imbricated, ovate-lanceolate to oblong-lanceolate, concave and usually with borders inflexed, often cucullate at apex, usually rounded-obtuse but sometimes subobtuse or apiculate, usually denticulate at apex only, 2.5–4^{mm} long; median cells 8–20:1, alar inflated, oblong, subhyaline or colored: upper perichætial leaves ovate-suborbicular; peristome teeth "purple," with 18–20 lamellæ, slightly papillose; trellis imperfect, the cilia united at the summit only; spores smooth. Common in brooks throughout, probably our most common species.

FIGURE 217. *Fontinalis Novæ-Angliæ* (From Sulliv. "Icones")

FIGURE 218. *Fontinalis dalecarlica* (From Bry. Eur.)

F. Cardòti Ren. is a recently described species of wide distribution and it may prove fairly common. It is closely allied to *Novæ-Angliæ*, from which it differs in being considerably larger and more densely foliate; leaves imbricated, with thicker cell walls; perichætial leaves entire, not lacerate when old; operculum longer; peristome teeth more papillose with fewer lamellæ (13–16); spores brownish and finely muriculate.

F. dalecárlica B. & S. Stems 1–4^{dm} long, much subdivided and branched, slender, attenuate at the ends; leaves rather close, erect-open to loosely imbricate, oblong-lanceolate to narrowly lanceolate, more or less long-acuminate, acute or narrowly obtuse, entire or subdenticulate at apex, concave with margins

PLATE LXXXVIII. a. *Fontinalis dalecarlica* × ½. b. Branch of *F. Novæ-Angliæ* × 5. c. Portion of same bearing capsules × 5. d. A short branch of *F. gigantea* × 1 rolled inwards, 2–3mm long; median cells narrow, attenuate, 15–20:1; alar cells somewhat inflated, subrectangular to subhexagonal: upper perichætial leaves usually somewhat narrowed at apex, apiculate, finally strongly lacerate; peristome reddish orange, sometimes brownish; teeth granulose with 15–22 lamellæ; trellis imperfect; spores in summer, lightly muriculate. Common. Easily distinguished from all our other common species by its slender habit and narrow leaves. It is often found growing intertangled with *F. Novæ-Angliæ*.

F. Sullivántii Lindb. (*F. Lescurii* var. *gracilescens* Sulliv., non var. *ramosior* Sulliv.) Very slender, regularly pinnate with distant attenuate branches; leaves very distant; stem leaves soft, somewhat concave, lanceolate, and narrowly long-acuminate, acute or subobtuse, entire or slightly denticulate, 4–6mm long; branch leaves much smaller, 2–3mm long, more rigid, concave, canaliculate, acuminate: operculum conic, long-acuminate; peristome teeth lightly papillose; spores very finely muriculate. Not common. Apparently more frequent near the coast than inland. All specimens referred to *F. disticha* Hook. & Wilson from our range belong to this species so far as is known to M. Cardot.

F. bifórmis Sulliv. is a rare but very interesting moss. The leaves are of two kinds, the so-called "vernal" leaves, which are so nearly like those of *F. Lescurii* and *F. Novæ-Angliæ* as to be confused with them by some of the best bryologists; and the so-called "summer" leaves which are much smaller and narrower, convolute and tubulose above, the inrolled edges overlapping. When fresh and floating the "summer" leaves often appear plainly three-ranked and are quite widely spreading. This form is easy to recognize. The "vernal" leaves are probably the leaves of young plants or shoots and the others the leaves of adult plants. Widely spread; New Hampshire, British Columbia, Florida, but often incorrectly reported.

DICHELỲMA Myr.

Plants growing near the edge or surface of the water, generally submerged at high water, shorter than *Fontinalis* with the appearance of *Drepanocladus;* leaves three-ranked, costate, narrowly lanceolate, secund to falcate-secund; leaf cells narrow, linear; basal shorter, brownish, not forming auricles. Dioicous; perichætium very long, cylindric, the leaves convolute, very long, spirally twisted, ecostate; seta of moderate length enclosed by the perichætial leaves, sometimes longer and sometimes shorter than the perichætium; peristome much as in *Fontinalis*, but the teeth shorter than the inner peristome.

KEY

1. Costa long-excurrent . . . . *capillaceum.*
   Costa subpercurrent to shortly excurrent . . . . 2.
2. Capsule extending beyond the perichætium; trellis of inner peristome perfect . . . *falcatum.*
   Perichætium exceeding capsule and seta in length; divisions of inner peristome free or united at summit only . . . . *pallescens.*

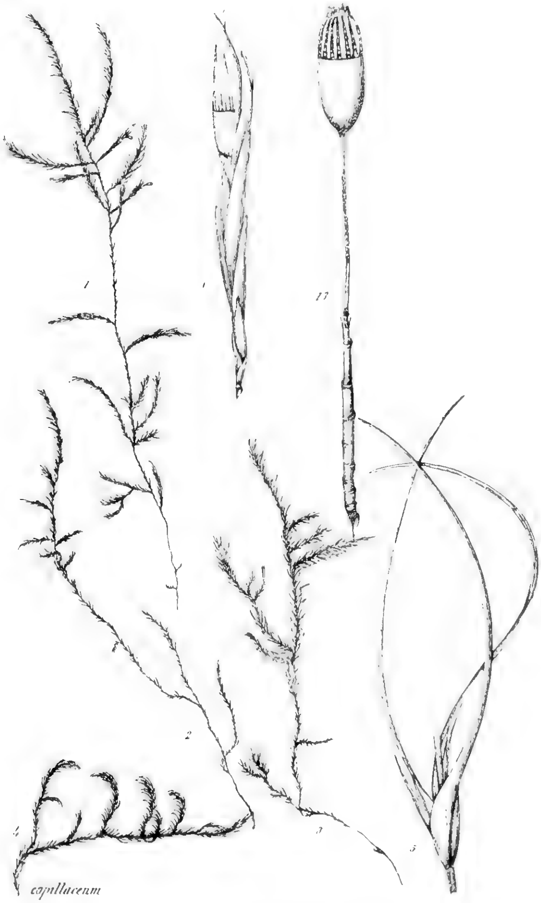


FIGURE 219. *Dichelyma capillaceum* (From Bry. Eur.)

D. capillaceum B. & S. Our only common species. Plants yellowish or brownish above, blackish below; stems slender, 5–15^{cm} long; leaves erect-spreading, secund to falcate-secund, *long-linear from a lanceolate base*, 5–7^{mm} long; usually denticulate above; *costa long excurrent;* spores in late summer. Attached to bushes and other objects in shallow water, especially in swamps.

D. palléscens B. & S. Plants lighter in color, sometimes yellowish and glossy, slender; leaves secund and more or less falcate, hooked at the ends of stems and branches, oblong-lanceolate, gradually long-acuminate, acute to somewhat obtuse, 3–4^{mm} long, denticulate above with few exceptions; costa percurrent or disappearing below the apex: perichætium longer than seta and capsule; peristome teeth poorly developed, linear; divisions of inner peristome free or united at summit only; spores in summer. In situations similar to those occupied by the last, but much less frequent.

FIGURE 220. *Dichelyma pallescens* (From Bry. Eur.)

D. falcàtum Myrin. Yellowish and glossy above, usually blackish at base, *having the habit and appearance of Drepanocladus*; leaves strongly falcate-secund, close, imbricate at base, oblong-lanceolate, then gradually narrowed and subulate-acuminate, 3–5^{mm} long, denticulate above; costa excurrent or disappearing in the apex; *seta usually markedly longer than the perichætium;* operculum as long as urn, obliquely beaked; peristome teeth strongly papillose, *trellis perfect*, longer than the teeth. A rather rare species of mountain brooks.

Sterile plants are easily distinguished from *Drepanocladus* by the lack of inflated alar cells. From the last species it may be known by its larger size and leaves more strongly falcate-secund throughout and more slenderly acuminate.

NOTE that the arrangement of families after the *Hypnaceæ* is different from that found on page 7. The *Pterygophyllaceæ* are omitted entirely as there is only one rare species, *Hookeria Sullivantii* C. M., that may possibly be found within our range.

KEY TO STERILE SPECIMENS

This key is not prepared with the idea that it will enable any one to identify every moss with absolute certainty, but with the idea that it may help the student in placing sterile specimens of special interest. I believe a key to sterile mosses that will enable a novice, no matter how intelligent, to name any considerable number of sterile mosses without other assistance is an impossibility.

Whenever it has been possible to trace out an entire family to one point the key has stopped there, as the keys to genera and species are based on gametophyte characters as far as possible.

a. Plants whitish or light gray, scarcely appearing green . . . *b.*
Plants green, yellow-green, or dark green to almost black . *c.*
b. Plants of bogs; leaves of large colorless cells surrounded by narrow green cells . . . . *Sphagnum.*
Plants showing but one kind of leaf cells (except in section). *Leucobryum.*
c. Leaves in two rows with edges apparently toward the stem. *d.*
Leaves in more than two rows or if apparently two-ranked the edges of the leaf are not toward the stem . . . . *e.*
d. Leaves apparently split on the inner edge and sheathing each other and the stem, costate . . . . *Fissidentaceæ.*
Leaves ecostate, not split at base but forming a continuous wing margin on stem in sterile plants . . . . *Schistostega.*
e. Acrocarpous. (See glossary. There is usually little difficulty in determining this fact even in sterile specimens.) . . *f.*
Pleurocarpous . . . . F.
f. Plants black or blackish green, except at tip of growing stems and branches; leaves with very thick cell walls; growing on rocks and trees . . . . *g.*
Plants green to light yellow-green, sometimes hoary, or, if blackish, growing on the ground . . . . C.
g. Leaves ecostate . . . . *h.*
Leaves costate . . . . *i.*
h. Leaves obtuse, never with hyaline apices . . . . *Andreæa petrophila.*
Leaves acute, mostly with hyaline apices . . . . *Hedwigia.*
i. Growing on rocks . . . . A.
Growing on trees . . . . B.

A

1. Leaves with a hyaline apex . . . . 2.
Leaves without hyaline apex . . . . 3.
2. Basal leaf cells narrowly linear-sinuose, thick-walled . . . *Rhacomitrium.*
Basal leaf cells not sinuose, thinner-walled than the upper. (excl. *Grimmia Pennsylvanica* and *G. apocarpa.*) . . . *Grimmia.*
3. Basal leaf cells narrowly sinuose and nodulose . . . . . . *Rhacomitrium* and *Andreæa Rothii.*
Basal leaf cells not as above . . . . 4.

4. Leaves crispate when dry . . . . *Amphidium* and *Ptycomitrium.*
Leaves not crispate when dry . . . . 5.
5. Plants almost black throughout, very brittle; almost exclusively alpine or subalpine . . . . *Andreæa.*
Plants green at tips, less brittle, many species common at low and medium altitudes . . . . 6.
6. Leaves papillose . . . . *Ulota Americana* and *Orthotrichum.*
Leaves not papillose (papillose in a few species) . . . . . *Grimmia.*

B

1. Leaves crispate when dry . . . . *Ulota.*
Leaves not crispate but closely imbricate when dry . . . . 2.
2. Plants in wide spreading mats with a pleurocarpous habit . . *Drummondia.*
Plants erect, usually in smaller rounded tufts . . . . . . *Orthotrichum.*

C

1. Leaves with numerous lamellæ on inner surface of costa (inconspicuous in *Catharinea crispa*) . . . . 2.
Leaves without lamellæ on inner surface of costa . . . . . 3.
2. Plants very small; rare; leaves ovate . . . . *Pterygoneuron.*
Plants large, common; leaves lanceolate . . . . *Polytrichaceæ.*
3. Stalked receptacles bearing gemmæ nearly always present . 4.
Plants without gemmæ or producing them on stems and leaves . . . . 5.
4. Gemmæ in terminal leafy cups . . . . *Georgia.*
Gemmæ in rounded heads on stalks . . . . *Aulacomnium.*
5. Plants minute, mostly annual, almost microscopic . . . . . *Ephemeraceæ* and *Phascum.*
Plants larger, easily seen without a lens . . . . 6.
6. Leaf cells papillose . . . . **D.**
Leaf cells not papillose . . . . **E.**

D.

1. Leaves strongly contorted to crispate when dry. (*Bartramia* species may be sought here) . . . . 2.
Leaves little or not at all contorted when dry . . . . . . 6.
2. Plants small, less than 1^{cm} . . . . *Weisieæ*, *Webera*, *Barbula*, *Rhabdoweisia* and *Desmatodon.*
Plants of medium size ($1-3^{cm}$) or larger . . . . 3.
3. Leaves spatulate to lingulate; costa often excurrent . . . . *Tortuleæ*, *Didymodon tophaceus* and *Encalypta.*
Leaves obtusely acuminate to slenderly long-acuminate . . 4.
4. Alar cells distinctly enlarged and inflated . . . . *Dicranum spurium*, *D. pallidum* and *D. montanum.*
Alar cells as well as basal often somewhat larger and hyaline but not distinctly inflated . . . . 5.
5. Leaves entire or merely denticulate above . . . . *Oncophorus* and *Tortulaceæ* (in part.)
Leaves strongly serrate . . . . *Timmia.*

6. Leaves plainly two-ranked (Fig. 34) . . . . *Swartzia.*
   Leaves not two-ranked . . . . 7.
7. Leaves obtuse, broadly ovate to oblong-ovate . . . . . . *Aulacomnium.*
   Leaves acute to acuminate . . . . 8.
8. Papillæ not on faces of cells but formed by projecting angles of cell walls . . . . *Bartramiaceæ.*
   Papillæ on surface of cells . . . . 9.
9. Leaves squarrose-recurved, strongly serrate . . . . *Paludella.*
   Leaves erect, entire except at apex . . . . *Ceratodon.*

E

1. Alar cells plainly inflated, often colored . . . . *Blindia, Dicranum, Dicranodontium* and *Campylopus.*
   Alar cells not distinctly inflated, but sometimes larger and hyaline . . . . 2.
2. Leaves bordered, at least in the lower half, by a margin of narrow elongated cells . . . . 3.
   Leaves not bordered . . . . 4.
   Leaves indistinctly bordered . . . . *Rhodobryum* and *Mnium cinclidioides.*
3. Leaves broader; leaf cells nearly as broad as long . . . . *Mnium.*
   Leaves narrower; leaf cells more elongated . . . . *Bryum, Mniobryum.*
4. Upper leaf cells 20^{μ} or more in diameter . . . . 5.
   Upper leaf cells small or narrower, rarely over 15^{μ} wide . . 10.
5. Leaf cells short, quadrate or rounded . . . . 6.
   Leaf cells elongated . . . . 7.
6. Costa excurrent . . . . *Pottia.*
   Costa ending below apex . . . . *Mnium stellare.*
7. Leaf cells mostly with pointed ends . . . . 8.
   Leaf cells flattened at the ends (or leaves large, wide and flaccid) . . . . *Splachnaceæ, Funariaceæ*
8. Leaves closely imbricate, green or pinkish . . . . *Plagiobryum.*
   Leaves closely imbricate and silvery white . . . . *Bryum argenteum.*
   Leaves scarcely imbricate . . . . 9.
9. Leaves usually narrow, costa not reaching apex . . . . . *Pohlia, Mniobryum albicans.*
   Leaves usually narrow, costa often reaching apex or excurrent . . . . *Bryum.*
   Leaves hair-like, costa long-excurrent . . . . *Leptobryum.*
10. Leaves short, glaucous, mealy looking . . . . *Sœlania.*
    Leaves not glaucous . . . . 11.
11. Leaves obtuse, rounded or somewhat apiculate . . . . . . 12.
    Leaves acute to slenderly acuminate . . . . 13.
12. Leaves serrate . . . . *Meesea* and *Aulacomnium* species.
    Leaves entire . . . . *Meesea* species.
13. Plants minute, rarely collected unless fruiting . . . . . . 14.
    Plants of medium size ($1-3^{cm}$) or larger . . . . 15.
14. Alpine or subalpine; rare . . . . *Brachyodus, Seligeria, Rhabdoweisia.*
    Plants of lower altitudes of frequent occurrence . . . . . *Bruchia, Pleuridium* and *Dicranella* species.

15. Leaves secund . . . . *Dicranella, Ditrichum.*
Leaves rarely secund . . . . 16.
16. Leaves squarrose-spreading . . . . . . *Meesea, Dicranella Schreberi.*
Leaves not squarrose-spreading . . . . 17.
17. Leaves entire or nearly so . . . . *Ditrichum, Didymodon, Trematodon, Dicranella.*
Leaves serrate . . . . *Ditrichum, Dicranella, Bartramia Œderi, Timmia.*

F. Pleurocarpi

1. Leaves papillose by reason of projections from the cell surface . *Leskeaceæ* (one or more exceptions).
Leaves not papillose, or rarely papillose by reason of the projection of the angles of the cell walls . . . . 2.
2. Leaves ecostate or with costa short and inconspicuous . . . . 3.
Costa well developed, usually single, sometimes double or forking . . . . 12.
3. Leaf cells from lower median region 1–5:1 . . . . 4.
Leaf cells 5–20:1 . . . . 6.
4. Complanate-foliate . . . . *Neckeraceæ.*
Not complanate-foliate . . . . 5.
5. Leaf cells thick-walled . . . . *Leucodontaceæ, Habrodon.*
Leaf cells thinner-walled . . . . *Amblystegiella, Leskea denticulata.*
6. Aquatic, long and floating . . . . *Fontinalis.*
Not aquatic or, if aquatic, not long and floating . . . . . . 7.
7. Leaves squarrose-recurved . . . . *Campylium, Hylocomium* species, *Plagiothecium striatellum*
Leaves not squarrose-recurved . . . . 8.
8. Strongly complanate-foliate . . . . *Plagiothecium, Entodon, Hypnum pratense.*
Not complanate . . . . 9.
9. Aquatic . . . . *Hygrohypnum, Raphidostegium, Scorpidium.*
Not aquatic . . . . 10.
10. Regularly pinnate and plumose . . . . *Hypnum, Hylocomium.*
Not regularly pinnate and plumose . . . . 11.
11. Growing on trunks of trees . . . . *Pylaisia, Platygyrium, Raphidostegium, Hypnum.*
Not growing on trees . . . . *Calliergon, Hypnum, Raphidostegium, Plagiothecium, Entodon seductrix.*
12. Median leaf cells 1–5:1 . . . . 13.
Median leaf cells 5–20:1 . . . . 18.
13. Large plants with dendroid habit . . . . *Climacium* (excl. forms of *C. Kindbergii*), *Porotrichum.*
Smaller plants, not dendroid . . . . 14.
14. Growing on trunks of trees . . . . 16.
Growing on soil, stones or decaying wood . . . . 15.

15. Leaves squarrose-spreading in most species . . . . *Campylium*.
Leaves complanate . . . . *Homalia*.
Leaves not squarrose-spreading or complanate . . . . *Amblystegium*, *Brykia*, *Brachythecium reflexum*.

16. Very small or very slender or both . . . . *Fabroniaceæ*, *Cryphæa*.
Plants of medium size . . . . 17.

17. Complanate-foliate . . . . *Homalia*.
Not complanate-foliate . . . . *Forsstrœmia*.

18. Leaves strongly falcate-secund, aquatic or growing in very wet places . . . . *Cratoneuron*, *Drepanocladus*, *Dichelyma*, *Hygrohypnum*.
Leaves not falcate-secund, some aquatic . . . . 19.

19. Leaves rounded at apex, obtuse or apiculate . . . . *Calliergon*, *Hygrohypnum*.
Leaves acute to acuminate . . . . 20.

20. Aquatic . . . . 23.
Not aquatic . . . . 21.

21. Leaves rugose . . . . *Rhytidium*.
Leaves not rugose . . . . 22.

22. Costa double or forking . . . . *Hylocomium*.
Costa single . . . . *Brachythecieæ*, *Hylocomium Pyrenaicum*, *Campylium*, *Drepanocladus* forms.

23. Long and floating . . . . *Drepanocladus* forms.
Not long and floating . . . . 24.

24. Costa double and forking . . . . *Hygrohypnum* (excl. *H. Closteri* and forms of *H. palustre*).
Costa single . . . . *Brachythecieæ*, *Amblystegium* forms.

CORRECTIONS

(Minor typographical errors that are in no way misleading are not noted here.)

Accents either not given or given incorrectly.

Page 64, juniperìnum.	Page 138, críspum.	Page 267, Pyrenàicum.
Page 67, capillàre.	Page 148, tophàceus.	Page 269, rugòsum.
Page 99, Bonjeàni.	Page 186, striàtum.	Page 272, salebròsum.
Page 103, pállidum.	Page 190, lùteum, rùbrum.	Page 277, digástrum, acùtum.
Page 109, álbidum.	Page 233, orthorrhýnchum.	Page 295, Cirriphýllum.
Page 122, unícolor.	Page 240, recógnitum, Philibérti.	Page 307, flùitans.
Page 137, pilíferum.		Page 314, Séndtneri.
Page 138, Sullivántii.		

The names of subfamilies are in many cases spelled with the ending "æ" instead of the correct ending "eæ," e.g., page 137, "*Weisiæ*" should read "*Weisieæ.*" Also Natürlichen is spelled Naturlichen in several places.

Page 16, end of line 21, for "*Webera*" read "*Pohlia.*"

Page 18, line 14. For "protenemata" read "protonemata." Line 3 from the bottom. For "the sex" read "these."

Page 30, line 9 of explanation. For "operculum" read "peristome."

Page 36, line 7. For "*Raphidostegium recurvans*" read "*Hypnum laxepatulum.*" Also page 49, second line from bottom.

Page 39, line 6 from end. For "*cribose*" read "*cribrose.*"

Page 43, line 5 from bottom. For "*Hypnum rugosum*" read "*Rhytidium rugosum.*"

Page 44. For "umbomate" read "umbonate." First line of note. For "22" read "23."

Page 46, line 5. For "Amlystegium" read "Amblystegium."

Page 48, section 12 of key. After "*Aulacomnium*" insert "*Bartramia Œderi.*"

The Encalyptaceæ are unintentionally omitted from key. Members of this family will probably be sought under the *Tortulaceæ.*

Page 49, section 22. After "*Myurella*" insert "*Thuidium paludosum,*" "*Leskea* species. Section 23. For "*Pylaisiæ*" read "*Entodonteæ.*"

Page 65, line 5. For "Piliferum" read "piliferum."

Page 67, line 15 from bottom. For "asymetric" read "asymmetric."

Page 70, line 2 from bottom. For "Fig. 2" read "Fig. 20."

Page 71, line 9 from bottom. For "*Buxbaumia's*" read "*Webera's.*"

Page 80, section 4 of key. For "inflated neck" read "slender neck."

Page 81, line 13. For "25^{mm}" read "2.5^{mm}."

Page 84, line 4. For "5^{cm}" read "1.5^{cm}."

Page 85, lines 8 and 11. For "*Distichum*" read "*Distichium.*"

Page 86, line 5. For "confine" read "confined"; and for "and of several" read "and several." Section 1 of key, second line. After "faintly" instead of "so" read "papillose."

Page 98, line 7 below key. Before "*Sauteri*" insert "*Bergeri.*"

Page 101, line 6 from bottom. For "(Hedw.)" read "Hedw."

Page 155, last line. For "1–3^{mm}" read "1–3^{cm}."

Page 169, line 11. For "Planzenfamilien" read "Pflanzenfamilien." Line 3 from bottom. For "(Hedw.)" read "Hedw."

Page 179, line 9. For "bigemminate" read "bigeminate."

Page 192, line 16 from bottom. For "*serrata*" read "*serratum.*"

Page 202, section 2 of key. Interchange the descriptions of basal cells to agree with text.

Page 207, line 4. For "Gaspe" read "Gaspé."

Page 228, line 12 from bottom. Before "serrate" insert "the leaves are."

Page 238, line 10 from bottom. Omit "loosely" before "pinnately."

Page 240, line 1. For "medium" read "median."

Page 245, line 3 from bottom. For "bicostate" read "double."

Page 253, line 14 from bottom. For "abrubtly" read "abruptly." Line 7 from bottom. For "*Schuetschkea*" read "*Schwetschkea.*"

Page 263, line 11. For "*Entodoneæ*" read "*Entodonteæ.*" Also page 299, line 22.

Page 264, line 1 of key. For "costa strong" read "costa evident." Section 2. For "*Entodoneæ*" read "*Entodonteæ.*"

Page 283, line 5. Before "rough" insert "seta."

Page 287, line 7. For "1.3–0.3^{mm}" read "1.3x0.3^{mm}."

Page 306, line 5. For "LXXII" read "LXXI."

Page 314, line 16. For "*Campylium riparium*" read "*Amblystegium riparium.*" Lines 17 and 18. For "*attenuatum*" and "*intermedium*" read "*attenuatus*" and "*intermedius.*"

Page 315, line 12. For "stand" read "strand."

Page 353, line 5 from bottom. For "*ubulaceum*" read "*subjulaceum.*"

Page 359, line 15. For "*Rapidostegium*" read "*Raphidostegium.*" Line 6 from bottom. For "*laxapatulum*" read "*laxepatulum.*"

Page 373, line 10 from bottom. For "*Rothei*" read "*Ruthei.*"

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* Illustrated.