LIVERWORTS OF THE WESTERN HIMALAYAS
AND THE PANJAB PLAIN

(ILLUSTRATED)

PART I

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PREFACE.

The only comprehensive work on Indian Liverworts was published by Mitten in 1860 (Jour. Linn. Soc. Vol. V. No. 18,19). His paper, however, gives only the names of the species already known, and descriptions are given only in the case of new species. Since then many more species have been described, specially by Stephani in his "Species Hepaticarum," the last volume of which was published in 1925. The descriptions in both these works are in Latin, and whereas the former work is very old and out of date, the latter, dealing as it does with the liverworts of the whole world, is too large and costly and, therefore, beyond the reach of the ordinary student. Both these works are without illustrations. It is highly desirable that a handy volume should be available on the Indian species of this fascinating group. For many years the writer has been observing and collecting these plants in the Himalayas and has described a number of new species. The present work has been undertaken to bring together the descriptions of all the species which have been seen by the writer in the Himalayas West of Nepal and the Panjab Plain, and to these has been added a number of species not seen by the writer but given by Stephani in "Species Hepaticarum" as occurring within this area. This work, therefore, should form the groundwork for a more intensive study of these plants. Many excellent works dealing with the local Liverwort Flora of European countries are available in English and other European languages, and it is the hope of the writer that the present little volume may lead to an increased interest in the plants of this group occurring in India when more detailed works would no doubt be forthcoming.

The present volume deals with the Anthocerotales, Marchanti-ales, Sphaerocarpales, and the Anacrogynous Jungermanniales. The second volume would deal with the Acrogynous Jungermanniales. It may be possible by and by to produce a work dealing with the Liverworts of the whole of India, but this requires large collections from the Eastern Himalayas and South India which are particularly rich in foliose forms.
In the case of indigenous species fuller descriptions and more figures are given than in the case of others which have a wider distribution and have been fully described and figured in many books.

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S. R. KASHYAP.
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INTRODUCTION

GENERAL CHARACTERS.

Liverworts form one of the two classes into which it is customary to divide the group Bryophyta, the other class being the Mosses. The liverworts are either thallose, without any differentiation into stem and leaves, or leafy. In the case of the thallose forms there is no difficulty in distinguishing them from the mosses. They are prostrate, dorsiventral, usually forked, fixed to the soil by means of rhizoids, and in many cases, possess scales on the ventral surface. The leafy forms superficially resemble the mosses, but can be distinguished from them more or less readily by means of several characters. The leafy liverworts are generally more or less prostrate and have as a rule two rows of leaves, though, in some, a third ventral row is present; but in mosses the leaves are usually spirally arranged in several rows. The leaves of liverworts are practically always without a midrib which is generally present more or less distinctly in moss leaves. The rhizoids of the liverworts (by which they are fixed to the substratum: soil, bark of trees, etc.) are unseptate, unlike those of the mosses which are transversely septate. The protonema in liverworts is small, ephemeral; in mosses it is very much developed, filamentous and branched. The capsule in liverworts contains, in most cases, besides the spores, sterile cells—elaters, which are absent from the moss capsule. The columella and the peristome, which are characteristic of most mosses, are absent in the liverworts except in the Anthocerotaceae where a columella is usually present.

ALTERNATION OF GENERATIONS.

The liverworts, like the mosses, exhibit a distinct alternation of generations. The ordinary plant is the sexual stage, gametophyte, and bears the sex organs, antheridium or the male organs containing sperms, and archegonia or the female organs containing the egg. The antheridia and the archegonia may occur on the same plant, when the plants are called monoecious, or they may be found on different plants, dioecious. After fertilisation
by the sperm the egg develops into the asexual stage or the sporophyte, called in Bryophyta by the special name sporogonium. In the higher forms the sporogonium consists of three parts, i.e., the foot, the seta, and the capsule. The foot serves to fix the sporogonium in the tissue of the gametophyte, seta serves to bring the capsule out, and the capsule is a sort of vessel for containing spores and elaters. The wall of the capsule is made of one or more layers of cells. The capsule dehisces variously, setting the spores free. The spores on germination again produce the gametophyte. In simpler forms the seta is very rudimentary, merely a constriction, and in some very simple forms both foot and seta are absent.

VEGETATIVE REPRODUCTION.

In addition to the usual mode of reproduction described above, these plants propagate themselves vegetatively also, when the conditions are favourable for vegetative growth. The commonest method is by the death of the older parts separating the younger branches, which grow into new plants. Many species propagate by means of gemmae which are found in receptacles of various shapes, on the tips of branches or on the margins of leaves. They are generally green and are meant for increase in number of plants during the favourable season. They germinate immediately, and if dried, die. Some plants form more or less definite tubers, by the modification of shoots or parts of shoots, to tide over the period which is unfavourable for growth. These tubers are usually buried under ground and are not much affected by changes of temperature or drought.

AREA DEALT WITH.

The area dealt with in this book consists of (1) the Himalayas from the border of Nepal in the east to Kashmir in the west: i.e., the Kumaon Himalayas, including the districts of Almora and Garhwal; the Panjab Himalayas, including the valleys of the Sutlej, the Beas, the Ravi, the Chenab (Chandra-Bhaga) with its two branches, the Chandra and the Bhaga; the Kashmir Valley; Ladak: the isolated valleys of Spiti and Zanskar; (2) the Panjab plain and some portions of the North-West Frontier Province. Collections have been made in all these localities by the writer personally, and the plants were seen in
the living condition. Specimens received from other sources are indicated in their proper places. Western Tibet proper from Kunawar to the source of the Sutlej has also been visited on several occasions but it may be stated at once that no liverworts have been found in that region. Strictly speaking, the districts of Garhwal and Almora should not be included in the "Western Himalayas" but as the country is in continuation of the Western Himalayas and they have been visited many times, they are included in this area. Both districts are very rich in liverworts. A few species have been included which have not so far been met with in the area but may be expected to occur.

Under distribution references are given to other parts of India also when specimens have been seen by or sent to the writer from such places.

CLIMATE.

(1) THE PLAINS.

Liverworts require a good deal of moisture during the growing season. The Panjab plains are very hot and dry during the summer which is, therefore, very unfavourable for their growth. The winter is a little less unfavourable. Some thallose forms are met with here and there near water and spore-formation is complete before the onset of the severe summer heat. The few liverworts met with in the plains right up to the foot of the hills are practically all thallose.

(2) THE MOUNTAINS.

The mountains are very much more favourable for the growth of liverworts. The winter, however, is the resting season there on account of low temperature and scanty precipitation. The growth is active during summer and the rainy season—May to September. The plants are in their full bloom in the rainy season—July and August, ripening their fruits from August to September. The number of species and individuals is directly proportional to the amount of moisture, especially the rainfall.

As is well known, in the western part between the Sutlej and Kashmir, the Himalayas form three more or less parallel ranges running south-east to north-west. The outermost is the Outer Himalayas on which most of the summer resorts of the Panjab are situated. The Middle Himalayan range is separated
from the outer by the Ravi (Chamba) valley, and is higher than
the outer range. The Inner or the Main range is the highest and
is separated from the middle by the valley of the Chandrabhaga
(Kishtwar, Padar, Pangi, and Lahul). Beyond this range lies
the Trans-Himalayan region (Ladak). The rainfall is heaviest
in the outer Himalayas and the liverworts are most numerous
in this region. The greatest development is reached at an
altitude of 5,000 feet to 8,000 feet above the sea level. In the
Ravi valley the rainfall is smaller, and in the Chandrabhaga
valley it is smaller still, and the number of species and indi-
viduals falls proportionately. Beyond the main Himalayas the
rainfall is exceedingly low and the number of liverworts is
reduced to a very few species. In Western Tibet as already
stated there are no liverworts. Their number, again, decreases
as we travel from the south-east to the north-west along the
whole mountainous area. At higher altitude cold becomes
another inhibiting factor, in addition to the decreased moisture.
The highest altitude is reached by Preissia quadrata, Marchantia
polymorpha and Sauchia spongiosa, just beyond the Bara Lacha
Pass at about 15,000 feet, the last species occuring at a slightly
lower level than the other two species.

The details of rainfall and temperature of some stations in
the plains and hills, together with the species occurring in
the plains and certain valleys are given in the appendices.

PERENNATION IN THE HILLS.

A few species like Anthoceros erectus and Notothylas Levieri
seem to be annual, but the rest are perennial. Some, as the
species of Dumortiera, Pellia and Marchantia, grow under water
or very near water, remaining alive and fresh throughout the
year, but even in these cases growth is not very active in
winter. Others simply dry up in winter, and resume their
growth at the beginning of the rainy season. These include all
the foliose forms and some thallose forms, such as the species of
Plagiochasma, Rebolia, Grimaldia, Fimbriaria, etc., which on
getting dry roll their margins upwards, protecting the upper
green surface and exposing the lower purple surface covered
with scales. On being moistened they become flat again and
begin to grow. Still others have their apical portion more or
less thickened and, in some, modified in other ways also, and this
is the only portion which persists in winter, the older portion dying away, *e.g.*, species of *Cyathodium*, *Cryptomitrium* and *Athalamia*. In some there are very definite rounded or cylindrical tubers with or without stalks which remain buried under ground during winter, such as species of *Exormotheca Stephensoniella*, *Fossonbromia*, *Sewardiella*, and *Anthoceros himalayensis*.

**HABITAT.**

The thallose forms, excepting the few that occur in very moist places or actually under water, are usually met with on exposed slopes, whereas the foliose forms are restricted to very shady and moist places on rocks or more often as epiphytes. Ecologically, therefore, the *Marchantiales* and the *Anacrogynous Jungermanniales* together with the *Anthocerotales* form one group, and the *Acrogynous Jungermanniales* another.

Plants of the same species *usually* vary in size according to the amount of moisture available. Specimens growing in moist places are larger than those in dry places. Similarly, speaking *generally* of the *Marchantiales*, species growing under water or on moist places are larger than those growing in dry places. *Dumortiera* growing actually under water possesses the largest thallus. *Conocephalum* occurring in moist places is not much smaller. *Wiesnerella* is fairly large. Passing through the many other species of medium size we reach the genus *Riccia* in which the thallus is usually very small and some of the species are among the smallest liverworts in this group.

**ARRANGEMENT OF GENERA.**

A few words are needed regarding the arrangement of families and genera. The arrangement adopted in this book is from the highest to the lowest, which is contrary to what is usually followed in most of the books. In the writer’s opinion the evidence for the derivation of simpler forms from the more complex ones is very strong. It is of course impossible to arrange all the genera along one line of descent. It is clear that there have been not only several lines of descent but also branches from these main lines, so that the arrangement along one line of descent becomes impossible. The reduction, moreover, does not affect all the organs uniformly. One part may be affected more than another. It is possible that, in some cases,
one part is being simplified, whereas another is being more highly differentiated. The relationships of the genera have been indicated, wherever necessary, in the body of the book. This subject is dealt with more fully in my Presidential Address to the Botany Section of the Indian Science Congress at Bombay, 1919 (Proceedings of the Asiatic Society of Bengal, New Series, Vol. XV, No. 4, 1919).

In the Anthocerotales it is probable that the simple genus Notothyelas has been derived by reduction from a higher form, as is shown by the presence of very definite and well-developed lines of dehiscence although the capsule never comes out of the involucre and has no chance of opening. It appears that the ancestral form in this group was erect and radial as is still the case in some specimens of A. erectus while the more common prostrate form is derived from it through intermediate stages.

In the Marchantiales, however, several lines of descent are traceable. One line is especially clear and includes a large number of genera. This is from the level of Marchantia downwards through Conocephalum, Exormotheca, and Aitchisoniella to Targionia. From Exormotheca a branch line is given off towards Stephensoniella, Boschia and Corsinia. Along this line the number of involucres in the receptacles is gradually reduced, though the number of archegonia in each involucre remains fairly large. The receptacle remains terminal but the stalk is gradually reduced till we find that in Targionia the lobe of the receptacle grows out into a vegetative lobe bearing the involucre at the apex. The stalk in the branch-line (Stephensoniella line) becomes gradually shifted to the dorsal side, becomes small, and is ultimately lost in Boschia and Corsinia. At the same time the capsule wall and the elaters undergo simplification as regards the fibrous bands found on them. In both cases the ultimate result has been the loss of the stalk, in one case without shifting of the position of the receptacle from the apex to the dorsal side and in the other cases along with this change in the position of the receptacle. For this reason the family Targioniaceae has been merged into the family Marchantiaceae. Another line is from Conocephalum to Dumortiera through Wiesnerella.

The Astroporae, Operculatae and Compositae of Leitgeb can be maintained for the sake of convenience of study only, otherwise there is no hard and fast line between them as shown by
forms like *Aitchisoniella*, *Athalamia pusilla* and *Sauchia spongiosa*.

In the *Astroporae* the number of involucres in the receptacle remains fairly large but the number of archegonia in each involucre is reduced to one ultimately, and the capsule retains the fibrous band on its wall-cells. The thallus, however, has in most cases developed the typical star-like pores with thick radial walls and narrow chambers.

In the *Operculatae* the capsule wall has lost the fibrous bands, the pores are thin-walled, but in the number of involucres and archegonia the group resembles the *Astroporae*. In both these groups the terminal stalk has ultimately been shifted to the dorsal side, as is seen in *Plagiochasma* and *Athalamia*. In *Plagiochasma* particularly this process is seen very clearly.

The occurrence of fixed elater-like cells at the base or apex or both places in the capsule of the higher *Marchantiales* probably indicates that it is a remnant of the columella which must have been present in the ancestral form. A nearer approach to the columella is found in some of the *Anacrogyneous Jungermanniales*, as *Pellia* and *Aneura*. In the *Anthocerotales* a columella is of course generally present.

In the *Jungermanniales* these lines are not so fully worked out, but it seems probable that the foliose forms have given rise to the thallose forms by condensation, and at the same time the terminal cluster of archegonia has become shifted to the dorsal side as the erect habit gradually passed into a prostrate one. *Fossumbronia* and *Sewardiella* are good examples of this process of derivation by condensation of one form from the other. It is well known that in some *Acrogyneous Jungermanniales* (*Pteropsiella*, *Metzgeriopsis* and *Protocephalozia*) the vegetative body is thallose but leaves appear in connection with the sex organs on fertile shoots. It is reasonable to suppose that the bracts in connection with the antheridia and archegonia in the thallose *Anacrogyneae* are homologous with the leaves of the *Acrogyneae* and vestiges of the leafy habit of the ancestral forms which has been lost in the vegetative portion. The bell-shaped perianth in forms like *Sewardiella* arises as a group of separate scales which are carried upwards later on by basal growth more or less in a circle. Here again the individual development indicates the presence of leaf-like structures at an earlier period. In the case of the antheridia these scales usually remain free.
INTRODUCTION

The main factor in this reduction in the whole class has obviously been an increase of vegetative growth at the expense of sexual reproduction (and therefore simplification of the structure of the sexual receptacles), probably as an adaptation to a drier habitat, at least in most cases. The probable origin of the genus *Riccia* is indicated under that genus in the body of the book.

VARIABILITY

Many of the liverworts are very variable. Details will be given at the proper places in connection with the different species. Disregard of this fact is apt to lead to multiplication of species, when as a matter of fact, we may be dealing only with modifications due to habitat. Field observations on living plants growing under various conditions are necessary to realize the great range of variability. It is very difficult to judge from scanty herbarium material whether a form is a species or merely a variety. Some of the species described in this book have a very wide range of distribution under very different climatic conditions and a few occur at altitudes varying from less than 1,000 feet to 10,000 feet, 12,000 feet, and even 14,000 feet above the sea level. Such plants afford a particularly favourable material for the study of variation in relation to the different climatic factors. It is not only the vegetative parts of the plant which vary in form and size but, in some cases, even such fundamental structures as the spores and the sexual receptacles differ a good deal in various ways in different individuals of the same species.

MYCORRHIZA.

Fungal hyphae are quite commonly met with in the cells of the midrib in the older parts of many thallose forms. In most cases the fact is mentioned at the proper place under the various species. The hyphae penetrate into the thallus through the rhizoids (in the case of the Marchantiales through the smooth rhizoids). As the fungus often occurs in the older parts of the thallus it appears that the union is not always symbiotic but the fungus is at least in many cases merely a parasite on the Liverwort.

SYNONYMS.

It will be seen that very few synonyms are cited, and these only where they were thought to be absolutely necessary. Synonyms are available to the specialist in larger works.
GLOSSARY

Accrescent, increasing in size with age.
Acrogynous, having the stem terminated by archegonia.
Acuminate, having a gradually diminishing point.
Adherent, showing union of parts usually separate.
Adnate, united with another organ.
Adventitious, produced abnormally.
Alveolate, with cavities on the surface (spores).
Amphigastria, underleaves.
Amplexicaul, stem-clasping (leaf).
Anacrogynous, stem not being terminated by archegonia and continuing to grow.
Androecium, male (antheridial) system.
Annular, like a ring.
Antical, upper surface (stem or leaf).
Appendage, part or process attached to the main body of an organ (scale).
Appressed, lying flat for the whole length of the organ.
Approximate, close together.
Arcuate, bent like a bow, curved.
Areolae, small spaces marked on the surface (spores).
Auricle, a small lobe or ear.
Auriculate, having auricles or small lobes at the base.
Bilabiate, two-lipped.
Bipartite, divided nearly to the base into two portions.
Biseriate, in two rows.
Bistratose, cells in two layers.
Bracteoles, modified underleaves.
Bracts, modified leaves protecting the sex organs.
Caducous, falling off early.
Caespitose, growing in tufts.
Calyptra, a protective covering around the young capsule derived from the archegonium.
Campanulate, bell-shaped.
Canaliculate, channelled.
Capillary, hair-like.
Capitate, head-like.
Carinate, keeled like a boat.
Carpocerehalum, female receptacle.
Chloroplasts, granules containing chlorophyll.
Chlophyll, the green colouring matter of plants.
Ciliate, fringed with hairs.
Ciliolate, fringed with very small cilia.
Circinate, coiled up into a ring completely or partially.
Cladogenous, cladocarpous, having a fruit terminating a lateral shoot.
Clavate, club-shaped (calyptra or hairs).
Collechymatous, having the walls of the cells thickened at the angles.
Columella, central column of sterile cells in a capsule (Anthoceros).
Commisure, the line of junction of the antical and postical lobes of a leaf.
Complanate, compressed, flattened.
Complicate, folded (leaf).
Compressed, flattened out (stem).
Concolorous, similar in colour.
Confluent, running into one another.
Connate, united.
Connicent, converging.
Constricted, suddenly narrowed.
Costa, midrib.
Contiguous, in contact (underleaves).
Cordate, heart-shaped.
Coriaceous, leathery.
Cortical, pertaining to the outer layer of the stem.
Costa, midrib (thallus).
Crenate, with rounded teeth.
Crenulate, with small rounded teeth on the margin.
Crisped-crispate, curled.
Cruciate, like a cross.
Cucullate, hood-shaped.
Cuneate, wedge-shaped.
Cuspidate, having a sharp, rigid point.
Cuticle, a layer of tough substance covering stem and leaves.
Deciduous, falling off.
Decumbent, prostrate but apical portion ascending.
Decurrent, leaf bases running down along the stem.
Decurved, curved downwards.
Deltoid, triangular.
Dehisce, to split open.
Dentate, toothed.
Denticulate, minutely toothed.
Dichotomous, repeatedly forked.
Dimorphic, an organism with two different forms.
Dioecious, with antheridia and archegonia on different plants.
Distichous, disposed in two rows.
Divergent, divericate; spreading apart.
Dorsal, the surface of the leaf away from the stem; the upper surface of a thallus or a prostrate stem.
Dorsiventral, with dorsal and ventral surfaces.

Echinate, with stiff bristles (spores).
Efflagelliferous, without flagella.
Elaters, sterile filaments or cells mixed with spores in capsules.
Emarginute, with a small notch at the apex.
Endogenous, arising from deep-seated tissue.
Epidermis, the outer covering.
Exogenous, arising from the superficial tissue.
Exserted, projecting beyond the surrounding parts.

Falcate, sickle-shaped.
Falcato-second, falcate and turned to one side of the stem.
Fasciculate, in close bundles.
Filiform, thread-like.
Fimbriate, fringed.
Flagellum, a fine thread-like branchlet.
Foliose, with leaves.
Foot, an organ of attachment and nutrition, the lowest part of the sporophyte.
Fugaceous, falling off easily.
Furcate, forked.
Fuscos, dull brown.
Fusiform, tapering at both ends like a spindle.

Galeate, shaped liked a helmet.
**Gamete**, sex-cell.

**Gametophyte**, a plant bearing sex organs and producing gametes which in turn produce the sporophyte.

**Geminate**, in pairs.

**Gemmae**, asexual detachments of plants meant for vegetative propagation.

**Gemmiferous, gemmiparous**, bearing gemmae.

**Geniculate**, abruptly bent like a knee.

**Gibbose**, with an enlargement on one side.

**Glaucous**, bluish green.

**Gemmulate**, composed of grains.

**Guard-cells**, cells surrounding a stoma.

**Homologous**, of one type, constructed on one plan though varying in form and function.

**Hyaline**, transparent, without colour.

**Hypogynous**, inserted below the archegonium.

**Imbricate**, overlapping like the tiles of a roof.

**Incised**, cut sharply.

**Incassate**, thickened (cell walls).

**Incubous**, the oblique insertion of distichous leaves, so that the lower overlap the upper on the same side of the stem on the dorsal surface, as in *Madotheca*.

**Incumbent**, leaning upon, folded.

**Infra-foliar**, below the leaves.

**Innovation**, a newly formed shoot which continues growth at the death of the older stem.

**Intercalary**, growth not apical, but between the apex and the base.

**Interfoliar**, between the leaves.

**Involucre**, a tubular structure serving to protect the archegonia and calyptra.

**Involute**, having the edges rolled inwards.

**Keel, carina**, a ridge like the keel of a boat.

**Lacerate**, irregularly torn or cleft.

**Laciniate**, cut into narrow lobes.

**Lacunose**, when the surfaces is covered with depressions, perforated with holes.

**Lamella**, a plate of tissue.
Lamina, expanded part of a leaf.
Lanceolate, tapering towards both ends, base a little broader, and with greatest breadth at about one-third from the base.
Lenticular, like a double convex lens.
Lignified, woody.
Ligulate, strap-shaped.
Ligulate, tongue-shaped.
Lumen, the cavity inside a cell.

Mammillate, having teat-shaped processes.
Marsupium, the fruiting receptacle of certain liverworts.
Midrib, costa (thallus); the vein of leaf.
Monoeious, the antheridia and archegonia on the same plant.
Muricate, rough with spinous processes.
Muriculate, rough with minute spinous processes.
Mucronate, abruptly pointed by a short spinous process.
Multifid, divided into many lobes.
Mycorrhiza, the symbiotic union of a fungus with a plant.

Nodulose, knotted, or thickened (trigones).

Obcordate, inversely heart-shaped, the notch being apical.
Obconical, inversely conical, i.e., attached at the narrower end.
Obcunlœae, inversely cuneate.
Obovate, inversely ovate.
Obtuse, with rounded end.
Ostiole, the tubular neck of the cavity containing antheridia.
Ovate, egg-shaped, broad end being basal.

Palmate, lobed like the fingers of the hand.
Papillae, minute processes on the surface.
Papillose, covered with papillae.
Paraphyses, sterile filaments occurring along with sex organs.
Parenchyma, more or less isodiametric cells.
Patent, spreading.
Patulous, spreading widely.
Pedicel, a short stalk.
Pellucid, wholly or partially transparent.
Perianth, inflated envelope surrounding the fertilised archegonium.
Perigonium, special bracts round the male flower.
Perigynium, the involucre of the female inflorescence in Bryophytes.

Pinnate, feather-like (leaves or branches).
Plicate, folded in plates.

Pores, small openings in the epidermis.
Postical, belonging to the lower surface of thallus, stem or leaf.

Procumbent, lying along the ground.
Proliferous, having offshoots.

Propagula, small caducous branchlet for vegetative propagation.
Proterandrous, the antheridia maturing before the archegonia.

Protonema, branched or unbranched filament, or a mass of cells developed from the spore and from which the plant arises later on.

Pseudo-elaters, sterile cells mixed with spores in the capsule of Anthoceros.

Pulvinate, like a cushion.
Punctate, dotted.
Pyriform, pear-shaped.

Quadrate, more or less square.

Radial, spreading from a common axis or centre.

Receptacle, a structure with or without a stalk containing archegonia or antheridia; applied also to gemmae-cups.

Recurved, curved backwards.
Reniform, kidney-shaped.

Repand, with slightly uneven margins, less than sinuous.
Reticulate, like a network.
Retuse, a blunt square end with a notch.
Revolute, rolled back.

Rhizoids, unicellular root-hairs springing from the underside of the thallus, stem or the receptacle.
Rhizoid furrow, a furrow in the stalk of the receptacle in the Marchantiaceae for conveying the rhizoids from the receptacle.

Rhizome, root-like underground stem

Rostellate, having a short beak.

Saccate, like a bag.

Sacculate, like a small sack.
Scale, a thin, flat, semitransparent plate of cells.
Scarious very thin and stiff like a scale.
Sclerenchyma, hard, thickened, elongated cells.
Second, turned to one side.
Serrate, toothed like a saw.
Serrulate, with fine teeth like a saw.
Sessile, without a stalk.
Setulose, bristle-like.
Sheathing, clasping round.
Sinuate, wavy.
Sinus, depression on the margin between two prominences.
Slime-papillae, papillae with slime extracted from the swollen extremity.
Spathulate, oblong with the basal end attenuated.
Sperm, motile male sex-cell moving by cilia.
Spinulose, having minute spines.
Sporogonium, the spore-bearing generation arising from the fertilised egg. The sporophyte of Bryophyta.
Sporophyte, the non-sexual generation or the part bearing spores.
Squarrose, arranged at right angles to the stem.
Stellate, star-shaped.
Stolon, a creeping stem with small leaves.
Stoma, Stomata, a breathing pore or aperture in the epidermis for communication of the internal space with outside.
Striate, with shallow markings or striae.
Stylus, a small awl-like lobule.
Subulate, like an awl.
Succubous, the oblique insertion of the distichous leaves of liverworts, so that the upper overlaps the lower on the dorsal side of the stem, as in Plagiochila.
Terete, cylindrical, not angular.
Tetrads, tetrahedral, spores remaining united in groups of four until mature.
Thallus, a plant body not differentiated into stem and leaves, flat and broad like a frond.
Trigones, the thickened angles of the cells.
Trigonus, having three obtuse angles.
Triquetrous, having three acute angles.
Tristichous, arranged in three rows.
**Truncate**, abruptly cut.

**Tuberculate**, with small warts.

**Tubercles**, peg-like projections on the inner walls of the rhizoids in *Marchantiaceae*.

**Turbinate**, top-shaped.

**Underleaves**, a third row of leaves on the under side of the stem.

**Undulate**, wavy.

**Uniseriate**, arranged in one row.

**Unistratose**, cells disposed in a single layer.

**Vaginate**, sheathing.

**Valve**, one of the divisions of the capsule wall after dehiscence.

**Venter**, the lower part of the archegonium.

**Vermiform, Vermicular**, worm-shaped.

**Verrucose**, covered with wart-like protuberances.

**Verruculose** with numerous small warts.
CONSPectus

Order I.

ANTHOCEROTALES.

Gametophyte a thallus, without air-chambers and scales, but possessing slit-like pores on the under-surface. Each cell with a large chloroplast. Rhizoids smooth. Antheridia in clusters, in closed cavities near the dorsal side. Archegonia embedded in the tissue of the thallus on the dorsal side. Sporogonium with a bulbous foot, a growing region, and a long capsule dehiscing from the apex downwards by two valves. Columella well-developed, of 16 rows of cells (except in Notothylas where the columella is often absent), arched over by the archesporium. Capsule wall usually green, and stomatiferous. Sterile cells simple or branched, mixed with the spores. Nostoc colonies are found embedded in the thallus.

Family I. Anthocerotaceae.

Characters same as those of the Order.

Order II.

MARCHANTIALES.

Gametophyte a thallus, and with the single exception of Dumortiera with air-chambers in the dorsal layer opening usually to the outside by means of pores. Scales on the under surface, usually in rows. Rhizoids usually of two kinds, smooth and tuberculate. Sex organs scattered on the dorsal surface in the simplest forms, arranged in receptacles in the higher forms, receptacles stalked in the highest forms. Capsule without a foot,
seta, and elaters in the simplest forms, but with all these in the higher forms.

**Family II. Marchantiaceae.**

Dorsal layer with well-developed air-chambers with or without assimilating filaments (exception *Dumortiera*). Pores well defined. Sex organs in groups, often on long-stalked receptacles. Sporogonium with foot and seta. Elaters present. Dehiscence by a more or less definite lid or valves.

**Family III. Ricciaceae.**

Dorsal layer with narrow air spaces or wide chambers; definite pores absent or rudimentary. Antheridia and archegonia usually scattered on the dorsal side and embedded in the dorsal tissue of the thallus. Sporogonium without foot and seta. Elaters absent. Spores come out by the decay of the capsule-wall and the thallus.

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**Order III.**

**Junggermanniales.**

Gametophyte a thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Archegonia usually arranged in groups but never raised on stalked receptacles, antheridia occasionally immersed in cavities. Sporogonium with foot and seta. Capsule wall two or more cells in thickness. Elaters present. Dehiscence usually by 4 valves.

**Suborder Anacrogynae.**

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the dorsal side. Archegonia in groups.
FAMILY IV. CODONIACEAE.

Thallose, foliose, or forms intermediate between them. In the foliose forms the leaves are in two rows, parallel to the stem or obliquely inserted and succulent, simple. Archegonial group surrounded by a perianth, and in the genus *Calycularia*, by an additional involucre also. Capsule usually with a long seta, globose or oval, dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells, well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base of the capsule or partly free, more rarely altogether free, 2-4 spiral.

FAMILY V. ANEURACEAE.

Thallus fleshy or membranous, in *Metzgeria* with a sharply-defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells of which the inner possesses more or less distinct semi-annular bands. Elaters either tapering towards each end, with one broad spiral band; or fixed, short and obtuse, with an indistinct spiral band, and persistent as erect tufts at the apex of the valves.

SUBORDER Acrogynae.

Gametophyte with stem and two rows of lateral, and frequently a third ventral row, of leaves. Archegonia in a terminal cluster. (To be taken up in the second volume).

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Order IV.

SPHAEROOCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on
the cells. Sterile cells thin-walled and disappearing at maturity. Dehiscence irregular.

**Family VI. RIELLACAE.**

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.
KEY TO THE GENERA.

Plants without air-chambers and pores, usually without scales on the ventral surface........................................... 2

Plants with air-chambers and pores (except Dumortiera), usually with scales on the ventral surface......................... 12

Capsule linear, thallus with Nostoc colonies.................................................. 3

Capsule more or less globose, thallus without Nostoc colonies except in Blasia......................................................... 4

Capsule long, linear, dorsal, coming out of the involucre

3

Anthoceros

Capsule short, marginal, included............................................................... Notothylas

Plants growing under water, with a dorsal wing, each sex organ in an inflated envelope................................................. Riella

Plants terrestrial, with lateral wings, individual sex organs without any envelopes......................................................... 5

Plants with leaf-like lateral lobes,.............................................................. 6

Plants with a midrib and lateral wing not divided into lobes. 7

Plants without Nostoc colonies, rhizoids purple. Fossumbronia

Plants with Nostoc colonies, rhizoids hyaline. Blasia

Plants bearing a tuber at the apex.............................................................. 8

Plants without apical tubers....................................................................... 9

Plants with dorsal lamellae, growing in the plains

Petalophyllum

Plants without dorsal lamellae, growing in the hills

Sewardiella

9

Sex organs on small shoots........................................................................ 10

Sex organs on ordinary main shoots............................................................ 11

Fertile shoots small, ventral; midrib distinct.

narrow; wing one cell thick................................................................. Metzgeria

Fertile shoots small, lateral; wing thick................................................. Aneura

Plants thin, under or near water sex organs without scales.

Pellia

Plants only on moist places, sex organs with scales.

Antheridia in pits................................................................................. 18

Pellia

Antheridia not in pits.............................................................................. Calycularia

Capsules embedded in the thallus.......................................................... 18

Capsules in involucres, not embedded in the thallus.................................. 14

21
| 13 | Thallus with long, lanceolate, purple scales on the ventral side, antheridia aggregated | **Ricciocarpus** |
| 14 | Thallus with small often fugaceous scales on the ventral side, scales sometimes absent, antheridia scattered | **Riccia** |
| 15 | Plants large, under or near water, no chambers and pores | **Dumortiera** |
| 16 | Plants in moist or dry places, and always with air-chambers and pores | 15 |
| 17 | Plants with gemmae-cups | 16 |
| 18 | Plants without gemmae-cups | 17 |
| 19 | Gemmae-cups goblet-shaped | **Marchantia** |
| 20 | Gemmae-cups lunate | **Lunularia** |
| 21 | Archegonia in a tubular bivalved involucre | 18 |
| 22 | just under the apex | 18 |
| 23 | Archegonia in stalked or sessile receptacles | 19 |
| 24 | Plants robust, large; involucres purple; scales conspicuous | **Targionia** |
| 25 | Plants delicate, small; involucre hyaline; scales minute | **Cyathodium** |
| 26 | Both male and female receptacles stalked | **Preissia** |
| 27 | Male receptacle sessile or antheridia sunken in the thallus | 20 |
| 28 | Female receptacle distinctly dorsal | 21 |
| 29 | Female receptacle terminal, marginal, or in the fork between two lobes | 22 |
| 30 | Male receptacle circular or horse-shoe-shaped | **Plagiochasma** |
| 31 | Antheridia sunken in the dorsal tissue of the thallus, papillae projecting | **Athalamia** |
| 32 | Female receptacle terminal, with a characteristic perianth | **Fimbriaria** |
| 33 | Female receptacle without a perianth | 23 |
| 34 | Female receptacles terminal, stalked, on small ventral shoots, arising from the midrib on either side | **Grimaldia** |
| 35 | Female receptacles terminal on the main shoots | 24 |
| 36 | Antheridia on the dorsal side of the thallus | 24 |
| 37 | no definite male receptacles | 25 |
| 38 | Antheridia in a definite, sessile male receptacle | 30 |
| 39 | Female receptacle sessile, with 1 or 2 involucres, plants small, air-chambers empty | **Aitchisonella** |
| 40 | Female receptacle stalked | 26 |
KEY TO THE GENERA

Female receptacle in the fork between two lobes:

26. involucres ................................................. Exormotheca

Female receptacle terminal, at least when young................. 27

Female receptacle terminal, becoming dorsal by continued

27. apical growth; apical tubers present.................. Stephensoniella

Female receptacle always terminal...................................... 28

Plants compact, scales of the female receptacle large, pores starlike with thick radial walls of

28. cells bounding these................................................. Sauteria

Plants spongy or thin, scales inconspicuous, pores

29. bounded by cells with thin radial walls........................................ 29

Plants thick, spongy; female receptacle convex............. Sauchia

Plants thin, flat; female receptacle flat.................. Cryptomittium

Female receptacle conical, dorsal surface with distinct

30. reticulations and distinct pores.................. Conocephalum

Female receptacle hemispherical, dorsal surface smooth..... 31

Plants near water, yellowish green, ventral

31. surface of the same colour...................................................... Wiesnerella

Plants in moist or dry places, deep green,

32. ventral surface purple......................................................... 32

Female receptacle hemispherical, with 7 to 9,

32. rarely fewer, lobes......................................................... Reboulia

Female receptacle flat, cruciate, with 4 involucres. Massalongsia

Note:—When a genus has been determined with the help of the above key, it should be confirmed by comparison with the full description.
Order I.

ANTHOCEROTALES.

Family I. ANTHOCEROTACEAE

Gametophyte a thallus, without air-chambers and scales, but possessing slitlike pores on the under surface. Each cell with a large chloroplast. Rhizoids smooth. Antheridia in clusters, in closed cavities near the dorsal side. Archegonia embedded in the tissue of the thallus on the dorsal side. Sporogonium with a bulbous foot, a growing region, and a long capsule dehiscing from the apex downwards by two valves. Columella usually well-developed, of 16 rows of cells (except in Notothyelas where the columella is often absent), arched over by the archesporium. Capsule wall usually green, stomatiferous. Sterile cells simple or branched, mixed with the spores. Nostoc colonies are found embedded in the thallus.

ANTHOCEROS L.


Thallus suborbicular, variously lobed, with the lobes more or less divided, of several layers of uniform cells in the middle, almost always without a sharply defined midrib. Nostoc colonies scattered in the thallus. Antheridia in closed chambers. Involucres dorsal, cylindrical. Capsule linear, bi-valved, much longer than the involucre. Epidermis of the capsule wall usually with stomata. Columella well developed. Pseudo-elaters with or without (Himalayan species) spiral bands. Spores usually with various projections.

Key to the species.

1 | Plants monoecious ........................................................................................................... 2
2 | Plants dioecious ................................................................................................................ 3
2 | Plants light green, thin .................................................................................................... A. Gollani
3 | Plants dark green, subturbinate .................................................................................. A. Longii

24
Plants usually erect or ascending, spores 30-40 μ........... A. erectus
Plants prostrate.................................................. A. himalayensis
Spores yellow, tetrahedral, 25 μ............................... A. chambensis
Spores opaque, faintly granular, 40-48 μ.................. A. chambensis

1. Anthoceros erectus Kashyap.


Plants dioecious, in dense clusters on damp earth. Thallus thick, fleshy, cavernous, often raised on a thick stalk-like structure and expanding above into a more or less cuplike body; more generally ascending or prostrate, fan-shaped, margin arising from the base as if diverging owing to a split. Deeply lobed, up to 10 mm. broad, margin slightly toothed. Male plants smaller. Involucres often fused in pairs, about 5 mm. long and 0.8 mm. in diameter; mouth truncate. Capsule slender, acute, up to 30 mm. long, wall with stomata. Spores black, granulose, 30-40 μ. Pseudo-elaters thin-walled, simple or branched, about 12 μ. broad.

Hab. Moist earth.

Distrib. Outer and Kumaon Himalayas, 5,000 to 8,000 feet. Mussoorie, etc., Kulu, Manali; S. India, Madras (Iyenger, Fyson); Travancore (Krupp).

Note:—From the description *A. Butleri* St. appears to be this plant, although he says it is dioecious. The plant can be easily recognised not only by its habit but also by the large chambers in the thallus filled with mucilage (not air) lumps of which come out when the plant is cut. In sections these chambers are very easily seen. The chambers are met within the involucre also where they are in one layer all round. In a transverse section of the involucre they appear in a circle round the capsule and inside the tissue of the involucre. The rhizoids are filled with some granular matter.

This species is apparently annual—one of the very few annual liverworts. The plant is interesting on account of its peculiar habit. It is often raised on a distinct stalk, the base of which may be thick or pointed. More often it has the appearance as if a funnel has been split along one side. Specimens from Madras (Fyson) have slightly larger spores (45 μ). They
have, moreover, minute spines on the surface which is merely granulose in the Himalayan specimens.

2. Anthoceros himalayensis Kashyap.


Dioecious. Closely attached to the substratum, green, black when dry, in large patches among moss and grass. Thallus variable in size; sterile plants long, linear, forked, about 5 mm. long and 1 mm. broad, tuber bearing; male plants smaller than the female plants and less divided; female plants large, circular, up to 20 mm. in diameter, deeply lobed, lobes again with divided margins and overlapping. Involucres often fused in pairs, cylindrical, slightly narrowed above, mouth usually truncate or indistinctly irregularly toothed, surface smooth, up to 5 mm. long. Capsule stout, cylindrical, obtuse, up to 30 mm. long, with stomata on the wall. Spores yellow, tetrahedral, convex surface with small rounded papillae, 25 p. Pseudo-elaters thin-walled, branched, occasionally some simple, 10 p. broad.

Hab. Moist shady places.

Distrib. Common throughout the Outer and the Kumaon Himalayas, 5,000 to 8,000 feet. Rarely in Lahore.

Note:—The plant bears rounded tubers. They are usually borne on sterile plants, at the apex, on the margin, or the ventral surface; occasionally on male and female plants also. They are sometimes embedded in the thallus but more often arise on long cylindrical stalks from the ventral surface or from the margins. The stalk may be up to 3 mm. long and the tuber up to 0.5 mm. in diameter. If the plants are growing among dense grass the tubers are mostly marginal and shortly stalked. Both the tuber and the stalk have some rhizoids.

The rhizoids in this species as well as in the other species of the genus are usually filled with granular matter.

This species is very variable in shape as stated in the description. Occasionally it grows under water and then forms dense patches of overlapping plants. Seen by themselves it would be impossible to refer them to this species, but a careful
Plate I.

Anthoceros Erectus. 1-4.
1. Five plants showing various forms.
2. A plant bearing sporogonia.
3. Spores.

Anthoceros Himalayensis. 5-8.
5. Sterile tuber-bearing plants.
6. A plant bearing sporogonia.
7. Spores.
examination of intermediate forms leaves no doubt about it. The plants growing under water are always sterile.

3. **Anthoceros chambensis** Kashyap.


Diocious. Plants closely creeping, firmly fixed to the soil, in dense circular or irregularly-lobed patches. Lobes thick, fleshy, cavernous, with large mucilage cavities inside, often overlapping; margin slightly raised, toothed. Patches up to 3 cm. or more in diameter. Lobes up to 1 cm. broad and up to 16 cells thick in the middle. No distinct midrib. Epidermal cells 32 μ x 20 μ. Rhizoids mostly smooth, some granular. Male plants not seen. Involucres tubular, narrowed above with a truncate mouth, 2.5 mm. long. Capsule 25 mm. long, solitary. Spores opaque, faintly granular, 40-48 μ. Pseudo-elaters thin-walled, usually branched, up to 100 μ long; slender.

Hab. Moist rocks.

Distrib. Chamba Valley; Punjab, *Sialkot* (Bishambar Das).

*Note*: Material poor. Requires more careful examination. Perhaps the same as *Anthoceros Gollani* St.

The following species have been described by Stephani but have not been seen by me.

4. **Anthoceros Gollani** St.


Monoecious. Plants small, light green, thin, cavernous. Thallus about 10 mm. long, oblong, furcate, lobes ligulate, regularly inciso-lobate. Involucres solitary, 4 mm. long, cylindrical, cavernous. Capsule 3 cm. long, thin, densely stomatiferous. Spores pale, almost smooth, 36 μ. Antheridia near the involucere, 2 in each chamber, chambers many.

Hab. Himalaya.

*Note*: —See remarks under *A. chambensis* above.
5. Anthoceros Longii St.


Plants monoecious, small, deep-green, subturbinate, frond about 5 mm. long, obcuneate, ascending. cavernous, repeatedly furcate. base thickened, margins thin, branches regularly narrowly lobed. Involucre solitary, 2 mm. long, delicate, cavernous, cylindrical, plicate. Capsule 2 cm. long, filiform, sparsely stomatiferous. Spores 45 μ. black, asperous. Androecia near the involucre, numerous, many antheridia in each cavity.

Hab. Himalaya, *Simla*.

*Note.*—Probably identical with *A. erectus* Kashyap, though the latter is dioecious.

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II. NOTOTHYLAS Sull.


Plants thalloso, thin, prostrate, furcate, very much branched, thick at the base, gradually becoming thin, one layered in the ultimate lobes. Androecial chambers often solitary, wide, with 2-4 antheridia in each. Antheridia large, oval, shortly pedicellate. Involucre short, oblong-cylindric, often folded. Capsule marginal, conical, with a large foot, never exerted, bi-valved, valves prominent by deeper colour or owing to the special cells along their margins. Stomata absent. Columella in the centre of the capsule large or altogether absent. Spores large, tetrahedral, with the convex side papillose. Elaters equal in size or longer than the spores. Yellowish, inflated, with spiral or simply oblique bands.

*Key to the species.*

Columella present, only a single row of special cells along the margin of each valve.............. ...... *N. indica*

No columella, four rows of special cells along the margin of each valve.............. .............. .............. .......... *N. Levieri.*
Plate II.

Notothylas Indica. 1—5.
1. A plant with sporogonia.
2. A portion of the same magnified.
3. Portion of the capsule wall showing the margins of the valves.
4. L. S. of capsule showing the columella.
5. A portion of one valve. Note the single row of marginal cells.

Notothylas Levieri. 6—10.
6. A plant with sporogonia.
7. A portion of the same magnified.
9. A portion of the capsule wall showing the margins of the valves.
10. A portion of one valve. Note four rows of special cells.


Dioecious. Plants growing singly or densely overlapping in patches. Thallus orbicular or suborbicular in the case of well developed singly growing plants, but in dense patches obovate, lobed, lobes with numerous blunt irregular processes; fully developed plants up to 15 mm. in diameter, lobes up to 6 mm. long and up to 8 mm. broad. *Nostoc* colonies scattered. Thickness in the middle 6 cells; upper epidermal cells 40×50 μ, middle cells 96×112 μ, lower epidermal cells 40×50 μ. Male plants not seen. Sporogonia marginal between the lobes, equal to or smaller than the full grown adjacent lobes, entirely within the involucres which are often in pairs; up to 3 mm. long and 0.5 mm. in diameter. Epidermis without stomata, wall of the cells very thick and brown, lumen fairly large, length of cells near base about 90 μ and near apex about 30 μ. Capsule with a very definite columella, and only a single row of thick-walled elongated cells along the margin of each valve; marginal cells 120 μ × 18 μ near the base and 32×21 μ at the apex. Spores opaque dark brown, minutely granular, 36 μ. Pseudo-elaters with oblique thin bands, 40 μ × 20 μ.

Hab. Moist rocks and earth.

Distrib. *Dehra Dun, Allahabad* (Dudgeon), *Bombay* (d’Almeida).

*Note:*—This is essentially a species of the plains ascending to about 2,000 feet. The species possesses a long and definite columella and is characterised by two rows of special cells along the suture, so that on separating the two valves, the margin of each valve has one row of these cells.

7. *Notothylas Levieri* Schiff. (Ms).


Dioecious. Plants thin, delicate, closely overlapping, in small thick patches, ascending or projecting outwards from vertical rocks. Largest plants circular in outline up to 15 mm.
in diameter, smaller plants usually obovate; margin lobed, lobes narrow small, toothed; *Nostoc* colonies scattered. Greatest thickness up to 6 cells in the middle, gradually thinning towards the single layered margin. Upper epidermal cell $41 \times 46 \mu$, internal cells $80 \times 96 \mu$, lower epidermal cells $40 \times 50 \mu$. Male plants not seen. Sporogonia marginal between the lobes, equal to or smaller than the full grown adjacent lobes, entirely within the involucres which often arise in pairs; up to 3 mm. long and 0.5 mm. thick. Epidermis without stomata; walls of the epidermal cells very thick and brown, cavity very narrow, cells $90-110 \mu \times 18-20 \mu$. Columella absent. Four rows of special thick-walled elongated cells along the margin of each valve; marginal cells at the base $160 \times 10 \mu$, those at the apex $66 \times 9 \mu$. Spores opaque, dark brown, minutely granular, 36 $\mu$. Sterile cells with oblique, curved, thin bands, or incomplete spirals, $45 \times 22-40 \mu$.

**Hab.** Moist rocks.

**Distrib.** Outer and Kumaon Himalayas, *Simla*, *Mussoorie*, etc. about 6,000 to 7,000 feet.

**Note:**—The presence of eight rows of special cells along the suture (four rows along the margin of each valve) is characteristic of the species. The cells are markedly different from the rest of the epidermal cells. They are deep brown in colour, very much darker than the neighbouring epidermal cells, their walls are quite straight and their thickness is not so striking though it is considerable. When the valves are separated the outer (free) walls of the marginal cells are found to be thin. It is along these thin walls of the marginal cells that the valves got separated when teased but the capsule, as usual in the genus, does not open under natural conditions, remaining always within the involucre. As the capsule ripens from the apex downwards, the marginal cells also are consequently found at different stages of development in the same order as the spores and elaters. There is no trace of a columella in this species and this character also distinguishes it from *N. indica*. Moreover this is a hill species occurring at higher levels than the latter. In other respects the two are very similar. The remarks about the marginal cells apply to *N. indica* also.

Occasionally a sporogonium may be met with on the dorsal surface instead of being marginal.
Order II.

MARCHANTIALES.

Family II. MARCHANTIACEAE.

Dorsal layer with well-developed air-chambers with or without assimilating filaments (exception Dumortiera). Pores well defined. Sex organs in groups, often on long stalked receptacles. Sporogonium with a foot and a seta. Elaters present. Dehiscence by a more or less definite lid or valves.

III. MARCHANTIA L.


Dioecious. Thallus richly dichotomously branched with a broad midrib and hexagonal areolae. Goblet-shaped gemmae-cups almost always present on the dorsal side of the thallus. Dorsal layer narrow, air-chambers in one layer, the filaments in the chambers frequently branched; pores barrel-shaped. Scales in two or three rows on each side of the midrib, inner ones (median) large, appendiculate; middle (laminar) without appendage, small, more or less ligulate; outer ones (marginal) near the margin, without appendage, small and more or less ligulate. Tuberculate rhizoids are given off from the surface of all the scales in addition to those arising in strands from the midrib. Male receptacle long-peduncled, disciform, stellately or palmately lobed; stalk with two rhizoid furrows on the anterior side. Stalk of the female receptacle with two furrows containing rhizoids on the anterior side and air-chambers on the posterior side; receptacle stellate, with 4–10 elongated rays, each with a rhizoid canal underneath; involucres 2-valved, alternating with the rays, enclosing several capsules, each surrounded by a perianth. Capsule with a long seta, dehiscing to below the middle by irregular valves. Capsule wall of one layer of cells: cells with annular bands. Spores small, tetrahedral, on the convex side irregularly lamellose.
Elaters simple, long, attenuate, bi-spiral. Gemmae more or less biconvex, vertically inserted, with one-celled hyaline pedicel, and an open sinus at each side, in groups at the bottom of goblet-shaped gemmae-cups, margin of the cup, shortly lobed or entire.

*Note:*—The pores on the thallus are barrel-shaped consisting of a few rings of super-imposed cells. Some of these rings are above the level of the epidermis while others are below, but there is no sharp distinction between these as one or two are bound to be opposite the epidermal cells and at the same level. The pores are broad in the middle and narrow above and below and the lower opening is in some cases more or less closed by projections from the bounding cells. In *Marchantia polymorpha* the inner pore is very variable in outline. Usually, however, each of the four or five cells bounding the pore is narrow and its inner wall bulges in its middle inwards into the cavity as a more or less well developed papilla which sometimes becomes very long giving the pore a cruciate appearance. In *Marchantia nepalensis* the inner wall of the bounding cells projects into the cavity of the pore very greatly and the pore is distinctly cruciate. In *Marchantia palmata* the bounding cells are narrow with a straight or slightly convex inner wall and is therefore quadrate in appearance. Stephani describes the pore of *Marchantia simulana* also as quadrate but I have not seen any specimens of this species.

**Key to the species.**

Inner pore quadrate bounded by narrow cells.

- Thallus with a median dark streak............. *Marchantia palmata*.
- Thallus without a median dark streak......... *Marchantia simulana*.

Inner pore cruciate ............................................. *Marchantia nepalensis*.

Inner pore bounded by narrow cells with a more or less well developed convex papilla from the middle of the inner wall of each cell.

*Marchantia polymorpha* L.


Dioecious. In large extended deep green patches. Thallus 2-10 cm. long, and 7-20 mm. broad, flat or slightly concave,
margins sinuate-lobed, apex emarginate. Dorsal surface with frequently a dark line along the middle; areolae somewhat distinct, epidermal cells 5-6-angled, walls thin, angles not thickened. Pores not visible to the naked eye, little elevated, with 5 superimposed concentric rings each of 4-5 cells, appearing oval from above, with 2-3 rings of cells above the level of the epidermis; inner pore quadrate to cruciate as seen from below, usually wide, bounded by 4 or 5 narrow cells the middle part of whose inner walls projects into the cavity of the pore as a convex papilla which is sometimes greatly elongated. The cells of the lowest ring rather elongated and projecting into the cavity of the inner pore as seen in a vertical section of the pore. Ventral surface brownish. Scales in three rows on each side of the midrib. Median scales largest, attached by a not very long base, appendage sub-rotund with an irregularly toothed margin; laminar scales more than half way from the midrib, without appendage, ligulate; marginal scales smallest, ligulate. Midrib scarcely prominent below, very gradually passing into the lamina, ending in a one-celled margin. Male receptacle with 8 short rounded lobes; stalk shorter than that of the female receptacle, air-chambers absent. Stalk of the female receptacle 3-5 cm. long, with air-chambers on the dorsal side. Spores spherical, 12 μ, nearly smooth. Elaters bispiral, long and narrow. Margin of gemmae-cup shortly-lobed, lobes triangular, acuminate, with a spinous margin.

Hab. Moist rocks and banks of streams.
Distrib. Common above 8,000 ft. Garhwal, Kedar Nath (11,000 ft.); Pangi; Ladakh, Leh, Kargil; beyond Bara Lacha pass about 15,000 feet.

Note:—The marginal scales are not arranged in one regular row but occur rather irregularly and very closely together, more or less overlapping. They do not correspond to the median or laminar scales in position and are more numerous than these. The cells of the inner pore are long and narrow, the middle part of the inner wall of the cells projects inwards into the cavity of the pore as a convex papilla. The size of the papilla is variable. In most cases it is quite small so that the papillae do not meet in the centre and a very large part of the cavity remains empty. In some specimens from Leh, however, these papillae were very long and almost meeting in the centre, leaving large empty spaces between their lateral walls.
The specimens from Leh are further characterised by the possession of a dark streak along the middle line, and the specimens, therefore, resemble the *forma aquatica* Nees. The dark median line, however, has chambers which are said to be absent in that form.

The Pangi specimens show another peculiarity. The thallus is much elongated, and the anterior margin of the gemmae-cup is mostly fused with the thallus and only slightly raised above it, giving the cup a superficial resemblance to the gemmae receptacle of *Lunularia*.


 Dioecious. Plants medium, green, growing in patches. Thallus 3-7 cm. or more long, dichotomous, with long narrow lobes 2-10 mm. broad, flat, margin entire, apex emarginate. Dorsal surface with a dark line in the middle; epidermal cells 5-6-angled, walls thin, angles not thickened. Pores with 6 superimposed concentric rings, each of 4-5 cells. 2 rings above the level of the epidermis, cells of the lowermost ring small, not projecting into the cavity of the inner pore as seen in a vertical section of the pore; inner pore quadrate as seen from below, bounded by 4 or 5 cells which are narrow and do not project into the pore. Ventral surface brown. Scales in two rows on each side. Median scales fixed by an oblique semilunar longly decurrent base, appendaged, appendage sub-rotund to ovate, coarsely and irregularly toothed; laminar scales without appendage, more or less quadrate; marginal scales absent. Midrib scarcely prominent below, gradually passing into the lamina ending in an acute margin. Male receptacle more or less circular with many short lobes, or palmatifid with long narrow diverging lobes, in the latter case 3-9 lobed; stalk 10-20 mm. long, air-chambers present on the dorsal side near the base. Stalk of the female receptacle up to about 35 mm. (mostly 20 mm.) long, green, with air-chambers on the posterior side; receptacle asymmetrical, deeply rayed, rays 7-11, narrow, slightly convex or flat, truncate or slightly emarginate. Involucres hyaline, margin crisped. Perianth purple. Capsules spherical, dark brown, several in each involucre. Spores yellowish brown.
reticulate, 24-30 µ. Elaters 540 to 630 µ. Gemmae-cups rather rare, margins shortly irregularly ciliate-dentate.

Hab. Moist rocks and water banks.

Distrib. Common in the Kumaon Himalayas and the Outer Himalayas up to Kashmir, up to 8,000 feet; fairly common in the plains, Lahore, Sialkot; Calcutta; Assam (S. L. Hora); South India (Iyengar). Often growing mixed with M. nepalensis.

Note.—The lobes are usually long and narrow and with a distinct dark line in the middle on the dorsal side. It can easily be distinguished from M. nepalensis by its narrow lobes with the dark mid-dorsal line and the female receptacles not being umbonate. The plant has a definite mycorrhizal region in the central part of the thallus. In a specimen from Lahore the stalk of the carpocephalum was seen to divide into two near its upper end. The undivided lower portion was 5 mm. long, while each of the branches was 1 mm. long. Each branch had a perfectly normal receptacle at its top. The main stalk showed four rhizoid furrows in two pairs, while each of the branches had one pair. Another specimen from Mussoorie showed that a lobe of the male receptacle after forming antheridia for sometime had begun to form ordinary vegetative tissue with even a gemmae-cup. The same specimen had an ordinary vegetative shoot arising from the ventral surface of another lobe of the male receptacle.

The male receptacle is very variable in form. The stalk sometimes possesses four furrows instead of two. The receptacle itself may be almost entire with a very slight indication of lobes or the lobes may be very long and narrow and diverging from each other.

Rhizoids of various diameters are met with, from 5 to 30 µ, and vary in colour from perfectly hyaline to bright yellowish brown. The narrowish rhizoids have long and short densely situated tubercles and are colourless. Others, a little broader, have rather thinner walls and are studded with tubercles and are either hyaline or are slightly yellowish brown. Still wider ones may have tubercles in one part and may be smooth in the remaining part, or may have a few small indistinct blunt tubercles scattered here and there and usually have a distinct yellowish brown colour and very thick walls. Still others have extremely thick
smooth walls and show no trace of tubercles. Some rhizoids of the large diameter are also met with which have smooth and thin walls. The walls of all the rhizoids except those of the last group are thick proportionately to the diameter. The scales usually have club-shaped mucilage cells projecting from the margin. The thallus usually has thick walled wide elongated (sclerotic) cells in the midrib, sometimes, however, these cells are practically absent. The number of cells bounding the inner pore may vary from 3 to 10, though usually it is 4 or 5.

10. Marchantia nepalensis L. et L.


Dioecious. In large patches of overlapping individuals. Branching richly dichotomous. Thallus larger in female plants, 18-30 mm. long and 6-12 mm. broad; lobes short and broad; flat, margin entire to crisped, apex emarginate. Dorsal surface pale green, without a dark median streak; areoles conspicuous; epidermal cells 5-6-angled, walls thin, angles not thickened. Pores with 6-8 superimposed concentric rings of cells, each of 4 or 5 cells, 2 rings above the level of the epidermis, the cells of the lowermost ring very long and projecting into the cavity of the inner pore as seen in a vertical section of the pore. Inner pore cruciform as seen from below, bounded by 4 or 5 cells projecting into it. Ventral surface brownish. Scales conspicuous, in two rows on each side of the midrib; median scales fixed by a long oblique semilunar decurrent base, appendaged, appendage ovate to ovate-lanceolate, tapering to an acute apex, distantly and irregularly toothed, sometimes almost entire; laminar scales very close to the median scales, ligulate, small; marginal scales absent. Midrib not prominent below, gradually passing into the acute margin. Male receptacle slightly lobed, lobes 6-8; stalk 3-6 mm. long, air-chambers absent. Stalk of the female receptacle 3 cm. or more long, green posteriorly, with air-chambers, brown anteriorly, beset with scales at its base. Receptacle umbonate, with 7-9 rays, rays obcuneate, strongly convex in the proximal part, thin and flat distally, apex crenate or occasionally emarginate. Involucres hyaline, fimbriate. Capsules pedicellate, several in each involucre. Spores brown, granular, 18-25 μ. Elaters
Plate III.

Marchantia polymorpha. 1—5.
  1. A male plant.
  2. A female plant.
  3. A gemmae-cup.
  4. A pore from above.
  5. Two pores from below.

Marchantia nepalensis. 6—10.
  6. A female plant.
  7. A male plant.
  8. Vertical section through a pore.
  9. A pore from above.
 10. Two pores from below.
400 to 640 μ. Gemmae-cups lobed, lobes deltoid, acute to acuminate, dentate to shortly spinose on the margins.

Hab. Moist rocks and water banks.

Distrib. Common in the outer Himalayas up to Kashmir, Garhwal and Kumaon, up to 8,000 feet; Punjab plain, Lahore etc.; Kaghan Valley (N. A. Qizilbash). Often growing mixed with *M. palmata*.

*Note.*—In the Kaghan Valley specimens apical adventitious shoots are present. Variations are met with in the rhizoids of this species also as described in the preceding species. The thallus possesses sclerotic cells and a mycorrhizal region as given under *M. palmata*. Oil-cells are found in the thallus in both the species. The plant can be distinguished from *M. palmata* by the absence of the median dorsal dark streak, by its generally broader and shorter lobes, the cruciate inner pore and the umbo-nate female receptacle.

The following species has been described by Stephani but not seen by me.

**II. Marchantia simlana** St.


Small, light green, ventral surface purple, up to 2 cm. long and 4 mm. broad, thin, midrib low, not prominent, gradually passing into the wings. Epidermal cells thin, delicate. Stomata large, slightly prominent; inner opening bounded by 5 narrow cells. Appendage of the scales large broadly ovate, acute, margin slightly crenulate, marginal cells small. Male receptacle not seen. Stalk of the female receptacle thin, short, 10 mm. long, naked, apex covered with filiform scales, scales of the involucre broadly lanceolate-cuspidate, or longly setaceous. Female receptacle small, 9-lobed, central disc large, lobes as large as the disc, linear, rather flat and distant; apex slightly cuneate, expanded. Involucres hyaline, lobate, lobes fimbriate. Rest not seen.

IV. PREISSIA Corda.

*Preissia* Corda in Opitz, Beitr. I p. 647 (1829).

Monoecious or dioecious Plants dichotomous, fertile ones with innovations from the apex. Air-chambers distinct, filled with filaments; pores barrel-shaped. Ventral scales large, in two rows. Male receptacle stalked (stalk shorter than that of the female receptacle), circular with a membranous margin, with scales on the under surface, stalk with 2 rhizoid furrows. Stalk of the female receptacle long, with 2 rhizoid furrows; receptacle hemispherical, with 3-5, usually 4, cruciate rays; involucres from the under surface alternating with the rays; perianth present. Foot large, seta distinct, capsule slightly exserted, subglobose, wall one-layered, cells with annular bands, dehiscing to about the middle by irregular, revolute valves, the cap breaking up. Spores reddish-brown, coarsely reticulate. Elaters yellowish, filiform.


Monoecious or dioecious. Plants in thin pale green patches. Thallus up to 3 cm. long and 5-10 mm. broad, nearly flat above or with a dorsal groove, margin thin wavy reddish brown entire or crisped, innovations obcordate, bilobed. Dorsal surface with distinct areolae, epidermal cells 4-6-angled, mostly quadrate at the margins, thin-walled, angles not thickened. Pores small, somewhat conspicuous, with 4 to 5 super-imposed concentric rings of cells, circular above with 2 rings, each of 4 to 6 cells, cruciate below with 3 or 4 larger cells. Ventral surface reddish brown, scales imbricate, in one row on each side of the midrib, semilunar, with minute lanceolate appendages. Midrib prominent below, containing longitudinal brown fibrous cells, rather suddenly passing into the lamina, ending in an acute margin. Stalk of the male receptacle up to 2 cm. long. Stalk of the female receptacle up to 5 cm. long, reddish-brown below. Receptacle usually 4-, often 5-lobed, with 4 or 5 involucres, each with a single capsule. Perianth inflated. Capsule wall of one layer of cells with numerous annular or spiral bands, lid dark brown.
PLATE IV.

MARCHANTIA PALMATA. 1—7.
1. A female plant.
2. A male plant.
3. A gemme-cup.
4. A pore seen from below.
5. Two pores from above.
7. A male receptacle, with two adventitious vegetative lobes.

PREISSIA QUADRATA. 8—11.
8. A female plant.
10. V. S. through the pore,
11. A pore from above.
Spores 58 to 74 μ in diam., reddish brown, coarsely reticulate. Elaters bi- or tri-spiral, reddish brown, 250 to 290 μ long.

Hab. On moist soil or rocks.
Distrib. Pangi, very common; Lahul; beyond Baralacha Pass, below Kinlung at about 15,000 feet; Kashmir, Asthanmarg (M. L. Sethi); Kaghan Valley (N. A. Qizilbash). Not met with in the Outer Himalayas at the ordinary hill stations, rare in the Ravi valley.

Note:—The receptacle is usually 4-lobed, with 4 sporogonia at maturity but 5 sporogonia are not uncommon and in specimens from the Kaghan Valley 6 sporogonia were seen in a receptacle.

The receptacles are terminal but growth of the thallus is continued by an adventitious shoot formed at the apex at the base of the stalk. The stalked circular male receptacle with a membranous margin is also characteristic.

When the pore is seen from above quite a broad membrane is seen projecting into the cavity of the pore. Short and broad elater-like cells with spiral or annular bands are found fixed to the base and apex of the capsule and projecting into the cavity, usually about 120-160 μ long and 40 μ broad at the base gradually tapering to an obtuse apex, with a few distant bands. Some are even shorter and without annular bands.

V. WIESNERELLA Schiffn.


Plants thallose, large. terrestrial, light green, prostrate, delicate, in large extended patches. Fronds monopodially or dichotomously branched, lobes oblong to quadrate. Dorsal surface more or less flat, chambers small, distant, densely filled with rudimentary filaments; pores simple, slightly raised. Ventral scales large, hyaline. Male receptacle in the mid-dorsal groove of the female branch, subsessile, cushion-like, surrounded by scales. Stalk of the female receptacle arising from a deep narrow notch at the apex; thin, hyaline, naked or surrounded at the base by
a few scales, 2-furrowed. Receptacle convex, papillose, stomata compound; with 5-8 (normally 6) long narrow radii alternating with the lobes. Involucres under the lobes, bilabiate, lips entire. Perianth nil. Archegonia up to four in each involucre. Capsule long-pedicelled, exserted, spherical, dehiscing by 4-6 irregular revolute valves to the middle. Wall cells brown, 1-layered, with annular bands. Spores reticulate, winged. Elaters long and narrow.

13. Wiesnerella denudata (Mitten) St.


Monoecious. In large extended yellowish green or light green patches, of irregularly overlapping individuals. Thallus thin, dichotomous. 2 cm. long and 1 cm. broad, nearly flat above, margin wavy, lobes oblong to quadrate, notched at the apex. Dorsal surface with distinct areolae, epidermal cells 6-6 angled, walls not thickened, angles thin. Pores large, slightly convex, formed by 4 series of 6 cells each. Ventral surface brownish; scales oblique, lunate, large, hyaline, in one row on each side, appendage large, subrotund, strongly constricted. Midrib narrow, distinct, passing into the wings gradually. Male receptacle in the mid-dorsal groove of the thallus behind the stalk of the female receptacle, forming a circular cushion, sub-sessile or shortly peduncled, surrounded by short brown ligulate scales. Stalk of the female receptacle terminal, arising from a narrow notch, 4 cm. long, often shorter, thin, hyaline, naked, or surrounded at the base by a few lanceolate, deciduous scales, shortly 2-furrowed. Receptacle convex, 6-lobed, with 6 involucres. Perianth nil. Capsule long-pedicelled, exserted, spherical, dehiscing by 4 irregular valves. Cells of the capsule wall brown, with annular bands. Spores reticulate, winged, wing broad, lobed, wavy, 40 μ in diam. Elaters narrow, bispiral, 340 μ long.

Hab. Very moist rocks, or actually under water.

Distrib. _Dalhousie-Khajiar_ road, Dulchi pass, about 6,500 feet.

Note:—The plant has been found by the writer in two places only and without ripe sporogonia. The description of the sporogonium is after Stephani who gives Kumaon also as one of the localities where the plant has been met with. At the localities where it was found by the writer it occurred along with
Conocephalum conicum. Stephani states that the lobes of the thallus are broadly linear but in my specimens they are oblong to quadrate.

VI. DUMORTIERA Reinw. Bl. et Nees.


Plants thallose, very large, terrestrial, near streams or actually under flowing water, green, prostrate, overlapping, in large expanded patches. Thallus flat or procumbent, repeatedly dichotomous or branching by apical innovations; apex notched, margin undulate; midrib very prominent; air-chambers absent and cells of outermost layer contain chlorophyll. Scales greatly reduced, hyaline, occurring as narrow long oblique ridges attached to the thallus on each side of the midrib in one row; often present near the apex and absent from the older parts. Male receptacle disciform, depressed in the centre, subsessile, with bristles on the margins, much like the female receptacle in appearance when young. Female receptacle sessile when young, stalked when mature. Stalk long, two-furrowed, base naked, top covered with chaffy scales. Receptacle disciform, convex, umbonate, with a few bristle-like hairs, with 6-10 short lobes, with one saccate, horizontal involucre on the underside of each enclosing a single capsule. Perianth absent. Capsule with a short pedicel, wall one-layered, cells with annular bands, dehiscing by 4-8 valves, with fixed elater-like cells arising from the bottom. Spores tetrahedral, dark brown, warty. Elaters long, 2-4 spiral, sometimes branched.

Note: —Different writers recognise different numbers of species of the genus based on the structure of the thallus, receptacles and involucre among other characters. Stephani describes three species, but Evans maintains that there are only two. Mr. B. L. Sethi, M. Sc., working in this department has examined a large number of specimens from various parts of the W. Himalayas and S. India. He comes to the conclusion that there is but one species which is exceedingly variable. Air-chambers are met with at the apex in plants growing in comparatively less moist places. The pores even in such plants are rudimentary and each
is bounded by 4 cells. Chambers are always absent everywhere in plants growing under water or on very moist places. The thallus may be densely covered with papillate cells on the dorsal surface, thus giving it a velvety appearance, the form distinguished as *D. velutina*, or the papillae may be few or wholly absent. The dorsal surface often shows distinct reticulations. Similarly characters based on receptacles are not reliable. Different forms showing the above mentioned variations are often met with in plants growing very near each other, some under water and others just outside; some in shade and others more or less exposed. All the forms, therefore, have been grouped here under one species *i. e.*, *D. hirsuta*.


Dioecious or monoecious. In extended, dark green, large patches of overlapping individuals. Thallus 4 to 10 cm. long and 8 to 12 mm. broad, repeatedly dichotomous, apex deeply emarginate; flat or slightly concave above, margin undulate; partly or wholly transluscent; with the midrib appearing conspicuous. Dorsal surface sometimes with a faint network, covered densely with papillate cells or with only a few such cells, or perfectly smooth and absolutely without such cells. Epidermal cells 4-6-angled, walls thin, angles not thickened. Ventral surface green, scales simple, hyaline, evanescent, occurring in older parts as narrow, long, oblique ridges attached to the thallus by their entire length in one row on each side of the midrib. Midrib prominent below, about 22 cells thick in the middle, formed of 5-6-angled cells with thick walls, passing very gradually into the lamina formed of large cells. Midrib cells often infected with fungal hyphae. Male receptacle terminal, with bristles on the margin, and much like the female receptacle in appearance when young. Female receptacle sessile when young, with a few bristles, stalked at maturity; stalk thick, reddish brown, with 2 rhizoid furrows, up to 3 cm. long. Capsule globose, reddish-brown, wall of one-layer of cells with numerous annular bands. Spores tetrahedral, dark brown at maturity, densely and finely muricate, 22 to 26 μ in diam. Elaters long, attenuate, 2-4-
PLATE V.

DUMORTIERA HIRSUTA. 1—10.

1. A female plant.
2. A male plant with apical innovations.
4. Portion of T. S. of thallus showing papillate epidermal cells.
5. A pore from near the apex, in surface view.
7. A dehisced capsule. Note the fixed elater-like cells at the base.
8. Spores.
9. Short elater-like cells.
10. Elaters; spirals not shown in the branched elater.
spiral, some branched, 450 to 900 µ long. Elater-like cells with 1 to 4 spirals, trumpept shaped, 50 to 100 µ long.

Hab. On moist earth or actually under running water on stones, on the walls of water reservoirs in rather dark places, in streams, etc.

Distrib. Common, 4,000 to 10,000 feet, in the Kumaon and the Outer Himalayas everywhere; Ravi Valley; Pangi, Lahul; and S. India.

Note:—Kidney-shaped androgynous receptacles are of frequent occurrence, especially in the forms collected from very moist places. These were in all observed cases sub-sessile, with a few or many bristles coming out from the margin and dorsal surface and had no central depression.

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VII. CONOCEPHALUM Necker.


Thallus large, dichotomously branched; dorsal surface areolate, areolae very distinct, mostly hexagonal, pores simple. Dorsal layer shallow, air-chambers large, terminal cells of filaments arising from the floor produced into pointed colourless beaks. Male receptacle disciform, papillose, sessile, at the apex of a branch, sometimes apparently lateral, in a cup formed by the growth of the thallus laterally and posteriorly. Female receptacle terminal in a pit; stalk long, with a single rhizoid furrow; receptacle obtusely conical, almost entire, composed of 5 to 8 tubular involucres on the under side, each enclosing a single capsule. Perianth absent. Capsule with rather long pedicel, clavate-pyriform, dehiscing at maturity by throwing off an apical cap, the remainder splitting longitudinally by 4 to 8 reflexed valves. Spores large, papillose, many-celled, beginning to germinate while still within the capsule. Elaters 2-4 spiral, bluntly fusiform.
Concepha!um conicum  (L.) Necker.

**Fegatella conica** Corda in Opiz, Beitr. I. p. 649 (1829).

Dioecious. In large dark green patches. Apical innovations common. Thallus dichotomous, up to 10 cm. long and 10 to 12 mm. broad, flat, with somewhat undulate margins; the apex emarginate. Dorsal surface with large conspicuous areolae forming a regular net work; epidermal cells thin walled, angles not thickened. Pores simple, elevated, visible to the naked eye, with 5 to 6 concentric rings of cells, the innermost ring composed of 6-7 cells. Ventral surface pale green, midrib conspicuous, usually with wide tubes scattered in it; scales rather distant, in one row on each side of the midrib, with a violet, reniform or orbicular appendage. Midrib somewhat suddenly passing into the lamina ending in a generally 2-celled margin. Male receptacle sunken in a cup formed by the dorsal growth of the thallus, terminal, or becoming apparently lateral. Antheridia scattered on the dorsal side in between the air-chambers. Female receptacle terminal, sunken (as a whole while young, or base of the stalk when old) in a cup formed by the growth of the thallus laterally and posteriorly. Dense scales below and round the young receptacle. Central part with distinct air-chambers and pores. Capsule wall of a single layer of cells except at the top, with annular bands. Spores green, multicellular, 85 μ. Elaters bluntly fusiform, 170 μ long.

Hab. Moist cool and shady rocks, usually near running water.

Distrib. Very common in the Kumaon and the Outer Himalayas up to Kashmir in the west, 5,000 to 8,000 feet; Middle Himalayas; Pangi.

Note:—Specimens from above Aluras show no trace of the wide tubes in the midrib. Tuberculate rhizoids occur on the midrib in bundles in the axils of the scales. Cavers states that during one growing season the archegonia are fertilised and the development proceeds till the spore formation, all this time the female receptacle remaining sunk in the cup. At the end of the season the growth stops. Next season at the very beginning the stalk elongates suddenly, the spores are dispersed.
WIESNERELLA DENUDATA. 1–2
1. Two plants.
2. T. S. of thallus.

CONOCEPHALUM CONICUM. 3–5.
3. A male plant.
4. A female plant.
5. T. S. of thallus.

LUNULARIA CRUCIATA. 6–7.
6. A plant.
7. A gemmae-cup.
and the former dies away. The writer has seldom seen ripe stalked female receptacles in the Himalayas. Male receptacles and young female receptacles are very common. Plants with remnants of the decayed stalk also are often met with. The plant forms extended patches of a dark green colour, sometimes extending over several feet, in moist and shady places. It is often accompanied by Pellia and Dumortiera and was accompanied by Wiesnerella denudata at the places where the latter was met with. It can be readily recognised by the conspicuous reticulations of the dorsal surface, the large scale appendages, the large disc-shaped male receptacles (with conspicuous papillae) inside a cup-like outgrowth and the conical female receptacle. This species is the largest thallose liverwort excepting only Dumortiera throughout the Western Himalayas.

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VIII. LUNULARIA Mich.


Thallus large, irreguarly furcate or innovating at the apex. Dorsal surface distinctly areolate when moist, with semilunar gemmae-cups. Dorsal layer narrow. Pores simple; air-chambers in one layer, with filaments. Male receptacle disciform, sessile, at the apex of a short branch, becoming, as with the female receptacle, apparently lateral, surrounded, except in front, by the elevated border of the thallus. Stalk of the female receptacle terminal on a short branch, becoming apparently lateral, without a rhizoid furrow. hairy, surrounded at the base by scales in several layers; receptacle young disciform, later almost always composed of 4 cruciate, horizontal, tubular involucres, each containing a single sporogonium. Perianth absent. Capsule with a long pedicel exserted from the bilabiatus opening of the involucre, dehiscing nearly to the base by 4 narrow valves. Cells of the capsule wall without annular bands. Spores tetrahedral, yellowish brown. Elaters bispiral, thread-like.
16. Lunularia cruciata Dum.


 Dioecious. Plants light green, thin, in large patches of overlapping individuals. Thallus up to 4 cm. long, dichotomously divided: lobes oblong to quadrate 8 mm. broad, deeply notched at the apex, with sinuate hyaline margin. Dorsal surface flat or slightly concave; epidermal cells 5-6-angled, angles and walls not thickened. Pores raised, bounded by 3 rings of 6-8 cells each. Chambers in one layer, containing short branched filaments. Ventral surface green; scales in one row on each side of the midrib, thin, delicate, attached by a long semilunar base, appendage rotundate. Midrib not much prominent below, gradually passing into the wings. Male receptacle sessile, disciform, terminal. Stalk of the female receptacle 2-2.5 cm. long, delicate, nearly pellucid, with scattered hairs or almost naked. Capsule dark brown, oval, wall of one layer of cells, without bands. Spores rounded, tetrahedral, smooth, yellowish brown, 14-17 μ in diameter. Elaters long, slender, yellowish brown, bispiral, 340 μ long. Gemmae receptacles semilunar; receptacle wall very high posteriorly gradually becoming lower forwards, the diameter between two ends being about 6 mm. Gemmae on unicellular stalks, circular, biconvex, margin thin, entire, with two lateral notches with overlapping margins.

Hab. Moist rocks.

Distrib. Himalayas, Darjeeling (Tirunarayanan); S. India, Madras, Ootacamand (Iyengar). Not met with so far in the Western Himalayas but may occur in Kumaon.

Note:—All the material available is sterile. Description of receptacles is after Macvicar: "The Student's Handbook of British Hepatics" and Stephani "Species Hepaticarum." Occasionally the anterior margin of the gemmae-cup in Marchantia remains rudimentary and the cups bear a certain resemblance to the semilunar gemmae-receptacles in this species.
EXORMOTHECA TUBERIFERA. 1--10.

1. Two fertile female plants.
2. A sterile tuber-bearing plant, from below.
3a. A portion of 3 magnified.
4. A pore from above.
5. A ventral scale.
6. T. S. stalk of the female receptacle
7. Vertical section of female receptacle.
8. A spore.
9. Three elater-like cells.
10. An elater.
IX. EXORMOTHECA Mitt.


Monoecious or dioecious. Plants thallose; thallus simple or dichotomous, lobes linear. Dorsal surface rather flat. Dorsal layer fairly deep. Air-chambers in one layer, full of filaments. Stomata raised, simple, often confluent. Midrib strongly produced ventrally. Scales large, densely imbricate, obtuse or acuminate, with or without appendages. Antheridia usually along the mid-dorsal groove. Female receptacle stalked, arising from the apex or the fork between two lobes. Stalk with one deep groove; receptacle convex. Involucres two, opposite, tubular or more or less bivalved, with a broad mouth. Foot large, seta short, capsule spherical, opening by irregular valves; wall one-layered, the cells with annular bands. Lid large, elater-like greatly thickened cells hanging from it. Spores areolate, with areoles smooth or papillate. Elaters yellowish, loosely bi- or tri-spiral.


Monoecious. Thallus twice or thrice dichotomously divided, with long linear lobes firmly attached to the soil; lobes up to 12 mm. long, and usually less than 2 mm. broad. Dorsal surface green, usually with a deep narrow groove and conspicuous, often confluent, stomata. Pores variable in size and in number of cells bounding them, round or elongated, the cells bounding these not differing from those of the epidermis. Filaments simple, terminal cells elongated, tapering upwards, and containing fewer chloroplasts. Midrib strongly projecting ventrally. Ventral surface purple; scales purple, occasionally hyaline, lunate, overlapping, directed outwards and forwards and without any appendage such as is described in other species of the genus. Antheridia often in a depression behind the stalk of the female receptacle or along the midrib in the median groove in a zigzag row; papillae red. Female receptacle arising
from a pit in the fork between two lobes, anterior wall of the pit wanting, stalk up to 10 mm. long, with one rhizoid furrow. Receptacle hemispherical, involucres 2, with 1–4 archegonia in each. Air-chambers with green filaments and stomata; pores well-formed, bounded by about 7 cells in one ring. Capsule fully exserted and directed upwards. Seta up to 1'5 mm. long. Cells of capsule wall with semi-annular bands, those of the operculum cells being thicker and broader. Operculum with a few short elater-like cells suspended from it. Dehiscence by 4 irregular valves. Spores tetrahedral, covered with conical papillae on the convex side, 55-60 μ. Elaters 120-140 μ, with 3 or 4 lax spiral bands.

Hab. Comparatively dry slopes.
Distib. Outer Himalayas; Garhwal, Mussoorie, about 6,000 feet; S. India, Madras (Iyengar).

Note:--The apex of the plant at the end of the season becomes narrow and the dorsal assimilating tissue decreases gradually, producing ultimately a short thick tuber-like structure directed downwards and more or less buried in the soil and protected by scales. This tuber in the next growing season gives rise to another plant. More definite tubers are formed in this species by the modification of the ventral shoots. Each tuber has a short cylindrical stalk and is a spherical body about 0'5 mm. in diameter, covered with rhizoids. The growing point is situated in a small depression surrounded by minute purple scales. The cells of the tuber are full of starch except the epidermal cells which are empty.

The scales have no appendages and the stomata on the female receptacle are well developed. As a matter of fact the bounding cells of these stomata are more definite as regards their number and shape than the stomata on the thallus. Solms-Laubach has stated that there are no stomata on the female receptacle of Exormotheca pusilla (Bot. Zeitung. Bd. 55, 1897). Stephani also states that the chambers on the female receptacle do not open to the outside (Sp. Hep. Vol. I, p. 218).
PLATE VIII.

STEPHENSONIELLA BREVIPEDEDUNCULATA. 1—10.

1. Two male plants.
2. Two female plants, note the continuation of the growth after the formation of the receptacle and the apical tuber.
3. L. S. of thallus.
4. Two ventral scales.
5. A pore from above.
7. Female receptacle.
8. A spore.
9. Three Elater-like cells.
10. Three elaters.
Plants growing singly among moss and grass or aggregated in large patches on rocks. Each plant with a thick base, simple or once or twice dichotomously branched and closely attached to the substratum, light green in colour, spongy above, with a solid midrib strongly projecting ventrally. Upper surface areolated. Chambers large, empty, directed forwards, opening by simple stomata. Ventral surface greenish; scales in 2 rows. Antheridia aggregated in a long and broad mid-dorsal groove in large numbers, close to each other, in 2 or 4 zigzag rows, forming a definite receptacle; papillae red, conspicuous at maturity. Female receptacle at first terminal, later on becoming dorsal by the continued growth of the thallus arising as a small hemispherical cushion in a deep pit, protected while young by scales. Involucres 2, broad, archegonia 1 to 6 in each involucre. Stalk short with a shallow anterior groove containing a few tuberculate rhizoids. Tissue of the receptacle well developed, with empty chambers and definite pores. Involucre tubular, opening by a wide mouth. Sporogonium wholly or partially included, with a small foot and a small seta; dehiscing by 3-4 irregular valves. Capsule wall of a single layer of cells, with thick brown bands on the radial walls only. Spores tetrahedral, large. Elaters short, stumpy, with spiral and annular bands.


Dioecious. Thallus up to 12 mm. long and 4 mm. broad, growing from a thick base, margins wavy; simple or forked once or twice; lobes obovate or oblong, apex emarginate. Ventral adventitious shoots common. Dorsal surface areolate: epidermal cells polygonal, walls thin. angles not thickened. Stomata often confluent; each pore surrounded by 1 or 2 rings of hyaline cells the number of which is variable. Ventral surface greenish; scales hyaline, small, in 2 rows, each scale with a few filamentous appendages arising from the apex and the margin. Midrib
projecting ventrally and gradually passing into the lamina. Antheridia in a cluster in a mid-dorsal groove, sometimes interrupted by sterile vegetative tissue. Female receptacle stalked at maturity, sessile and protected by scales when young. Stalk short, up to 1.5 mm. long, with a wide shallow groove anteriorly, without scales at maturity. Capsule wall of a single layer of cells, the cells with bands on their radial walls only. Spores tetrahedral, large, opaque, covered densely with low large and small papillae, irregularly toothed or bluntly lobed along the margin, 80-100 µ. Elaters very small, with only annular bands or a single lax spiral band, 80-140 µ long. Short elater-like cells, only annularly or spirally thickened, hanging from the apex of the capsule.

Hab. On rocks, or among grass and moss.
Distrib. Common in the Kumaon and the Outer Himalayas. Mussoorie, Simla; Kulu, Dulchi pass; etc., 6,000 to 7,000 ft.

Note:—The growth of the thallus after the formation of the female receptacle may be very slight, resulting only in a small process or a cylindrical tuber, or it may give rise to a large, even branched shoot. The female receptacle, therefore, becomes definitely dorsal. Correlated with this is the fact that the groove in the short stalk of the receptacle is very shallow and contains only a few rhizoids. The rhizoids naturally cannot reach the ground and have no function to perform and they are being eliminated.

At the end of the season each lobe produces at the apex a cylindrical downwardly directed tuber. This is a continuation of the midrib of the lobe, the lamina not having been formed. The tuber remains underground in winter and grows into a new plant next year. This tuber of the apex also explains the fact that the adult plants are thick at the base, having grown from the tubers.

The plant is closely related to E.rormotheca as shown by the position of the receptacles and its two involucres particularly. It is also clearly a reduced form from a type like E.rormotheca as seen by the empty chambers, simpler pores, simpler elaters and the shifting of the terminal female receptacle to the dorsal side. Both the Himalayan E.rormotheca and this species bear tubers. They are often met with growing in the same locality.
PLATE IX.

AITCHISONIELLA HIMALAYENSIS.

1. Five plants showing various forms; an., antheridia; T., tuberous apex; S. sporogonium.

2. T. S. of thallus.

3. A pore in surface view.


5. L. S. of thallus and sporogonium. Note continuation of the thallus tissue into the involucre.

XI. AITCHISONIELLA Kashyap.


Monoecious. Singly or in small patches. Thallus small, _Riccia_-like, dichotomously branched, sometimes apparently pinnate. Plants light green, rather grey. Dorsal surface perfectly smooth. Pores simple, not raised. Chambers in one layer or two layers near the margin, oblique, without filaments. Ventral scales in 2 rows with terminal filamentous appendages. Antheridia in 2 rows along the midrib, embedded in the thallus behind the female receptacle, papillae very inconspicuous. Female receptacle terminal, lateral, or in the fork between two branches, subsessile, with 1 or 2 tubular involucres, joined to the thallus by a stalk-like constriction, having a groove on the anterior side. Receptacle tissue continuous with the tissue of the thallus behind. Archegonia 5 or 6 in each involucre. Capsule included, with a well developed foot, and a very short seta, wall one-layered, cells of the wall with annular and spiral bands. Short elater-like cells with annular bands projecting from the base and the apex of the capsule into the cavity. Elaters fusiform.

19. _Aitchisoniella himalayensis_ Kashyap.


Monoecious. Thallus dichotomously divided or occasionally apparently pinnate, lobes 4 mm. long and 2 mm. broad, oblong-ovate, with a notch at the apex. Dorsal surface perfectly smooth: epidermal cells thin-walled. Pores minute, simple, not raised, each surrounded by a ring of 6 cells with slightly thickened radial walls. Air-chambers empty in 1 layer, or in 2 layers near the margin. Ventral surface hyaline or bluish, scales small, distant, hyaline or bluish, triangular or lunate, with mucilage papillae on the margin and the body, not projecting beyond the margin; appendage of 3-5 cells, last cell mucilaginous. Midrib thick, projecting strongly on the ventral side and passing abruptly into the thin lamina. Antheridia on the dorsal side, in 2 rows, behind the female receptacle; papillae very inconspicuous.
Female receptacle variable in position, terminal, lateral, or in the fork between two sterile lobes. Receptacle of 1 or 2 involucres joined to the thallus by a small stalk-like constriction having a distinct groove and a few scales on the anterior side. Each involucre with a single sporogonium: foot well developed. Seta a mere constriction. Spores tetrahedral, densely covered with round papillae on the convex side, 96 μ. Elaters simple or branched, tri-spiral, 120 μ long.

Hab. Comparatively dry slopes.
Distrib. Fairly common, Mussoorie, Simla; Kulu, Dulchips Pass.

Note:—A most remarkable plant in having a subsessile female receptacle.

The plant is related to Targonia in the structure of the capsule. As regards the position and structure of the receptacle and the involucre it is intermediate between Exormotheca and Targonia. If the stalk of the receptacle in Exormotheca is eliminated we get a receptacle of the type of Aitchisoniella, and if the stalk-like portion in the latter genus goes on growing into an ordinary thallus, the condition as seen in Targonia is reached. In the position of the female receptacle and the variations as regards the number of involucres in each receptacle the plant shows much resemblance to the male receptacle of Cyathodium tuberosum. In the structure of the thallus (air-chambers and pores), the plant resembles Athalamia. On account of the above mentioned features this species breaks down the demarcation between the Compositae of the Marchantiaceae and the Targioniaceae. Owing to the transitional character of Aitchisoniella the family Targioniaceae has been merged into the family Marchantiaceae.

In its natural habitat the plant looks very much like a Riccia, and can only be found after a careful observation unless it forms a large patch.
MARCHANTIACEAE

XII. CYATHODIUM Kunze.

*Cyathodium Kunze* in Lehm. Pug. VI, p. 17 (1864).

Monoecious or dioecious. Plants thin, small, tufted, on rocks or on ground. Thallus thin, consisting of a dorsal and ventral layer of cells separated by an air-space divided by thin vertical partitions. Dichotomously divided. Air chambers in one layer, empty, with or without simple pores. Pores when present large, bounded by concentric rings of cells. Scales minute, in two rows, or wholly absent. Rhizoids smooth, some thick-walled but not tuberculate. Position of the male receptacle variable; terminal, lateral, or in the fork between two branches. Antheridia numerous, ostioles papillose. Involucre at the apex usually on the undersurface as in *Targonia*, tubular or bi-valved; archegonia a few, in a cluster. Capsule globose, inserted by a small foot. Seta small, slender, delicate. Wall 1-layered, cells of the upper part with annular bands, those of the lower half thin walled, lid definite, of 2 or 3 layers of cells, the outermost layer usually of 4 cells. Capsule dehiscing by 8 equally large valves after separation of lid. Spores spherical, more or less muricate. Elaters fusiform, trispiral.


Dioecious. Sterile plants small, yellowish or green, once or twice dichotomously divided, densely overlapping, the lobes linear to oblong. Male plants more or less branched, lobes linear or oblong-obcordate. Female plants linear or linear oblong, but more often, owing to repeated rapid dichotomy, fanshaped, with ascending margins; the narrow plants less than 2 mm. broad, the large ones 1 cm. long and 2 cm. broad. Dorsal surface usually flat; epidermis with chloroplasts. Pores on the dorsal surface absent in sterile and smaller male and female plants, ventral pores present in many. Dorsal pores found only in well developed female plants, scattered, circular behind the apex, elongated.
and elliptic further back. Each pore bounded by 2 or 3 series of 4 or 5 cells each. Ventral pores simple, large, bounded by ordinary cells of the thallus, elongated antero-posteriorly. Ventral surface flat. Midrib absent. Rhizoids both thin walled and thick walled, but the latter without pegs. Scales simple cell-rows or small plates, cells with chloroplasts. Male receptacle lateral and cushion-shaped: or in the fork between 2 branches and then circular or elongated laterally; or terminal and then disc-shaped, 4-10 lobed. sub-sessile, with a stalk-like constriction having a shallow groove anteriorly, lobes with scales on the under surface and antheridia on the upper surface in acropetal order. Number of involucres in large female plants very large (up to 20 or more), with 1-4 ripe sporogonia in each. Involucres ovoid, opening by a circular or elliptic mouth, margins often purplish. Sporogonium with a foot of two lobed cells, seta of one row of cells. Capsules 0.5-0.75 mm. in diam.; lid 80 μ in diam.; cells of the outermost layer of the lid usually 4; cells of the upper portion of the wall with annular bands; cells of the lower portion thin-walled. Spores spinous, 40 μ in diam. Elaters 17-30 in number, sometimes very few, even only 2 or 3, trumpet-shaped, usually fixed by the broader end to the wall of the capsule along the lines of dehiscence, very closely broadly trispiral, 500-550 μ.

Hab. In moist shady places and dark caves.

Distrib. Outer and Kumaon Himalayas, common up to 8,000 feet; Panjab Plain, Jullundur (A. R. Akhtar). Allahabad (Dudgeon); Lucknow (S. K. Pande); Benares (N. K. Tiwari); Mount Abu (V. V. Apte); Karla Caves, Poona (S. L. Ghose); Bombay (d’Almeida); Madras (Iyenger); N. Kanara (Sedgwick); Rangoon (S. L. Ghose).

Note: Towards the end of the season the apical part of the sterile plants and the sterile lobes of the male and female plants becomes thick and compact and marked off from the thallus behind. Each possesses one or two growing points and is beset with spike-like forwardly directed hairs on all sides. These resting structures, "tubers," are formed at the end of the season, remaining dormant during the winter, and growing into new plants at the beginning of next summer. Tubers are formed in the Himalayan plants only, they have not been seen in plants from the plains.
CYATHODIUM TUBEROSUM.

1. Six male plants showing the various forms and positions of the male receptacle.


3. Apical "tubers."

4. T. S. of a "tuber."

5. A dorsal pore in surface view.

6. A ventral pore in surface view.

7. Operculum. Three of the four original cells have further divided in one figure.

8. Two ventral scales.


10. The ends of an elater from a specimen from Mount Abu.

11. The broad fixed end of an elater from a Himalayan specimen.
The plant grows in dark and moist places, and under these conditions it has a yellowish phosphorescence. Plants growing in comparatively open places, under trees, etc., are very much larger. The male plants under these conditions, have many-lobed large terminal receptacles and they are usually hidden under the female plants, while the latter are large, fan-shaped, green, with dorsal stomata.

After fertilisation stiff short hairs, similar to those on the 'tubers' begin to grow from the base, apex and margin of the scales near the involucre, the ventral surface of the involucre, and the margins and sometimes even from the dorsal surface of the thallus for some distance behind the apex.

The air chambers sometimes contain small colonies of some blue green alga or even the eggs of some insects which have no doubt entered through the ventral pores.

The plant is very variable and very likely the species described as Cyathodium cavernarum Kunze and C. aureo-nitens (Griff) Schiffn. are merely forms of C. tuberosum.

The variability is not limited merely to the vegetative parts but extends also to the receptacles, the spores and the elaters.

The thallus may be very yellowish, small with long linear lobes and then occurs in thick patches of overlapping plants, or the plants may be larger, distinctly green, growing singly, fan-shaped with upturned margins, possessing large dorsal pores. The possession of large very much simpler pores on the ventral side of the former type is very interesting. The male receptacle is very interesting. It is very variable as stated in the description. Obviously the size of the receptacle is inversely proportional to the vegetative branches. It is very small and without distinct lobes when it is lateral or in the fork between two vegetative lobes. When it is terminal, as for example, in plants occurring hidden under the large female plants, it is large, distinctly lobed, with a short stalk-like constriction which has even a shallow groove anteriorly. The lobes bear antheridia acropetally and possess scales on the under surface. The whole receptacle in these cases is undoubtedly of the type met with in the higher Marchantiaceae.

The outermost layer of the lid consists usually of four cells, but sometimes some of the cells are again divided. Griffith has figured such a lid with divided outer cells in C. aureo-nitens.
The elaters are always few, though their number varies greatly. They are fixed by their broader end to the capsule wall along the lines of dehiscence, in rows when their number is comparatively large. In the specimens from Mount Abu all the 6 or 7 elaters came out of the capsule on teasing and are apparently free, but even in these specimens one end of the elater is always pointed and the other is blunt and obliquely broad.

The spores always possess spinous projections. In a specimen from N. Kanara sent by the late Mr. Sedgwick their size was rather large, being 54 μ.

See also the note at the end of the next genus, Targionia.

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XIII. TARGIONIA L.


Monoecious or dioecious. Plants thallose, terrestrial, prostrate. Thallus simple, with ventral innovations near the apex, or rarely dichotomously divided, with indistinct areolae on the dorsal surface. Pores simple. Air chambers distinct, full of filaments. Ventral scales in two rows. Antheridia on the dorsal surface of the disc-like ends of short ventral innovations arising from the midrib, or in long and broad mid-dorsal cushions on the main shoots; ostioles papilliform. Involucres 2-valved, on the under side just behind the apex, the 2 valves inter-locked by means of small microscopic teeth on the cells of their margins. Archegonia several, sporogonium usually one in each involucre, rarely 2. Perianth absent. Capsule shortly pedicellate, with a well developed foot, at length breaking through the calyptra, the 2 valves of the involucre separating, leaving a slit-like opening. Apical portion of the capsule becoming detached in one or more fragments at maturity, the remainder being divided into 5-8 irregular valves. Capsule wall of one layer of cells with spiral and annular bands. Spores reticulate. Elaters long, bispiral.

Note:—Although the archegonia are said to be on the under surface and behind the apex, they really are on the morphologically upper surface (only apparently on the under surface). The apical growing point has been pushed downwards and backwards so that the apical cell is situated on the apparently under surface
and the archegonia are formed in the usual acropetal order so that the youngest archegonium is just behind the apical cell and the oldest further back, *i.e.*, towards the anterior end of the thallus, near the apical notch. This is true also of *Cyathodium*, though Lang (Annals of Botany, 1905) states that in *Cyathodium cavernarum* the archegonia are actually on the dorsal surface and the ventral shifting of the archegonia does not take place in that species. In the involucre of the other *Marchantiaceae* also the archegonia are found apparently on the under surface for the same reason. In forms like *Plagiochasma* they can be clearly seen to be on the upper surface in the very young receptacle.

21. *Targionia hypophylla* L.


Monoecious or dioecious. Thallus usually 10-15 mm. long, occasionally 20 mm. long, and 2-4 mm. broad; often with adventitious ventral shoots, and rarely dichotomously divided; apex incised bi-lobed; dorsal surface green; margin entire: areolae indistinct; epidermal cells 5-6-angled, walls slightly thickened and angles much thickened. Dorsal layer shallow, air-chambers distinct, containing green filaments. Filaments of the air chambers anastomosing and reaching the roof, except under the pore. Terminal cells of the filaments under the pore hyaline with very few chloroplasts, in other places chloroplasts numerous in all the cells. Pores simple, conspicuous, slightly elevated, with 4 concentric rings of 6 cells each. Ventral surface purple; scales obliquely broadly triangular, with long subulate apex. Margin usually with projecting mucilage cells. Midrib prominent below, rather suddenly passing into the lamina. Antheridia aggregated on the discs of the short ventral shoots, or on the dorsal side of the main shoot forming a long and broad mid-dorsal cushion. Involucre sub-globose, keeled, purple, containing 5 or 6 archegonia but ultimately only one sporogonium or occasionally two sporogonia. Capsule spherical, wall of a single layer of cells with annular and spiral bands. Spores 30 to 40 μ. Elaters 140 to 188 μ.

Hab. On moist and dry rocks.

Distrib. Common throughout the region, at altitudes of 5,000—7,000 feet.
Note:—Stephani does not describe it as occurring in India, whereas, Mitten has described it from the N.W. Himalayas under *T. Michelli* Corda, which is given by Stephani as a synonym of the above species.

In moist and shady places the plants form masses of deep green overlapping individuals which are fixed to the soil only at their base. The scales and involucres in such cases are purple. In exposed places the plants are closely creeping, almost always dichotomously divided, light green or yellowish above, with hyaline or light purple scales and involucres. The spores in these cases are smaller, 25 to 30 μ, and elaters longer, 180 to 200 μ. Antheridia are usually found on the well-known small disc-like ventral shoots with cylindrical stalks. These shoots have a more or less circular margin and are covered on the dorsal surface with antheridial papillae. Occasionally, however, these disc-like shoots develop more or less well-developed wings and in such cases the antheridia form a definite cushion in the middle. The scales on the under surface of these shoots are scattered. Sometimes antheridia are met with in the form of a large definite mid-dorsal cushion on the ordinary lobes of the thallus also. In such cases usually the growing point at the apex divides and the scales on the under-surface just behind the apex appear to be scattered. It appears, therefore, that the short ventral male shoots are merely greatly condensed ordinary shoots with many growing points, the latter having become obscure.

**XIV. CRYPTOMITRIUM** Austin.

*Cryptomitrium* Austin, in Underwood Bull. ILL. St. Labor. II, p. 36 (1884).

Plants thallose, broad, thin, green, closely creeping, attached to the soil by the midrib only. Thallus once or twice divided. Dorsal surface flat. Dorsal layer low; air-chambers large, empty. Stomata slightly raised, simple. Midrib narrow, passing into the thin broad wings. Scales small, distant, in two rows. Antheridia in the mid-dorsal groove, 2- or 3-seriate, papillae very small. Female receptacle terminal, stalked; stalk long, naked, with one or two furrows, and a few ridges. Receptacle thin, broad, circular, with an irregular
PLATE XI.

TARGIONIA HYPOPHYLLA. 1—3.
1. A female plant from above.
2. Three specimens showing male ventral shoots. Note the male cushions on the main shoot also in the right hand specimen.
3. T. S. thallus showing variations in the pore structure.

CRYPTOMITRIUM HIMALAYENSE. 4—10.
4. A fertile plant.
5. The tuberous apex from above.
6. Female receptacle from below.
7. Ventral scale from the ordinary thallus.
8. Scale from the tuberous apex.
9. Vertical section of involucre with sporogonium.
10. Two spores.
margin, convex on the dorsal side, flat ventrally, stomata barrel-shaped. Involucres wholly on the under side, not reaching the margin, up to six in each receptacle; archegonia 3-4 in each. Perianth absent. Sporogonia not exserted. Foot spherical, seta small. Capsule included, lid definite, 2-layered, cells of the capsule wall without bands. Spores brown, tetrahedral, reticulate. Elaters sinuous, often branched, bi- or tri-spiral.

22. Cryptomitrium himalayense Kashyap.


Monoecious. Thallus yellowish or green, very delicate, once or twice forked, lobes quadrate, up to 6 mm. long and about 6 mm. broad, apex cordate, margin irregularly bluntly crenate. Dorsal surface areolated; epidermal cells thin-walled. Pores small, slightly raised, not in all areoles, bounded by 3 rings of 8 cells each. Ventral surface brownish; scales minute, hyaline or greenish, purplish and much larger under the tuberous apex, ovate, distant, in 2 rows, margin of the scale occasionally toothed, apex with a filament of 5 or 6 cells, cells of the scale contain chloroplasts. Antheridia in a mid-dorsal groove, just behind the stalk of the female receptacle or on the adjacent lobe. Female receptacle usually on one lobe of the fork. Stalk with one deep groove, up to 3 mm. long, and with 6 to 8 ridges. Receptacle thin, broad, circular, with irregularly toothed margin, slightly convex on the dorsal side in the centre, flat on the ventral side, margin often curved upwards. Involucres 2-4, most often 3, not reaching the margin. Opening long, narrow; archegonia 2 in each. Sporogonia 1 to 3, foot and seta small, capsule wholly included. Operculum 60 μ in diam.; cells of the capsule wall 50 to 80 μ x 20 μ. Spores brown, 55 to 60 μ, tetrahedral, broadly reticulate-lamellate on the convex side, border light brown, reticulations 2 or 3 in diam. (excluding the border). Elaters 350-400 μ long, closely trispiral.

Hab. Moist and often dark places.
Distrib. *Mussoorie, Simla*, 6,000—7,000 feet.

Note:—The plant grows in moist places under the dense shade of trees or in caves, often along with *Cyathodium tuberosum*. Like the latter it has a yellowish colour.

the only other species of the genus, the stalk of the female receptacle may have one or two furrows. The Himalayan species has always only a single furrow. It is of interest to note in this connection that a plant from Mussoorie showed two perfectly normal receptacles at the top of a stalk arising from the apex of an ordinary lobe and even this stalk had only a single furrow. Compare the branched stalk of the female receptacle in *Marchantia palmata* described under that species.

At the end of the season the apical portion of the lobes becomes thickened and marked off by a crescentic purple band behind. The more or less circular terminal portion becomes changed into a crumpled knot on drying and remains in this condition during the winter. The rest of the thallus dies away. Next summer the twisted persistent portion spreads out and begins to grow.

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The following plant, *Massalongoa tenera*, has been described by Stephani, but has not been seen by me.

**XV. MASSALONGOA** St.

23. *Massalongoa tenera* St.


Thallose, large, delicate, green, terrestrial, prostrate, clustered. Fronds simple, thin, apex briefly inciso-bilobed, innovating from the apex; dorsal surface subplane. Dorsal layer well developed, chambers in three series, wide, margins crenulate. Midrib broad, low. Pores compound, inner opening bounded by eight conical converging cells. Ventral scales large, narrowly triangular, apex with a long setaceous appendage. Dioecious. Female receptacle shortly and strongly peduncled, stalk with a deep groove, receptacle large, disc-shaped, margin coarsely crenate. Involucres four, cruciate, cup-shaped, and half covering the ripe capsule; calyptra delicate, partly united to the involucre. Capsule thin, wall one-layered, brown, lid large, regularly dehiscing. Spores large, 74 µ, laxly reticulate. Elaters 470 µ, tri-spiral, long attenuated, strongly twisted. Male receptacle not seen.

Hab. Sikkim Himalaya ((Gollan); *Mussoorie* (Gollan).
MARCHANTIACEAE

XVI. FIMBRIARIA Nees.

Fimбриария Nees, in Hor. phys. Berol., p. 45, (1820).

Monoecious or dioecious. Plants thallose, terrestrial, prostrate, small or medium, green. Thallus simple, rarely divided, innovating from the apex and often with ventral (fertile) innovations. Dorsal layer low, chambers narrow, often very irregular, and with numerous secondary lamellae, in one or several layers, empty or containing filaments. Stomata simple, slightly convex, rarely highly conical. Ventral scales with appendages, in one row on each side of the midrib. Male receptacle sessile, naked, disc-shaped, or cushion-like, just behind the stalk of the female receptacle, on ordinary main shoots, or on small ventral shoots; papillae small. Female receptacle terminal, on the main shoot, or on small ventral shoots, stalked; stalk with one rhizoid furrow covered with scales; receptacle flat, convex, conical, or umbonate, usually 4-lobed: stomata barrel-shaped. Involucres arising from the margin of the lobes, thin, cup-shaped or campanulate. Archegonium one in each involucre. Perianth usually ovate or oblong with an obconic apex, dividing longitudinally by many teeth. Sporogonium one in each involucre. Capsule globose, shortly pedicelled, wall one-layered, lid of thick-walled cells. Spores tetrahedral, reticulate-lamellate on the convex side, more or less yellow. Elaters short, simple or furcate, mono- or bi-spiral.

Note.—It is curious that all the five species of the genus described here from my own observations differ from each other in the position of the male and female receptacles. The position of the receptacles in itself could hardly always be a distinctive specific character, though it is quite constant in these species. It so happens, however, that in each of these species this character is also associated with other specific characters. In fertile plants it is, therefore, very easy to distinguish the species by an examination of the position of the receptacles.

Key to the Species.

Of the twelve species described here only five, have been collected by the writer. The remaining seven have been included as they have been described by Stephani in "Species Hepaticarum"
as occurring in the Himalayas. Only the first five species are included in this key.

1. Plants dioecious......................................................................................................................... F. angusta
   Plants monoecious......................................................................................................................... 2

2. Male receptacles on the main thallus......................................................................................... 3
   Male receptacles on short ventral shoots arranged laterally......................................................... 2

3. Female receptacles terminal on the main shoot in front of male receptacle........................................ F. Blumeana
   Female receptacles on short ventral shoots, male on the main shoot.................................................. F. pathankotensis.
   Female receptacles terminal on the main thallus............................................................................. F. reticulata
   Female receptacles also on small ventral shoots............................................................................. F. mussurienisis

24. Fimbriaria Blumeana Nees.


Monoecious. Thallus about 7 mm., sometimes 10 mm., long and 3 mm. broad, linear, simple, or once or twice dichotomously branched, apex notched, lobes obcordate, margin entire. Dorsal epidermal cells polygonal, walls thick, trigones not very large. Dorsal layer rather shallow. Pores large, bounded by two series of 6 cells each. Air-chambers large, empty. Midrib not very conspicuous ventrally. Ventral surface usually green; scales few, distant, purple, appendage lanceolate, acute or long acuminate, entire, occasionally with a few projecting cells on the margins. Male receptacle cushion-like, behind the stalk of the female receptacle. Female receptacles stalked; stalk 8-10 mm. long, purple, thin at the top, top paleaceous, paleae long, linear. Receptacle convex, usually 3-lobed, perianth hyaline, oblong, 1/2 exserted. Spores golden yellow, wing crenate, 72 μ in diam. Elaters bispirall, 260 μ long.

Hab. On rocks.

Distrib. Mussoorie, Simla, etc. 5,000—7,000 feet.

*Note.*—Peisal (Botanisches Archiv Vol. X, p. 434), figures vegetative shoots coming off from the stalk of the receptacle as well as the receptacle itself. The same thing is sometimes seen in *Marchantia palmata*. 
Plate XII.

FIMBRIARIA BLUMEANA. 1—5.
1. A fertile plant. Note the male receptacles behind the stalk of the female receptacle.
2. T. S. of thallus.
3. Vertical section through a pore.
4. A ventral scale.
5. T. S. of stalk of female receptacle.

FIMBRIARIA ANGUSTA. 6—9.
6. A female plant.
7. A male plant.
8. Vertical section through a pore.
9. Ventral scales.
PLATE XIII.

FIMBRIARIA PATHANKOTENSIS. 1—3.
1. A fertile plant. Male receptacle just behind the apex of the main shoot; female receptacles on short ventral shoots.
2. Vertical section through a pore.
3. A ventral scale.

FIMBRIARIA MUSSURIENSIS. 4—6.
5. Vertical section through a pore.
6. Three ventral scales.
25. **Fimbriaria angusta** St.


Dioecious. Thallus up to 20 mm. long and 3 mm. broad; linear or linear-oblong, with apical innovations; dorsal surface flat or slightly canaliculate, margins wavy, often purple, apex notched. Epidermal cells 5-6-angled, walls and angles thickened. Pores large, bounded by 3 series of 6 cells each. Air-chambers usually in one layer above the midrib, with a few free filaments; in more layers in the wings and empty. Midrib, strongly convex, gradually passing into the wings, older parts mycorrhizal. Ventral surface purple, scales purplish, triangular, lunate, with a long lanceolate acuminate appendage, latter often unequally divided at the apex. Antheridia on the main shoot forming a long cushion. Female receptacle disciform, usually with 4 or 5, often only 2, lobes, stalked, stalk 2 mm. long, paleaceous at the top, scales purple, linear. Perianth horizontal, sometimes directed upwards, ovate, 2/3 exserted. Spores tetrahedral, dark brown, closely reticulate, reticulations often imperfect; margin papillate, papillae rounded or conical; 63 μ in diam. Elaters monospiral, yellowish, 162 μ long.

**Hab.** Generally on dry rocks.

**Distrib.** Common in the Himalayas, 4,000—7,000 feet. A very xerophytic species, forms large patches on dry rocks. *Mussoorie, Simla,* etc.

26. **Fimbriaria pathankotensis** Kashyap.


Monoecious. Closely creeping, in dense green patches. Thallus once or twice forked, up to 2 cm. long, lobes linear or linear-oblong, up to 8 mm. long and 2 mm. broad. Dorsal surface green, flat or slightly convex; margin wavy, purple. Areolae small, indistinct; epidermal cells 5-6-angled, walls thin, angles not thickened. Dorsal layer not very deep. Stomata small, bounded by 2 series of 5 cells each. Air-chambers small, many layered, empty. Midrib convex, gradually passing into the lamina. Ventral surface purple; scales overlapping, purple, exceeding the margins,
appendage long, linear, entire. Male receptacle cushion-like, just behind the apex on the main thallus, antheridial papillae small, purple. Female receptacles on very small ventral shoots. Stalk up to 5 mm. long and about 1 mm. thick, paleaceous at the top. Receptacle flat with high stomata and 1 or 2 involucres. Perianth hyaline or reddish, ovate, 2/3 exserted. Capsule one in each involucre. Spores brown, opaque, broadly reticulate, wing finely punctate, 90 µ in diam. Elaters monospiral or partly bispiral, brown, up to 175 µ long, generally less, sometimes branched.

Hab. Banks of ponds, and other moist places.
Distrib. *Pathankot, Lahore, Dehra Dun.*

*Note*:- A species of the plains occurring chiefly near the foot of the hills about 2,000 feet above sea level. Not common.

27. *Fimbriaria mussuriensis* Kashyap.


Monoecious. Thallus green, closely creeping, unbranched, long, narrow, linear-oblong, with ventral and occasionally apical innovations, up to 10 mm. long and 2 mm. broad. Apex round; margin entire. Epidermal cells 5-6-angled, walls and angles thickened. Dorsal layer shallow. Stomata small, bounded by 2 or 3 series of 6 cells each. Air-chambers small, empty, in several layers. Ventral surface greenish or reddish; scales hyaline or reddish, appendages 1 or 2, reddish, linear, entire. Midrib flat, gradually passing into the wings. Antheridia in a hemispherical cushion on small ventral shoots, papillae small. Female receptacles also on small ventral shoots arranged irregularly with the male shoots. Stalk of the female receptacle 10 mm. long, sparsely paleaceous at the base and the whole length, but densely so at the top; paleae purple, long, linear. Receptacle flat or slightly convex, 2-4-lobed, stomata high; perianth conical, lanceolate, 2/3 exserted. Spores opaque, margin entire, 100 µ in diam. Elaters bispiral, up to 200 µ long, occasionally branched.

Hab. Moist shady places.
Distrib. *Mussoorie, 5,000 to 7,000 ft.; Lahore* (rare); probably common in the outer Himalayas.
Note:—The small male and female ventral shoots irregularly mixed, or alternating, or male on one side and female on the other side of the plant, are a characteristic feature of this plant. The apex of the plant bends down into the soil at the end of the season and grows up again next year producing a characteristic bend.

In a specimen from Mussoorie the stalk was divided into two parts. The lower undivided portion was 2 mm. in length, while each of the branches was 4 mm. Each branch bore a perfectly normal receptacle at the top.

28. Fimbriaria reticulata Kashyap.


Monoecious. Thallus yellowish green or slightly purplish, thin, once or twice dichotomous, up to 6 mm. long and 4 mm. broad, lobes obovate to obovate-oblong, with apical and ventral shoots; dorsal surface flat; margin entire, purplish. Areolae not prominent; epidermal cells 5-6-angular. Stomata bounded by a ring of 6 or 7 cells. Air-chambers fairly wide, in several layers, empty. Ventral surface greenish; scales purple, ovate, overlapping, reaching the margins. Appendage ovate to ovate-lanceolate, acute, entire. Midrib broad, slightly projecting ventrally, rather suddenly passing into the lamina. Antheridia cushion-like, on very short lateral branches arising on both sides of the midrib. Female receptacle terminal on main shoot, stalk naked, reddish at the base, up to 5 mm. long. Receptacle flat or slightly convex, stomata only slightly raised. Involucres up to 4, perianth hyaline, 2/3 exserted. Spores 50-64 μ in diam., brown, reticulate-lamellate, reticulations obscure, 2-3 in the diam. (excluding the wing), wing narrow, finely punctate. Elaters dark brown, more or less loosely bispiral, 200-250 μ.

_Hab._ Shady places along the road, 8,000 to 10,000 feet.

_Distrib._ Kashmir; Lahul, Kyelang.

Note:—The apical part of the thallus in sterile plants becomes narrowed and thickened and apparently persists in this condition throughout the dry period.
The following species of the genus have been described by Stephani but have not been seen by me.

29. **Fimbriaria maculata** St.


Monoecious. Green above, hyaline below, large. Thallus up to 20 mm. long and 3 mm. broad, linear, with apical innovations, dorsal surface plane, ventral surface slightly convex, stomata large, bounded by 5 series of 8-9 cells each. Epidermal cells very thick, the walls trabeculate, and trigones large, almost nodular. Dorsal layer in the middle of the frond as high as the midrib; chambers narrow, with filaments. Midrib 1/3 of the breadth of the frond, ventrally broadly keeled. Scales oblique, lower half purple, upper half hyaline, appendage as long as the body of the scale, lanceolate, with a single spine above the base, apex setaceous. Male receptacles on short ventral branches. Female receptacle stalked, stalk short (5 mm.), thick, straw-like, subterete, covered all over with long hyaline scales. Receptacle small, disc-like, slightly convex. Lobes as long as the central disc, not at all free, highly papillate, emarginate. Perianth ovate-oblong, acuminate, mouth shortly beaked, tubular. Capsule light brown, lid with thick trigones. Spores 70 µ, dark brown, wing narrow, crenato-lobate. Elaters 144 µ, thick, rigid, equally broad, reddish brown, monosporal.

Hab. Himalaya, *Sansidara* 5,000 feet (Duthie).

30. **Fimbriaria nepalensis** Taylor.


Monoecious. Small, yellowish green, delicate, margin purple. Fronds up to 7 mm. long and 2 mm. broad, innovating from the apex and the midrib. Dorsal surface flat, ventral broadly convex. Dorsal epidermal cells with thick trigones. Dorsal layer in the middle as high as the midrib, chambers large, with short free filaments. Stomata large, slightly convex, bounded by 5 series of 8 cells each. Midrib broad, plano-convex ventrally, about half the breadth of the frond. Scales small, pink, caduceous, appendage lanceolate or ligulate, apex unequally shortly bifid.
Male receptacle near the stalk of the female receptacle, sometimes occupying the whole thallus, highly inflated in the middle, ostioles small, hyaline. Female receptacle stalked; stalk 3-4 mm. long, covered with long hairs at the top, everywhere else with hyaline narrowly lanceolate spreading scales. Receptacle plano-convex, centre small, highly papillose. Lobes sub-horizontal, spreading, inflated, as large as the central disc, mouth slightly decurved. Perianth ovate, apex narrow, distinctly beaked, hyaline and obliquely spreading. Capsule yellowish. Spores 72 μ red, wing narrow, slightly rough. Elaters yellowish, 170 μ bispiral.

Hab. Nepal, (Wallich); N. W. Himalaya, (Gollan, Gamble).

31. *Fimbriaria parvipora* St.


Monoecious. Small, dark green, up to 7 mm. long and 2 mm. broad, simple or innovating at the apex, dorsal surface strongly canaliculate. Epidermal cells thin. Dorsal layer in the middle of the thallus narrow; chambers low, with very few lamellae, without free filaments, almost empty. Stomata small, not prominent, bounded by 6 cells. Ventral surface blackish. Midrib plano-convex, rather broad, half the breadth of the frond, wing strongly attenuated. Scales small, deep purple, with a large appendage, appendage acuminate from a broad base, and very slightly or not at all constricted at the base. Male receptacle small, in the groove of the thallus; ostioles hyaline, short. Stalk of the female receptacle 10 mm. long, apex with a few purple, triangular scales. Receptacle hemispherical, papillate with small stomata. Lobes as long as the central disc, apex decurved, crenato-lobulate. Perianth oblong, ovate, 2/3 exerted. Capsule? Spores yellowish, 70 μ, wing renado-lobulate, narrow. Elaters yellowish, 360 μ, bispiral, attenuated, spirals in the middle compact, those at the apex loose.

Hab. Kashmir, Lidar Valley 13,000 feet (Duthie).

32. *Fimbriaria sanguinea* L. et L.

*Fimbriaria sanguinea* L. et L. in Lehm. Pug. pl. IV, p. 5. n. 3.

Monoecious. Plants small, up to 15 mm. long and 3 mm.
broad; linear, innovating at the apex, (female branches very small, from the sides of the midrib); dorsal surface almost flat, green. Dorsal layer above the midrib low, with narrow chambers, filaments reduced to conico-papillate cells. Midrib slightly convex, 1/4 of the breadth of the frond, wings loosely chambered. Stomata large, strongly convex, bounded by 5 series of 6 cells each. Epidermal cells thin-walled. Ventral surface blackish red; scales lunate, long appendaged, appendages 2, side by side, linear, apex subulate, large-celled. Male receptacle always on the dorsal side of the main thallus, disc-like, ostioles purple, numerous. Female receptacle stalked; stalk short, up to 5 mm., straw-coloured, perfectly terete, everywhere covered with linear hyaline scales and especially so at the apex. Receptacle small, hemispherical, lobes equal to the central disc, decurved. Involucres as long as the lobes. Perianth oblong, 2/3 exserted. Rest not seen.

Hab. Nepal, (Wallich); Simla, (Griffith).

Note:—Very near F. pathankotensis described above.

33. Fimbriaria multiflora St.


Monoecious. Plants green, robust, of medium size. Thallus up to 10 mm. long and 2 mm. broad, innovating at the apex. Dorsal surface green, slightly concave, ventral surface convex. Epidermal cells delicate. Dorsal layer in the middle of the thallus equal to the midrib; chambers large, filled with numerous filaments. Stomata large, slightly convex, bounded by 5 series of 8 cells each. Ventral scales small, with long appendages; appendages narrow, lanceolate, two cells broad, apex setaceous. Male receptacle at the apex of the thallus, circular. Female receptacles on ventral branches aggregated towards the apex of the thallus; stalked, stalk up to 10 mm. long, sub-terete and slightly angled; everywhere covered with filiform hyaline scales. Receptacle plano-convex, centre slightly papillate, deeply 4-lobed; lobes spreading in an umbellate manner. Perianth 2/3 exserted, ovate, obtuse, apex often purple. Capsule yellow, delicate, lid large, strongly thickened. Spores yellow, 54 μ, margin narrow, entire. Elaters 170 μ, yellowish, monosporous, spiral thread-like.

Hab. N. W. Himalaya, (Duthie, Gamble).
34. **Fimbriaria Gollani St.**


Dioecious. Plants small, deep green, robust, gregariously growing on moist rocks. Thallus up to 15 mm. long and 5 mm. broad, oblong, simple rarely furcate, 1'5 mm. thick in the middle. Dorsal surface canaliculate, wing strong. Midrib strong (2'5 mm. broad and 0'75 mm. thick). Ventral scales large, appendage solitary, lanceolate, as long as the body, attenuate, acute. Androecia in the middle of the frond, ostioles inconspicuous. Female receptacle disciform, concave, central disc small umbo-nate. Involucres 4, broadly obconic, half free, margin repand or lobulate. Perianth large, as long as the involucre, obovate, pale. Spores dark-brown, 45 μ, margin asperous. Elaters rigid, worm-like, 180 μ, spirals in pairs, loosely twisted.

Hab. Himalaya (Gollan).

35. **Fimbriaria papulosa St.**


Monoecious. Plants yellowish, delicate, terrestrial, up to 7 mm. long, plane, simple, oblong (2 mm. broad and 0'37 mm. thick), wings very thin, membranous. Midrib strong (1'5 mm broad, 0'3 mm. thick). Ventral scales destroyed. Androecia at the base of the stalk of the female receptacle, chambers large, numerous. Stalk of the female receptacle 7 mm. long. Receptacle disciform, slightly concave, central disc rather prominent. Involucres 4, somewhat decurved, margin repand. Perianth as long as the disc, ovate, pale. Spores reddish-brown, asperous, wing broad, expanded, 72 μ. Elaters 200 μ., rigid, bispiral, spirals laxly twisted.

Hab. Himalaya, Mussoorie (Gollan).
XVII: GRIMALDIA Raddi.


Monoecious or dioecious. Plants thallose. Thallus furcate, with ventral or apical innovations; lobes linear. Dorsal layer with well developed air-chambers, the latter opening by simple stomata, filled with free, erect filaments, often subdivided. Stomata strongly convex. Midrib thick, produced ventrally; scales large, in 2 rows, each with 1 or 2 lanceolate appendages. Antheridia scattered or clustered without any scales, ostioles projecting, purple. Female receptacles terminal on short ventral shoots. Stalk of the female receptacle long, with one deep rhizoid furrow, base paleaceous. Receptacle small, convex, papillose with barrel-shaped pores, shortly 4-lobed. Involucres under the lobes, mostly 4, from the margin of the receptacles, directed downwards obliquely, each with one archegonium, opening by a circular mouth at maturity. Perianth none. Capsule spherical, shortly pedicellate, with a large foot, opening by a definite lid and a distinct annulus. Calyptra thin. Spores large, laxly reticulate, areoles inflated. Elaters short, fusiform, trispiral.

36. Grimaldia indica St.


Monoecious. Thallus about 12 mm. long and 2 mm. broad, linear, often simple; dorsal surface flat or slightly concave; margins thin, entire, usually purple. Areolae indistinct; dorsal epidermal cells 5-6-angled, walls thick, trigones small. Dorsal layer shallow, densely chlorophyllous, chambers empty near the margins. Pores simple, bounded by 3 series of 7-9 cells each. Ventral surface purple; scales purple, overlapping, not exceeding the margin, lunate, entire; appendage rarely hyaline, linear-lanceolate, curved, entire, one or two, sometimes 3, appendages to each scale. Antheridia in a mid-dorsal elliptical to linear-oblong red cushion, not sharply marked off from the thallus; papillae purple, conspicuous. Female receptacles always on very small ventral shoots, 4 or 5 of which may be formed on each side of the main frond. Stalk up to 3 cm. long, slender, naked. Receptacle
PLATE XIV.

FIMBRIARIA RETICULATA. 1—3.

1. A plant. Female receptacles at the apex of the main shoots; male receptacles on short ventral shoots.

2. Vertical section through a pore.

3. Two ventral scales.

GRIMALDIA INDICA. 4—6.

4. A plant.

5. Vertical section through a pore.

6. Two ventral scales. Note mucilage hairs.
convex; involucres up to 4; capsule slightly exserted; operculum large, brown, 1 mm. in diam., basal cells of the wall 65 × 25 μ, annulus cells 30 × 30 μ, operculum cells 35 × 45 μ. Spores brown, spherical, with large rounded papillae appearing as lobes on the margin, 60-69 μ in diam. Elaters closely trispiral 190-290 μ.

Hab. On moist as well as dry rocks and soil.

Distrib. Common in the W. Himalayas. A very xerophilous form. In dry places often the only Liverwort. A very widely distributed species throughout the Western Himalayas extending from the plains and the foot of the hills right up to the main range up to an altitude of 10,000 feet. Lahore, Amritsar, Pathankot; Dalhousie; Kulu; Pangi; Lahul, Kyelang; Mussoorie, etc.

Note.—Stephani (Sp. Hep. Vol. I, p. 90) and Mitten (Hep. Ind. Orient. Trans. Linn. Soc. Vol. V, p. 126) have described G. dichotoma Raddi also from the Himalayas. The spores and elaters of the plants described above vary a good deal. Several specimens were examined from nine different localities, and several capsules from each locality. The spores varied from 60 μ to 69 μ, and elaters from 190 to 290 μ. In some specimens from Mussoorie the spores were unusually large and measured 90 μ² while the elaters were 250 μ. Similarly the basal cells of the capsule wall measured 20-30 μ × 58-79 μ, and the operculum cells 30-50 μ × 43-60 μ. I can not distinguish G. dichotoma from G. indica by any character.

XVIII. REBOULIA Raddi.


Monoecious or dioecious. Thallus dichotomously branched and innovating at the apex, coriaceous, without distinct areolae on the dorsal surface. Pores simple, air chambers empty, in several layers as in Plagiochasma. Ventral scales in two rows. Male receptacle sessile, cushion-like, at the apex of a lobe, oval to semicircular, surrounded by small scales. Female receptacle terminal on ordinary lobes, stalked. Stalk surrounded at
the base and apex by narrow scales, with a single rhizoid furrow. Receptacle conical or hemispherical, divided to the middle into 4-9 obtuse lobes, with air spaces and compound pores; involucres arising on the underside of the lobes from the margins, 2-valved, the margins of the valves involute in the young condition but opening at maturity; each enclosing a single sporogonium which does not completely fill the cavity. Perianth absent. Capsule subglobose, shortly pedicellate, with a large foot, irregularly dehiscing at the apex. Elaters 2-3-spiral.

37. Reboulia hemispherica (L.) Raddi.


Dioecious or monoecious. In dense patches of overlapping individuals, deep green, with usually purple margins. Thallus dimensions very variable, 10-30 mm. long and 3-8 mm. broad, lobes oblong or obovate with emarginate or bilobed apex, margins ascending, crenulate, sometimes purple. Dorsal epidermal cells 4-6-angled, with walls slightly thickened, trigones thick. Pores a little elevated, with 3-5, (up to 8) concentric rings of 6-8 (-10) cells each, radial walls and trigones thickened. Ventral surface purple; scales purple, imbricate, in one row on each side of the midrib, obliquely lunate, reaching halfway to the margin, with two linear appendages. Midrib thick, gradually passing into the lamina ending in the one cell thick margin. Male receptacle at the apex of a lobe, small, disciform, surrounded by chaffy scales. Stalk of the female receptacle about 30 mm. long, receptacle hemispherical, 4-9-lobed. Capsule spherical; wall of a single layer of cells. Spores spherical, brown, reticulate-lamellate with a broad wing, 3-4 areoles in the diam., 65-75 μ. Elaters 2-3-spiral, coiled, 300-400 μ long, occasionally branched.

Hab. Moist rocks.
Distrib. Common throughout the hill area. Very widely distributed from 5,000 to 13,000 feet. Mussoorie; Dalhousie; Simla; Pangi; Kulu; Spiti; Lahul,
PLATE XV.

REBOULIA HEMISPHERICA.  1–5.

1. A male plant.
2. Two female plants.
3. A ventral scale.
4. Vertical section through a pore.
5. T. S. stalk of the female receptacle.

MINDAL PANGIENSIS.  6–8.

6, 7, 8. Three plants.

PLAGIOCHASMA INTERMEDIUM.  9–12.

10. Vertical section through pores.
11. A ventral scale.
12. Appendage of the ventral scale.
PLATE XV.

REBOULIA HEMISPHERICA. 1–5.
1. A male plant.
2. Two female plants.
3. A ventral scale.
4. Vertical section through a pore.
5. T. S. stalk of the female receptacle.

MINDAL PANGIENSI S. 6–8.
6, 7, 8. Three plants.

PLAGIOCHASMA INTERMEDIUM. 9–12.
10. Vertical section through pores.
11. A ventral scale.
12. Appendage of the ventral scale.
Kyelang; S. India, Madras (Iyengar), Nilgiris (Rangachariar), Tinnevelly Hills (Rangachariar); Kaghan Valley (N. A. Qizilbash).

Note:—The plant described as *Mindal pangiensis* by the writer (Jour. Bom. Nat. Hist. Soc. Vol. XXIV, p. 346, 1916) is very incompletely known. It is undoubtedly very near *Reboulia*, and possibly may be a mere form of *Reboulia hemispherica*. It differs from the latter in the continued growth of the thallus after the formation of the male and female receptacles by means of apical adventitious shoots; in the size of the pores which are bounded by 2 or 3 rings of 8 cells each; in the small number of the involucres, which are only 1 or 2 on the small receptacle; and lastly in the size of the spores and elaters. These last were described from stray individuals sticking to the walls of the capsule and are: spores yellowish, reticulate, 30 μ in diam., and elaters 180 μ, closely trispiral. Even last year (1928) while passing through Pangi where the plant was first collected I could not secure any good material. Until the plant is better known it is as well that it may be treated as a variety of *Reboulia hemispherica*, especially as that plant itself is very variable.

The specimens from Spiti are in an unsatisfactory condition. The plants are narrow with purple margins; air-chambers small in several layers; ventral scales purple, with 1 or 2 appendages, appendage entire, purple, lanceolate, acuminate,

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**XIX. PLAGIOCHASMA** L. et L.


Monoecious or dioecious. Plants large, caespitose, in large patches, green. Chambers narrow, in several layers, empty. Pores sometimes with thick radial walls of the cells bounding them. Scales in 2 rows, with appendages. Male receptacle sessile, usually horse-shoe-shaped, surrounded by linear scales; papillae small; air-chambers with simple pores between the antheridia. Female receptacle sessile when young, usually stalked at maturity; stalk arising from the dorsal side of the thallus, without a rhizoid-
furrow, with scales at the base and apex. Receptacle more or less concave on the dorsal surface (in the Indian species), with barrel-shaped pores, 2-9-lobed, involucres large, inflated, bivalved, margins of the valves involute in the young condition, one of which opens out at maturity while the other remains folded inwards, each containing one archegonium and later on one sporogonium. Calyptra thin. Capsule short, with a large foot, opening by an indistinct lid. Capsule wall thin, one layered, cells without annular or spiral bands, lid 2-3 cells thick. Spores, large, yellow, tetrahedral. Elaters rather short, bi- or tri-spinal, sometimes uniformly thickened without spirals, yellowish, occasionally furcate.

*Note:*—The margins of the involucral valves in the young condition are bent inwards, projecting into the cavity of the involucre. Later on when the capsule is ripe and the involucre opens, one of the margins spreads out and opens outwards, while the other becomes more closely pressed along the inner surface of the valve and never opens out. In the allied genus *Reboulia* the young valves have their margins similarly bent inwards but at maturity both valves open outwards.

The female receptacles are distinctly dorsal in all the species except *P. articulatum* in which they are at first terminal but the thallus goes on growing invariably by an adventitious shoot immediately after the formation of the receptacles whether the latter are fertilised or not, so that a distinct line of articulation is always clearly visible in that species. Sometimes in *P. appendiculatum* also growth stops partially after the formation of the receptacles and a similarly articulated appearance is produced but a close examination shows this to be only apparent and, in any case, partial.

*Key to the Species.*

1. Thallus distinctly articulated, female receptacle borne at the articulation

1. Plants as a rule not articulated, female receptacle always dorsal

2. Lobes broad, obtuse, scale appendage large, broad, strongly constricted at the base

2. Lobes narrow, linear

1. *P. articulatum.*

2. *P. appendiculatum.*
3 (Scale appendages not constricted..........................P. similensis
(Scale appendages constricted..........................P. intermedium.

38. **Plagiochasma articulatum** Kashyap.


Monoecious. Thallus 2-5 cm. long and 6-8 mm. broad; lobes oblong-ovate, flat, with undulate margins, apex notched. Dorsal surface dark green, epidermal cells 5-6-angled, walls thin, angles thickened. Dorsal layer well developed, chambers empty, in several layers. Pores simple, inconspicuous, bounded by 3 series of 7 or 8 cells each. Ventral surface purple; scales purple, overlapping, each with 2 or 3 long, narrow, purple, appendages, which bend over the growing point. Midrib inconspicuous, gradually passing into the lamina, ending in an acute margin. Receptacles always terminal to begin with, becoming dorsal by the formation of apical adventitious shoots and therefore, situated on the line of junction in the middle. Male receptacles formed one after the other, or a male receptacle may be followed by a female receptacle; horse-shoe-shaped, surrounded by small scales, and with 2 growing points; pores on the receptacle tissue simple. Stalk of the female receptacle none or up to 2 mm. long. Receptacle with 3-4 lobes. Capsule wall of a single layer of cells except at the top. Spores yellowish, reticulate-lamellate, 60-80 μ in diam. (including the wing), 2-4 reticulations in the diameter (excluding the wing), wing 12 μ broad more or less lobed, surface punctate. Elaters normally bispiral, 220-260 μ long.

Hab. Rocks, etc. The same as that of *P. appendiculatum*, but more adapted to drier localities.

Distrib. Common throughout the Outer and Kumaon Himalayas up to about 8,000 feet; also. Ladak, Leh 11,000 feet; sometimes coming down to the plains. Lahore etc.; Ootacamund (Rangachariar); Nilgiris (Sedgwick); Bombay, Panchgani (Blatter).

*Note.*—Although the plant often occurs along with *P. appendiculatum*, it is more commonly met with in dry localities,
is generally much smaller and distinctly xerophilous. The poor plants of *P. appendiculatum* sometimes resemble this species very much. The elaters, like those in *P. appendiculatum*, sometimes do not develop the spiral bands. Stalk of the female receptacle may or may not be developed. It resembles *Reboulia hemispherica* in the general appearance of the thallus and the form of the scales.

Both the male and female receptacles are at first terminal. Shortly after, however, growth of the lobe is continued. In other words an apical adventitious shoot is formed. There is thus always a distinct line of articulation between the old and the new part of the lobe and the receptacle is situated between the two. In *P. appendiculatum* and other species, there is never any stoppage of growth and the receptacles are distinctly dorsal. *P. articulatum* shows clearly how the position of the receptacle has been shifted from the apex to the dorsal side, and how a form like *Reboulia* could have given rise to a form like *Plagiochasma*. Apical adventitious shoots are common in *Reboulia*. The main difference between the two genera is the form of the female receptacle. Compare also the genera *Preissia* and *Stephensoniella* as regards this character.

39. *Plagiochasma appendiculatum* L. et L.


Monoecious. Thallus forming large patches, thick, 1-4 cm. long and 4-10 mm. broad, dichotomously divided, occasionally with adventitious ventral shoots; lobes oblong obcordate; dorsal surface smooth, slightly concave; margins undulate, ascending, crenulate. Areolae not visible to the naked eye, epidermal cells large, 5-6-angled, angles thickened. Dorsal layer well developed, chambers empty in several layers. Pores large, bounded by 3 or 4 rings of 6-10 cells each, radial walls thickened, nodulose. Ventral surface purple: scales in 1 row on each side of the midrib, purple, broadly lunate, body with 1 or 2 appendages, reaching half way to the margin, bent over the apex; appendage large, usually hyaline, entire, rotund or ovate obtuse, occasionally purple, ovate-lanceolate and acute. Midrib not conspicuous below, gradually passing into the lamina. Male receptacle
horse-shoe-shaped, sometimes once or twice furcate, surrounded by small scales, with distinct growing points; pores on the receptacle simple. Female receptacles sessile or stalked. Receptacle usually with 5 or 6, often as many as 9, lobes. Capsule wall of a single layer of cells except at the lid, lid of 3 layers of cells, cells equally thickened on all sides. Spores yellowish, reticulate-lamellate, 50-90 μ (including the wing), 2-3 reticulations in the diameter (excluding the wing), wing broad, 12 μ, entire or slightly lobed, surface of wing finely punctate. Elaters 220-290 μ, bispiral; often with uniformly thick walls and without spirals.

Hab. Rocks, etc.

Distrib. Exceedingly common in the Outer, and the Kumaon Himalayas up to 9,000 feet, sometimes coming down to the plains. Lahore, Rawalpindi, Saharanpur, Hardwar, Dehra dun, etc.; Jammu Patni pass; Simla; Mussoorie; Nainital (Baini Prasad); Nilgiris (Rangachariar).

Note.—Stephani mentions that the receptacle has 2 or 3 involucres, but in the specimens examined by me there are usually 5 or 6 involucres, though as many as 9 are sometimes seen. According to him the scales bend over the margins but I have not found any specimens in which the scales were more than half way towards the margin.

The large and broad lobes, with a smooth dorsal surface, forming usually large patches, sometimes extending to several feet, along with the large hyaline appendages conspicuously bent upwards at the growing point, distinguish this species from the others. The appendages are usually rounded or ovate, obtuse and hyaline. The epidermal cells have thin or slightly thickened walls and trigones are as a rule much thickened. The number of cells bounding the pores is very variable. There are usually 6-8 cells in each ring but as many as 10 may be present, and stomata are found in the same piece of the thallus with any number of cells between 6 and 10. Specimens from Hardwar show some peculiar characters. The epidermal cells are thin-walled and the trigones are not thickened. The scale appendages as usual are large, one or two to each scale, but ovate or ovate-lanceolate, acute, and purple. It may appear from a combination of these characters that the plants belong to another species. The great variation in liverworts,
however, should be borne in mind. In perfectly typical specimens which would be easily recognised as *P. appendiculatum* the epidermal cells may be thick- or thin-walled and the scale appendages may be acute. The colour of the scale appendages and the absence of trigones are not sufficient characters to separate the Hardwar specimens as a distinct species. Further examination of the plant would no doubt bring to light other variations.

The plant is usually met with in moist places. In favourable localities the male receptacle is often seen branching once or twice, with long narrow lobes, in which the antheridia are borne distinctly in an acropetal order. Several receptacles may be formed one after the other. The female receptacle is usually perfectly clearly dorsal, and several receptacles may be formed one after the other, especially when they are not fertilised. The relative position of the male and female receptacles is very variable. A male receptacle may be formed in front of, behind, or beside the female receptacle on an adjacent lobe. Sometimes bisexual receptacles are met with. Occasionally growth is more or less stopped under unfavourable circumstances after the formation of the receptacle and is resumed later. In these cases it appears as if the receptacle was terminal and growth had been continued by an apical adventitious shoot. It may then become difficult to distinguish this species from *P. articulatum*, but a little careful examination will show that the two parts of the thallus are absolutely continuous at least in some portion and there is never a complete line of articulation as in *P. articulatum*.

Sometimes the elaters develop no spiral bands, probably when the plants do not get sufficient moisture owing to the rains having stopped while development was still going on. The spores and elaters vary in size to some extent and as a rule they vary inversely to each other.

Some of the cells in the female receptacles and sometimes even in the thallus are brown in colour and contain oil.
PLATE XVI.

PLAGIOCHASMA ARTICULATUM. 1—3
  1. Three male and female plants.  2. Two ventral scales.
  3. Vertical section through a pore.

PLAGIOCHASMA APPENDICULATUM 4—7
  4. A plant with male and female receptacles.
  5. T.S. of thallus.
  6. Two ventral scales.  7. A female receptacle.

PLAGIOCHASMA SIMLENSIS. 8—11.
  10. Vertical section through a pore.  11. Two pores from above.
40. Plagiochasma similensis Kashyap.


Monoecious or dioecious. Closely creeping, bluish green, dichotomously branched, up to 15 mm. long and 4 mm. broad; lobes narrow, linear; apex rounded; margin entire or slightly crenulate, purple; dorsal surface smooth, plane. Areolae not distinct; epidermal cells thin-walled, angles not thickened. Dorsal layer shallow. Pores minute, simple, bounded by 4 or 5 cells. Ventral surface purple; scales purple, overlapping, not reaching the margin, triangular, entire, appendage not sharply constricted off from the body, purple or hyaline, ovate to lanceolate, usually ending at the apex in a 2-celled filament. Cross section of the thallus biconvex in the middle, gradually thinning towards the margins. Male receptacle middorsal, either on different lobes of the thallus bearing female receptacles or on different plants, cushion-like, circular or notched anteriorly. Female receptacle sessile or shortly stalked; stalk, if present, up to 2 mm. long; receptacle concave dorsally. Sporogonia, 1 or 2. Spores broadly reticulate-lamellate, 3 reticulations in the diam, (excluding the wing), wing broad, 8 μ, punctate, finely ciliate about 112 μ in diam. Elaters closely 3-4-spiral, broad, occasionally branched, 340-400 μ long.

Hab. Near a stream.
Distrib. Outer Himalayas, Simla: S. India, Kodai Kanai (Rangachariar)

Note.—Stephani (Sp. Hep. Vol. I, p. 81) has described a plant under the name of P. nepalensis from Nepal, which from the description appears to be the same as P. similensis.

41. Plagiochasma intermedium Ldbg. et G.


Dioecious. Plants forming patches. thallus up to 25 mm. long and 4 or 5 mm. broad, simple or slightly dichotomous, frequently with apical and ventral innovations; lobes strap-shaped; dorsal surface green, sub-plane; margins thin, purple,
raised, almost entire to dentate. Epidermal cells polygonal, walls and trigones rather thick. Dorsal layer well developed. Pores large, bounded by 3 or 4 rings of 7 to 9 cells each, radial walls slightly thickened. Ventral surface purple; scales purple, overlapping, lunate. appendaged, appendages 2 or 3, oblong-lanceolate, constricted at the base, entire, acute. Midrib broad, gradually passing into the wings. Male receptacle at the apex on the main thallus, often with an adventitious shoot in front. Female receptacle sub-sessile, or very briefly stalked, on the dorsal surface in the middle. Receptacle concave above, with 1-4 involucres, scaly below, scales linear-lanceolate. Spores brown. reticulate-lamellate, winged, wing broad, entire, reticulations 2-3 in the diam. (excluding the wing). 70 (66-95) μ. in diam. Elaters concolorous, uniformly thickened, without spiral bands, 250 μ.

Hab. On a wall.
Distrib. Nurpur, (Pathankot—Dalhousie road) about 2,500 feet.

Note.—The species has not so far been described from India. Stephani (Sp. Hep. Vol. 1, p. 79) describes it from Mexico, while Evans (Bull. Torr. Bot. Club 42: 1915, p. 301) describes it from several localities in America and gives China and Japan as its range of distribution. The characters agree with the descriptions of the above writers with very slight differences. Evans says that the plant is monoecious, that the walls of the epidermal cells are thin, and that the elaters are without or with only rudimentary spirals. According to Stephani the elaters are without spirals. My specimens agree closely with the description given by Stephani.

As was pointed out by the writer in connection with P. articulatum and P. appendiculatum (New Phyt. Vol. XIII, 1914, pp. 318-323) spirals on the elaters may or may not be present in the same species, and the absence of spirals, therefore, has no specific importance. Probably the absence of spirals is associated with a decrease in the amount of moisture available at the time when the spores and elaters are approaching maturity. According to Evans the spores are usually verriculose and occasionally reticulate, but the few spores seen by me were all reticulate as stated in the description. The length of the stalk is also very variable.
The following species have been described by Stephani from the Himalayas but have not been found by the writer.

42. **Plagiochasma cordatum** L. et L.

*Plagiochasma cordatum* L. et L. Pug. IV. p. 13 (1832).

Monoecious. Thallus up to 20 mm. long, and 10 mm. broad, dorsal surface plane, margins ascending, attenuate, wavy, crenulate. Stomata large, bounded by 4 series of 6 or 7 cells each. Ventral surface not coloured, slightly convex; scales large, pink, imbricate, oblique, semilunate; appendages 2, long, parallel, linear, acute, margin coarsely toothed (erosodentatis). Male receptacle on branches arising either from the apex or from the sides of the midrib. Female receptacle stalked; stalk up to 7 mm. long, thin, apex slightly scaly. Receptacle concave on the dorsal surface, smooth. Involucres 2 Spores 68 μ. Elaters 290 μ, bi- or tri-spiral, spirals narrow.

Hab. Nepal (Wallich). Himalaya (Hooker, Duthie).

43. **Plagiochasma quadricornutum** St.


Plants dioecious, large, robust, rigid, yellowish, on soil or rocks, in patches. Thallus 25 mm. long and 5 mm. broad, simple or furcate, margin minutely crisp, reddish. Stomata large, low, bounded by several rings of 6 cells each, inner pore closed by four conical radially converging cells. Midrib narrow, slightly produced. Ventral scales large, purple, long appendaged, appendage linear, cuspidate, entire. Male receptacle not seen. Stalk of the female receptacle short, thick. Receptacle globose, margin slightly emarginate involucres four, mussel-shell-shaped, opening wide, entire. Rest not seen.

Hab. Himalaya, Simla (Long).
XX. SAUCHIA Kashyap.


Plants occurring singly or in patches, small, light green, dorsal side spongy. Chambers in one layer, directed forwards obliquely, empty, very wide in older parts. Pores simple, slightly raised. Ventral surface greenish; midrib thick; scales scattered, hyaline, small, triangular or ovate, entire, acuminate. Antheridia on the dorsal surface of short ventral shoots, papillae conical. Female receptacle stalked, in the fork of 2 lobes; stalk with one rhizoid furrow containing a few tuberculate rhizoids, naked at the base, paleaceous at the top. Receptacle 4-lobed, with 4 bivalved or slightly tubular involucres under the lobes; receptacle tissue absent. stomata none, involucre wall with large chambers opening by irregular fissures inwards. Archegonium one in each involucre. Sporogonium with well developed foot when young. seta a mere constriction, capsule wholly included. wall of one layer of cells, cells with spiral, annular, or semiannular bands, annular bands sometimes branched. Elater-like cells attached to the base and top of the capsule. Spores tetrahedral, margin crenate. Elaters closely trispiral, often branched.

44. _Sauchia Spongiosa_ Kashyap.


Monoecious. Plants singly or in patches, thallus spongy, light green, thick. once or twice forked, often with numerous small adventitious shoots from the ventral surface just within the margin, lobes broad, oblong, 5-10 mm. long and 4 mm. broad, apex notched rather deeply, margin entire or slightly toothed, slightly raised. Dorsal surface areolated, flat or with a narrow shallow indistinct groove in the posterior part: epidermal cells with chloroplasts, walls thin, angles not thickened. Dorsal layer deep. Pores simple, slightly raised, not well differentiated, surrounded by 3 series of 6-8 cells each, innermost cells usually collapsed, circular when young, drawn out when old. Air-chambers wide and deep, in one layer, empty, directed
PLATE XVII.

SAUCHIA SPONGIOSA. 1—9.

1, 2. Two female plants.
3. A male plant, note the ventral male shoot.
4. A male shoot.
5. T. S. of thallus.
6. Four pores. The dots in one case represent the Chloroplasts.
7. A ventral scale.
8. T. S. of Stalk of the female receptacle.
9. Two scales from below the female receptacle.
forward obliquely. Ventral surface greenish; scales scattered, hyaline, small, triangular or ovate, entire, acuminate. Midrib prominent below, gradually passing into the raised margin. Antheridia on short ventral shoots in a mid-dorsal cluster, papillae long, conical, 4-8. Female receptacle in the fork between two lobes, stalked; stalk up to 7 mm. long, with 1 rhizoid furrow containing a few tuberculate rhizoids, naked at the base but paleaceous at the top; scales persistent, lanceolate, with a thin-walled proximal and a thick-walled distal half. Receptacle 4-lobed, with 4 bivalved or slightly tubular involucres; receptacle tissue absent. stomata none; involucre walls with large chambers opening by irregular fissures inwards. Perianth absent; calyptra thin. Archegonium one in each involucre. Sporogonium with a well developed foot, seta a mere constriction, capsule 880 μ in diameter. Spores 60-64 μ, winged, wing narrow, crenate-lobate. Elaters closely trispiral, 200-250 μ long. Elater-like cells small. Some elaters and many short elater-like cells fixed to the base and apex of the capsule, projecting into the cavity.

Hab. On moist shady rocks or actually under cold flowing water.

Distrib. Middle and Main Himalayas 9,000-14,500 feet. Above Alrus on the Pangi Road, 9,000 feet; both sides and top of Rotang Pass, 13,400 feet; beyond Baralacha Pass. 14,500 feet; Chandra Valley, Manh Pass.

Note:—This species was described (Jour. Bomb. Nat. Hist. Soc. Vol. XXIV, p 347 1916;) from some scanty material from Chamba—Pangi Road. In 1928 more material was collected from this and several other localities. The original description has been amplified from these specimens.

The capsules are not quite ripe in the specimens. Spores and elaters are still brownish, and the spores are without fully developed surface marks. In the oldest parts the stomata become disorganised and the chambers open by the whole width and are visible to the naked eye. The chambers sometimes contain the eggs of some insect which resemble the antheridia. They are white in colour and oblong-cylindrical in shape.

The male shoots resemble those of Targionia and some Fimbriarias in possessing a cylindrical stalk-like and an
expanded terminal portion which bears the antheridia.

The difference in the thickness of the cell-walls in the proximal and distal half of the scale is more marked in the case of the scales at the top of the stalk of the carpocephalum than in the case of scales from the thallus.

Allied to *Sauteria*, from which it differs in having thin-walled cells around the pores and its delicate texture. Resembles *Stephensoniella brecipedunculata* in appearance and texture. The latter, however, occurs at lower levels.

The following species *Sauteria alpina* has been described by Stephani, but has not been seen by me.

**XXI. SAUTERIA** Nees.


Plants thallose, small, green. Thallus thick, dichotomously divided or with innovations from the side of the midrib; sterile lobes ligulate, fertile ones broadly ob-cordate; dorsal surface almost plane. Dorsal layer narrowly cavernous, chambers in one layer. Stomata small, simple, bounded by a ring of 5 or 6 cells with thick radial walls. Midrib strongly produced ventrally; ventral scales in 2 or 4 rows, small, delicate, scarcely imbricate. Antheridial group not sharply marked off, without scales, irregularly arranged, in the middle of the thallus, ostioles narrow and hyaline. Female receptacle terminal. Stalk long with one rhizoid furrow, naked at the base; sometimes paleaceous at the top. Central disc of the receptacle small, stomata none, deeply divided into 3-5 decurved, obovate, often unequal lobes. Involucre tubular. apex truncate, wide, open. Calyptra thin. Foot small, seta small or nil, capsule globose, not exserted, dehiscence irregular, wall with well developed semi-annular bands. Spores more or less papillate. Elaters fusiform, curved, bi- or tri-spiral, obtuse.

45. **Sauteria alpina** Nees.

*Sauteria alpina* Nees, Nat. eur. Leb. IV. p. 143.

Monoecious. Thallus usually up to 12 mm. long, green in the middle, hyaline at the margins, twice as broad as thick, ventrally subangular, convex, and in section, therefore, the
thallus broadly triangular. Dorsal layer shallow; epidermal cells not thick-walled. Ventral scales imbricate, in 4 rows, hyaline, oblique from a broad base, formed of large irregular cells, apex gradually acuminate, upper half coarsely and irregularly dentate or subacinate with clavate cells. Female receptacle stalked, stalk up to 20 mm. long, hyaline, furrow deep with obtuse lips. Scales on the ventral side of the receptacle large, oblong, obtuse. Capsule distinctly pedicellate, reddish-

KEY TO THE SPECIES

{ Plants large, thick, with thin ascending 
  
  1 { wings, scales conspicuous at apex ............... 2
  
  Plants small, scales inconspicuous .................. A. pusilla.

  2 Plants monoecious ...................................... A. pinguis.

  Plants dioecious, with a metallic lustre ........... A. dioica.

Sporangium opening by means of long slender stigmata through each involucre. Sporogonium with a well developed foot and a seta. Capsule exserted, wall of one layer of cells with thick bands. Capsule dehiscing by 4 or 5 irregular valves, apex with a few elater-like cells hanging into the cavity. Spore brown, papillate. Elaters 2-3-spiral.

46. Athalamia pinguis Falc.


Monoecious. Plants growing upwards from a thick base and again bending the thick apex into the soil. Thallus 10-15 mm.
thallus broadly triangular. Dorsal layer shallow; epidermal cells not thick-walled. Ventral scales imbricate, in 4 rows, hyaline, oblique from a broad base, formed of large irregular cells, apex gradually acuminate, upper half coarsely and irregularly dentate or subacuminate with clavate cells. Female receptacle stalked, stalk up to 20 mm. long, hyaline, furrow deep with obtuse lips. Scales on the ventral side of the receptacle large, oblong, obtuse. Capsule distinctly pedicellate, reddish-brown. Spores deep brown, 59 µ, densely papillose. Elaters usually up to 200 µ, bi-spiral.

Hab. Kaschmir, Liddar Valley, 13,000 feet (Duthie).

XXII. ATHALAMIA Falconer.


Plants green, in patches, on rocks or earth, branching dichotomous. Air-chambers narrow, empty, in one layer; pores simple, bounded by cells with usually more or less thick radial walls. Ventral scales scattered without distinct appendages. Antheridia usually behind the stalk of the female receptacle, ostioles forming a cushion or scattered in zigzag rows, conspicuous. Female receptacle dorsal, stalked; stalk without a rhizoid-furrow, sulcate, paleaceous only at the top. Tissue of the female receptacle minute or nil, a short knob being formed where involucres meet, stomata absent, number of involucres variable. Involute bi-valved, directed upwards, walls of the involucre with chambers opening inwards by long fissures. Archechonium one in each involucre. Sporogonium with a well developed foot and a seta. Capsule exserted, wall of one layer of cells with thick bands. Capsule dehiscing by 4 or 5 irregular valves, apex with a few elater-like cells hanging into the cavity. Spore brown, papillate. Elaters 2-3-spiral.

46. Athalamia pinguis Falc.


Monoecious. Plants growing upwards from a thick base and again bending the thick apex into the soil. Thallus 10-15 mm.
broad, simple or forked once or twice, lobes not divergent, light green, fleshy, wings wide, very thin, erect, dorsal surface deeply concave, densely papillate. Epidermal cells 5-6-angled, elongated antero-posteriorly, walls thickened. Pores minute, slightly raised, each bounded by 1 ring of 4 or 5 cells, radial walls of cells very thick, giving the pore a star-like appearance. Air-chambers very narrow, slit-like on the midrib, slightly broader in the wings. Ventral surface greenish or hyaline; covered with numerous scales, scales white, large, triangular or lanceolate, entire, not appendaged. Midrib prominent below, mycorrhizal, rather suddenly passing into the lamina. Antheridia a few, generally behind the stalk of the female receptacle, sometimes in front of it, and occasionally on distinct lobes, in 2 rows, ostioles conspicuous. Female receptacle arising from the dorsal surface on the midrib; two may be formed one after the other. Young receptacle surrounded by scales, scales smaller than the ventral scales and with numerous cells projecting from their margins, later carried to the top of the stalk; stalk up to 6 mm. long and 1 mm. thick, circular or more or less triangular in cross section, sulcate. Receptacle with 3-5(-8) involucres; involucres inflated, upturned, 2-valved, each with one archegonium; receptacle tissue nil or a minute knob without stomata. Sporogonium one in each involucre, but not in every involucre; capsule with a well developed foot, fully exserted and directed upward, seta up to 1-5 mm. long, cells of the capsule wall with annular bands. Spores brown, tetrahedral, with obtuse papillae, appearing reticulate with a toothed margin in surface view, 65-70 µ in diam. Elaters trispiral, sometimes branched, 140-200 µ long. From the top of the capsule hang a few short elaterlike cells.

Hab. Exposed slopes.
Distrib. Very common in the Outer and the Kumaon Himalayas, 5,008 to 8,000 feet. Mussoorie, Simla, Kulu. Ravi valley, etc.

Note:—The thick fleshy thallus, upturned thin wings, and the tuft of white scales at the apex distinguish this species from other thallose forms. The scales may occasionally have a cell projecting from the margin. The apex becomes thickened at the end of the season and is directed downwards into the soil, where it persists, while the rest of the plant dies in winter. This apical portion is smooth and without any scales, which are found
Plate XVIII.

ATHALAMIA PUSILLLA. 1—6.

1, 2. Two fertile plants. No. 2 shows a dehiscing capsule.

3. L. S. of thallus (only a portion).

3a. T. S. of thallus.

4. Two pores from above.

4a. Vertical sections through two pores. The lower one shows the side view.

5. A ventral scale.

6. A scale from a young female receptacle.

ATHALAMIA PINGUIS. 7—13.

7, 8. Two plants, note the antheridial papillae, an.

9. T. S. of thallus; my, the mycorrhizal region.

10. L. S. of thallus (only a portion).

11. Two pores from above.

12. A ventral scale.

13. A scale from a young female receptacle.
on its lateral sides, and bears only a few rhizoids.

The scales on the young female involucre resemble the ventral scales of the thallus of *Athalamia pusilla* described later.

47. **Athalamia dioica** Kashyap.


Dioecious. Thallus thick, fleshy, green, once or twice forked, lobes oblong, up to 6 mm. long and a little less broad. Dorsal surface with a white metallic lustre. Stomata simple, surrounded by 5 or 6 cells, with thick radial walls, epidermal cells thin-walled. Air-chambers rather wider than those of *A. pinguis*. Scales triangular or ovate, acuminate, entire, produced into a filament of a few cells. Antheridia in 2-4 zigzag or straight rows on the mid-dorsal line or a definite raised naked receptacle. Capsule only slightly exserted. Spores deep brown, with numerous high conical papillae, 50-55 µ in diam. Elaters brown, rather closely trispiral, 200-250 µ long.

Hab. On road-side.

Distrib. Pangi, about 7,000 feet, between Kilar and Sauch.

Note:—Doubtfully distinct from *A. pinguis*.

48. **Athalamia pusilla** Kashyap Nov. Comb.

*Gollaniella pusilla* St. Hedwigia. Bd. LXIV, p. 74 (1905).


Usually monoecious, occasionally dioecious. In large patches on bare rocks or crumbling hard earth. Plants small, delicate, thin, closely creeping, from a thick narrow base, up to 15 mm. long and usually about 1.5 mm. broad, with a dorsal groove; once or twice forked, rarely with ventral innovations; lobes linear to obovate, notched at the apex, margin thin, wavy, purplish, ascending. Dorsal surface with inconspicuous stomata; epidermal cells 5-8-angled, walls thin. Pores small, inconspicuous, bounded by 2 rings of 5 or 6 cells each, radial walls of cells usually thin, sometimes slightly thick. Dorsal layer shallow, with small, empty, air-chambers. In a cross section the chambers in several layers in the middle, in only one or two layers in the wings, wing usually
consisting of an upper and a lower layer of cells separated by the air-space. Midrib projecting ventrally, rather suddenly passing into the wings. Ventral surface greenish or sometimes reddish; scales scattered, delicate, hyaline or reddish, lanceolate, acuminate, numerous cells projecting outwards at the margins. Apex formed of a filament of 4 or 5 cells, shorter filaments sometimes projecting from the sides also, cells of scales with chloroplasts. Antheridia few, usually behind the stalk of the female receptacle, sometimes in front of it; arranged in two zigzag rows, or on a more or less well-developed cushion, papillae hyaline. Female receptacle dorsal, on the midrib, very small while young, covered by linear scales, cells of the scales with chloroplasts. Receptacle tissue nil. Involucres 1 or 2, rarely 3. Archegonium one in each involucre. Stalk developed only if the archegonium is fertilized, up to 10 mm. long and fairly thick, sulcate, naked, covered at the top by linear scales. Capsule with a seta 1-1.5 mm. long, fully exserted. Cells of capsule wall with annular bands. Dehiscence by irregular recurved valves. Spores brown, with numerous high papillae, 45-56 µ in diam. Elaters bispiral brown, 140-180 µ long. A few short elater-like cells with annular bands project into the cavity of the capsule from the base and the apex.

Hab. Moist and shady places,
Distrib. Common in the Outer and the Kumaon Himalayas, 6,000 to 10,000 feet. Simla; Kulu, Dulchi pass; Lahul, Kyelang; Mussoorie, Joshi math, etc.

Note:—The cells bounding the pores are usually thin-walled. Sometimes, however, the radial walls of the cells are slightly thickened. The radial walls are never very thick and the pores are never star-shaped.

Stephani described this plant under the name *Gollaniella pusilla* and the description was amplified by me (New Phyt. Vol. XIV, p. 14, 1915). The ripe capsule wall, consisting of a single layer of cells, has, in my specimens, well developed thick annular and spiral bands—not semi-annular bands as described by Staphani—on of the cell walls. In view of the close similarity of the chief characters between *Athalamia pinguis* and this plant it is not necessary to put it in a separate genus, and *Gollaniella* has, therefore, been merged into *Athalamia*. 
PLATE XIX.

RICCIOCARPUS NATANS.  1—5.

1. Floating form.
2. Land form.
3. Ventral scale from floating form.
4. T. S. of floating form.
5. A portion of T. S. of land form.

RICCIA MELANOSPOREA.  6—7.

6. Two plants.
7. T. S. of thallus.
Family III. Riciaceae.

Chlorophyll-bearing layer with narrow air-spaces or with larger chambers. Pores absent or rudimentary. Archegonia immersed singly in cavities on the dorsal surface. Sporogonium without a foot or seta and remaining enclosed in the calyptra, dehiscing by the decay of the capsule wall; sterile cells absent.

Epidermis without pores: antheridia scattered in the thallus ................................................................. Riecia.

Epidermis with distinct minute pores. antheridia aggregated in a median furrow of the thallus .................................................. Ricciocarpus.

XXIII. Ricciocarpus corda.


Plants thallose thick, cavernous, dichotomously branched. with obovate lobes, rarely forming rosettes, floating in water and then sterile, or fruiting on mud. Chlorophyll-free layer very weakly developed. the thallus consisting for the greater part of polyhedral air-chambers; the dorsal epidermis with pores. Ventral surface with long. dentate, violet-coloured scales. Antheridia in a long definite cushion in the median furrow on the dorsal side. Archegonia in rows, each surrounded by a rudimentary cup-shaped involucre. Capsule immersed, in the tissue of the thallus.

49. Ricciocarpus natans corda.


Floating form:—Very much like Lemna, with broadly obovate lobes more or less violet, with long, pendent, serrated, violet scales on the ventral surface, and with a few smooth rhizoids or none.
Terrestrial form:—Caespitose. Thallus forming semi-rosettes 10 to 12 mm. in diam., once or twice dichotomously divided. Lobes obcordate or broadly linear, 2 mm. broad, notched at the apex. Dorsal surface with a distinct furrow. Air-chambers large, with one-layered walls. Pores bounded by 6 to 8 cells with slightly thickened walls. Ventral surface with usually violet dentate scales and purple smooth rhizoids. Cross section nearly flat, becoming thinner towards the margin, slightly convex on the ventral surface. Capsules singly or in pairs, in rows, in the centre of the thallus. Spores 51 μ, reticulate, reticulations sometimes imperfect, margin narrowly winged, escaping through a slit along the median furrow of the thallus.

Hab. Floating on water or rooted on mud.

Distrib. Kashmir, the Dal Lake (Sahni); Peshawar (N. A. Qizilbash).

Note.—The specimens in my collection are all sterile. The description of fertile plants is after Macvicar. "Students' Handbook of British Hepatics."

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XXIV. RICCIA L.


Monoecious or dioecious. Thallus dichotomously branched, with linear to obcordate segments, terrestrial or more rarely floating on water. Dorsal surface usually green, generally with a distinct median furrow; margin occasionally with cilia. Chlorophyll-bearing layer with narrow and deep air-spaces, or with large chambers opening by their whole width. Ventral scales usually in one row at the apex, but later, through rupturing in the median line, apparently 2-rowed, well developed, rudimentary or sometimes absent, hyaline or coloured. Rhizoids usually of two kinds, smooth and tuberculate, sometimes only smooth, and in Riccia fluitans (floating form) absent. Antheridia and archegonia scattered singly on the dorsal surface, immersed at maturity in the chlorophyllaceous tissue. Involucrum none. Ostioles of the antheridial chambers usually below the epidermis, though in some cases long and prominent. Archegonia usually purple at the tip, neck occasionally projecting.
Capsule sessile, immersed in the midrib, without a foot and a seta. Calyptra persistent. Spores included. Large, tetrahedral.

Note:—The genus *Riccia* may be derived from a genus like *Targionia*, in which the vegetative tissue of the thallus has still further increased at the expense of the sex organs as given under the genera *Targionia* and *Cyathodium*. Lang has found that in *Cyathodium cavernarum* the archegonia lie actually on the upper surface within the valves of the involucre, the growing point being right at the apex in front. If this growth of the apex is continued forwards and the valves of the involucre are further reduced in size, a condition resembling the one found in some *Riccias* would be arrived at. In the male shoots of *Targionia* the receptacle has well-developed air-chambers between the antheridial chambers, and if similar chambers are developed in between the archegonia in the above mentioned case we would have a plant resembling *R. puthankotensis* which has a broad channel on the dorsal surface. By the further reduction of the ridges of the dorsal channel the last and the simplest condition is reached, as seen in *R. sanguinea* in which there is often no trace of the dorsal furrow, and further there are no scales and tuberculate rhizoids.

It should, however, be borne in mind that some species of the genus *Riccia* (specially the sub-genus *Ricciella*) may have arisen by reduction from types like *Boschia* and *Corsinia*. The species generally referred to the genus *Riccia* seem to have arisen along more than one line. This genus, therefore, is the last term in a long series of forms and not the first term in an ascending series.

**Key to the species.**

1. Plants aquatic ................................................................. *R. fluitans.*
2. Plants on moist or dry soil, never aquatic ........................................ 2
   Air-spaces wide, sporogonia prominent on the
   ventral side ...................................................................... 3
3. Air-spaces narrow, sporogonia prominent on
   the dorsal side ........................................................................ 4
4. Plants thin, delicate, usually cruciate in form,
   spores 60 μ ................................................................. *R. cruciata.*
5. Plants thick, robust, spores 80 μ ........................................ *R. robusta.*
4 Dioecious, male plants red, scales absent
   \( \rightarrow \) \( R. \) sanguinea.

5 Monoecious, scales present
   \( \rightarrow \) \( R. \) himalayensis.

6 Scales bent over the margin
   \( \rightarrow \) \( R. \) pathankotensis.

50. Riccia pathankotensis Kashyap.


Monoecious. Plants overlapping in dense patches, occasionally singly and spreading when on open space. Thallus once or twice forked, compact, light green, up to 5 mm. long; lobes oblong, obtuse, 2-3 mm. long and 1 mm. broad. Cross section oblong, twice as broad as high. Dorsal surface with a broad median channel. Air-spaces narrow. Wings thick. Cilia usually present on the margins and occasionally also on the dorsal surface. Epidermal cells hyaline, spherical. Ventral surface hyaline or blackish, broad, flat or slightly convex. Scales small and hyaline, almost overlapping, not projecting beyond the margins. Antheridia globular, or slightly elliptic. Papillae slightly projecting, hyaline, in 2 or 3 rows, in the channel. Capsules also in the channel in 2 or 3 rows, with very little vegetative tissue between them, visible from the dorsal side. Spores tetrahedral, reticulate, with 8 areoles in the diameter, papillose in profile, margin slightly and irregularly crenate, 95 \( \mu \) in diam.

Hab On the banks of streams and other moist places.

Distrib. Pathankot, Lahore; Kulu, Manali.

Note:--This species can be readily distinguished from the other species of the genus, by the broad channel on the dorsal surface. The capsules occur in groups. Sometimes as many as six are found together touching each other without any green tissue between them, the small amount which was present in the beginning having been disorganised.
PLATE XX.

RICCIA PATHANKOTENSIS. 1—4.
1. A patch of plants.
2. Three plants showing habit.
4. A spore.

RICCIA HIMALAYENSIS. 5—9.
5. A patch of plants.
6. A plant.
7. T. S. of thallus.
8. T. S. of fungus-infected thallus. Note the perithecia with projecting necks.

RICCIA ROBUSTA. 10—12.
10. Two plants.
11. Three T. S. of thallus from various plants.
12. A spore.
Riccia himalayensis St. (Ms.).


Dioecious. Plants once or twice forked, compact, closely creeping, up to 5 mm. long and 1-2 mm. broad; lobes linear or oblong. Dorsal surface green, with a narrow median sulcus. Air-spaces narrow, slit-like. Epidermal cells hyaline, thin-walled, mammillate. Ventral surface purple, midrib convex, projecting downwards. Cross section 3 times as broad as high. Margins often purple, entire, bent downwards. Scales small, semilunar, distant, purple or hyaline, bent over the margin. Antheridia in one median row, papillae long, red, projecting, conspicuous. Capsules in a single median row, spores coming out by the rupture of the dorsal tissue. Spores tetrahedral, finely reticulate, 9-10 reticulations in the diameter, margin narrow, entire, maximum diameter 100 μ.

Hab. Moist soil.

Distrib. Common in the Himalayas from the foot to an altitude of 9,000 feet in Lahul, sometimes coming down to the plains, Lahul, Salgraon; Lahore, Pathankot; Kulu; Simla; Mussoorie; etc., Tinnevelly Hills (Rangachariar); Calcutta. Darjeeling (Tirunarayanan); Rangoon (Ghose).

Note:—The apex at the end of the season grows down into the soil and becomes thick. Next season it grows up and gives rise to a new plant. Some plants were once found attacked by an ascomycetous fungus which formed sunken perithecia with necks projecting on the dorsal surface. These could easily be mistaken for capsules. The perithecia were full of asci each containing 2-celled spores. This is the only liverwort, so far as I know, found attacked by an ascomycetous fungus bearing perithecia. Some specimens from Dehra dun have long narrow lobes, 2 mm long and 1 mm. broad.

This species often occurs with another form, seen only in the sterile condition, which is much smaller and distinctly blue in colour. Otherwise the latter is similar to the above. It is perhaps the young condition of Riccia himalayensis fixed under some unknown condition or possibly a different species.
52. **Riccia melanospora** Kashyap N. S.

Monoecious. Plants small, dichotomous, in patches; lobes oblong-obovate, up to 2 mm. long and 1 mm. broad. Dorsal surface green or greyish green, with a deep narrow sulcus near the apex, and broad flat or slightly concave in the posterior part. Air-spaces narrow, slit-like. Epidermal cells rounded, hyaline. Ventral surface hyaline in the middle, purple below the wings: midrib projecting ventrally, gradually passing into the thick margins. Margins purplish or black, appressed to the substratum. Cross section semicircular, about twice as broad as high. Scales small, purple, confined to below the apex, absent everywhere else. Rhizoids mostly smooth, a few tuberculate. Antheridia in a middorsal row. Sporogonia prominent on the dorsal side, dehiscing by decay of the dorsal tissue. Spores perfectly opaque, black, 80 μ.

Hab. On moist soil.

53. **Riccia robusta** Kashyap.


Monoecious. Thallus very spongy, of a yellowish green colour, forming rosettes up to 15 mm. in diameter, plants sometimes small and overlapping, lobes spreading, up to 2 mm. broad. Dorsal surface flat, margins often turned upwards, specially before dichotomy, often with a fairly broad median groove; occasionally in closely creeping plants the margins are firmly bent downward. Air chambers large, opening by large indefinite pores, the large pits on the posterior part being quite visible to the naked eye. Ventral surface greenish, midrib strongly projecting; scales none. Antheridial papillae not distinct. Capsules project ventrally. Spores tetrahedral, brown when young, quite opaque (black) at maturity, reticulate, reticulations clear in young condition, 4 or 5 large reticulations in the diameter, often each reticulation again divided into two or more smaller ones; wing usually broad and finely dentate, sometimes narrow or even absent; up to 80 μ in diameter, often much smaller.
RICCIACEAE

Hab. Moist places.
Distrib. Lahore, Shalamar Gardens, Ravi banks; Lucknow (S. K. Pande); Bandu, banks of the Ken; Lahul above Kyelang, 11,000 feet Spiti 13,000 feet Indore (T. C. N. Singh).

Note:—The plant grows on the river banks at Lahore, also in the cracks between the bricks of the floor in the Shalamar Garden, Lahore, during winter. It has a very wide range: 700 feet in Lahore to 13,000 feet in Spiti. Plants from Lucknow have practically no wing or a very narrow one on the margin of the spore and the reticulations are 6-7 in the diameter. Many of them incomplete. Mr. S. K. Pande informs me that he has seen very small rudimentary scales at the apex. Lahul specimens have no tuberculate rhizoids, only rarely a rhizoid shows a tubercle at long intervals; spores are not quite opaque and are rather smaller, about 70 μ. Plants from Lahul and Spiti are very small, densely overlapping, rosettes often incomplete, usually less than 12 mm. in diameter, resembling the young plants found in the beginning of the winter in Lahore.

The thick thallus and the spongy texture with the wide pits visible to the naked eye in the posterior part on the dorsal surface distinguish this species from the rest.

54. Riccia cruciata Kashyap.


Monoecious. Thallus yellowish green, spongy, thin, delicate, usually twice forked, with divergent lobes, thus forming as a rule a cruciform rosette, about 10 mm. in diam., lobes obovate-oblong with a shallow narrow median sulcus. Cross section oblong, 4 or 5 times as broad as high, both surfaces flat, chambers large, epidermis thin, hyaline. Scales small, delicate, fugacious, often only as small oblique ridges or absent. Rhizoids chiefly smooth, a few tuberculate. Antheridia globular, papillae inconspicuous. Capsules projecting ventrally. Spores tetrahedral, completely reticulate. 60 μ in diam.

Hab. Moist beds in gardens; river banks.
Distrib Lahore, Ravi banks, Lawrence Gardens; Bandu, banks of the Ken.
Note:—*Riccia robusta*, *R. cruciata* and *R. sanguinea* very often occur together during winter in the plains. *R. cruciata*, however, is rather rare.

55. *Riccia sanguinea* Kashyap.


Dioecious. Male plants minute, red, linear or once or twice forked, or forming red or greenish-red rosettes (always smaller than the female rosettes). papillae red, conspicuous. Female plants usually in large compact green rosettes, often overlapping in large clusters: rosettes 15 mm. in diam., lobes linear-oblong to obovate-oblong, parallel. closely attached to the substratum. Dorsal surface flat or slightly convex, occasionally with a narrow middorsal groove. Thallus compact. Air-chambers narrow. slit-like. Epidermis of a single layer of cells, cells hyaline, thinly-walled. Cross section elliptic or semicircular: midrib gradually passing into the obtuse margins; wings practically absent. Scales absent. Rhizoids only smooth, rarely a few with faint tubercles. Antheridia oblong, cylindrical, in 1 or 2 rows: papillae red, projecting, conspicuous. Archegonia usually indicated in the young stage by red dots on the dorsal side, neck not projecting. Capsules in 1 median row on each lobe. distant. dehiscing by the rupture of the dorsal tissue. Spores opaque. tetrahedral, granular or with very close, irregular, almost wavy streaks, 50 µ in diam.

Hab. On banks of streams.


Note:—The plant is very widely distributed in the plains in India, especially on the banks of rivers. Fully developed plants form circular rosettes, male red and female green. The absence of scales, of the tuberculate rhizoids and often of the dorsal groove, and the very small size, without branching in many cases, all indicate that the species is the simplest
PLATE XXI.

RICCIA CRUCIATA.  1—5.
1. A patch of plants.
2. A single plant.
4. A portion of above, magnified.
5. Three spores.

RICCIA SANGUINEA.  6—9.
6. A male plant.
7. A female plant.
8. T. S. of thallus. The upper figure shows a capsule.
9. Two spores.

RICCIA FLUITANS.  10—13.
10. Floating form.
13. A spore.
in the genus *Riccia*, and, therefore, the simplest of the *Marchantiales*. Perhaps identical with *Riccia Frostii* Austin.

56. *Riccia fluitans* L.


Monoecious. In sterile patches floating on stagnant or slowly moving water, yellowish green. Thallus 30-50 mm. long and 1 mm. broad, several times dichotomously branched; segments divergent, linear, apex emarginate or truncate; thin, with a groove near the apex, flat, yellowish green on both surfaces, no scales or rhizoids on the ventral side. Cross section almost flat, margin obtuse, air-chambers large, in several layers. Terrestrial form thick, broadly channelled, occasionally tinted with violet on the sides and margin; rhizoids numerous; ventral scales small, confined to near the apex, colourless or violet. Cross section semilunar, margin obtuse. Air-chambers large in several layers. Capsule forming a spherical protuberance on the ventral side, furnished with rhizoids on the enclosing tissue. Spores-brownish-yellow, translucent, 75-90 µ in diam.; margin broad, 4-7 µ across, entire or nearly so; face with 4 or 5 areolae across the diameter, those in the centre large.

Hab. Stagnant or slowly moving water, or banks of streams.

Distrib. Garhwal, Jumna valley; Kashmir; *Peshawar* (N. A. Qizilbash); *Madras*, (Iyenger).

Note:—*Fysonia tenera* Kashyap from South India is merely a form of this species. The “foot” of that plant, the chief character in which it differs from the present species, is no doubt a group of cells of the thallus, more or less modified on account of the proximity of the capsule.
Order III.

JUNGERMANNIALES.

Gametophyte an undifferentiated thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Sex organs usually arranged in groups but never raised on stalked receptacles, occasionally immersed in cavities. Sporogonium with a foot and seta. Capsule wall two or more cells in thickness. Elaters present. Dehiscence usually by 4 valves.

Family IV. CODONIACEAE.

Thallose foliose or forms intermediate between them. In the foliose forms leaves in two rows, parallel to the stem or obliquely inserted and succubous, simple. Rhizoids always present. Male and female inflorescences scattered on the dorsal side or in groups. Archegonial cluster surrounded by an involucre and in the genus Calycularia by an additional perianth also. Capsule usually with a long seta, globose (oval in Blasia), dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells (four in Blasia, Treubia), well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base or apex of the capsule or partly free, more rarely altogether free, 2-4-spiral.

XXV. FOSSOMBRONIA Raddi.

Fossombronia Raddi, in Atti Soc. Ital. Mod. 18 (1818).

Stem creeping, simple or dichotomously branched, flattened above and strongly arched below, with long, mostly violet-coloured smooth rhizoids. Leaves green, in 2 rows, succubous, obliquely inserted and decurrent, generally broader than long, with irregularly sinuate and usually lobed margin, base more
than one cell thick, rest 1-lavered, cells large, thin-walled. Antheridia orange-yellow, accompanied by bracts, on the dorsal surface of the stem near the insertion of the leaves. Archegonia in a group on the dorsal surface of the stem towards the apex at the base of the leaves, becoming enclosed in a large campanulate perianth. Perianth with a wide lobed mouth and narrow base, often longitudinally plicate, frequently incised to the base. Calyptra pyriform, thick at the base. Capsule shortly pedicellate, globose, dehiscing irregularly or imperfectly by 4-valves. Wall of two layers of cells, the inner layer with frequently incomplete bands. Spores large, rounded, tetrahedral. Elaters short, bi- or tri-spiral.

57. **Fossumbronnia himalayensis** Kashyap.


Monoecious or dioecious. Plants caespitose among grass or moss or singly on moist rocks; small and compact in former places but open and longer in latter places; two or three times branched, branches up to 6 mm. long. Rhizoids usually violet, sometimes hyaline. Leaves oblong, wavy, ascending, overlapping to about 1/3 of the length; outer margin irregularly and indistinctly toothed. Perianth with wavy margin, sometimes split to the base along one side. Seta up to 5 mm. long, often very short; capsule usually exserted. Cells of the outer layer of the capsule wall with thin walls those of the inner layer with U-shaped bands on the inner and radial walls near the apex, but only simple bands on radial walls at other places. Dehiscence by separation of the apical portion. Spores with furcate high lamellae, sometimes forming a few reticulations, 40 to 50 µ in diam. Elaters laxly bi- or tri-spiral, 100 to 140 µ long.

Hab. Moist rocks or among grass and moss.

Distrib. Common. Outer Himalayas, Ravi valley, Simla, etc.; Kumaon, Mussoorie, etc. 5,000 to 7,000 ft. Lahore, rare. South India, Nilgiris (Rangachariar); Bombay, Panchgani (Blatter).

*Note:*—Towards the end of the season the apex of the plants
ceases to form the leaves, bends downwards and becomes thickened. These apical tubers are thus borne on cylindrical stalks and remain buried in the ground during winter. They grow out into new plants next spring.

XXVI. SEWARDIELLA Kashyap.


Dioecious. Plants thalloid, simple or forked, occurring in thick patches on rocks or singly among grass and moss in shady places. Thallus winged, wings attenuated, directed upwards. Dorsal surface concave. Midrib thick, projecting ventrally, flat above and rounded below. Ventral surface usually with minute red scales in two rows. Wings many-layered at the base, gradually becoming thin, and 1-layered throughout the greater portion, ascending, margin wavy. Male and female plants similar. Antheridia in a cluster on the dorsal side of the midrib mingled with a few bracts. Archegonia in a cluster on the dorsal side. Perianth bell-shaped, margin lacerated into numerous processes, often split at one or more places up to the base, many-layered at the base, 1-layered above. Calyptra thin, 1-layered. Sporogonia 1 or more in each perianth; foot small; capsule included or slightly exserted. Capsule wall 2-3-layered; inner layer with thick bands. Spores reticulate-lamellate. Elaters bi- or tri-spiral; no fixed elater-like cells anywhere in the capsule.

58. Sewardiella tuberifera Kashyap.


Dioecious. Thallus up to 10 mm. long and 12 mm. broad, often once forked, arising from a thick base and ending in a wingless stalked tuber at the apex, the apical wingless portion often forked, midrib mycorrhizal, thick, projecting ventrally, rounded below. Ventral surface usually with minute red scales in two rows. Wings often unequal, many-layered at the base, gradually becoming thin, one-layered throughout the greater
portion, ascending, margin wavy; upper surface of the thallus concave. Antheridia on the midrib, each antheridium globular, on a short stalk; bracts few, scattered between the antheridia. Perianth bell-shaped, margin lacerated into numerous narrow processes; calyptra thin, 1-layered. Sporogonia 1-3, sometimes more, in each perianth; foot small; seta up to 1.25 mm. long, capsule 1 to 1.3 mm in diameter, included or slightly exserted. Capsule wall 2-3-layered; the cells of the outer layer usually thin-walled, sometimes with thick bands on the radial walls; cells of the inner layer with U-shaped bands on inner and radial walls or only simple bands on the radial walls. Spores reticulate-lamellate, less than 4 reticulations in the diameter, 40 μ. Elaters bi- or tri-spiral, 300 to 400 μ; no fixed elaters at the base or elsewhere.

Hab. In large patches on moist rocks, occasionally singly among moss or grass.

Distrib. Common at 5,000 to 7,030 feet Mussoorie, Simla etc.

Note:—Towards the end of the season the plant forms apical tubers like Fossombronia tuberifera. The thick tubers are borne on cylindrical stalks, are covered by small red scales and remain buried in the soil during winter. When the tubers germinate next year the scales are carried on the under surface of the plants but are naturally restricted mostly to the posterior part of the plant. The tuber-bearing portion often forks and sometimes the whole plant is forked, each branch bearing a tuber at the apex.

The plant is closely allied to Fossombronia tuberifera not only as regards tuber-forming habit but in the position of the sex organs, the perianth and the structure of the sporogonium. As a matter of fact, the only difference between the two genera is that, whereas, in Fossombronia the wing is divided into lobes (leaves), in Sewardiella it is entire. The plant may well be put in the genus Fossombronia if the same procedure is followed in the other Anacrogynous Jungermanniales, and the difference between an entire and a lobed wing (leafy stem) is not considered to amount to a generic difference.

The plant can be easily recognised by its saddle-shaped thallus raised up in the middle and bent down both anteriorly and posteriorly, and ascending wings. From the apical tuber, which lies buried underground, the plant on germination
begins to grow upwards, then grows horizontally for a short distance and bends down again to form a new tuber. The midrib in this way forms a characteristic bend with the concavity downwards. Several such bends may be met with in the same plant behind one another indicating several years' growth, but the wing, naturally, disappears in the older parts.

In the young condition the plant is exceedingly like the tuberous prothallus of Gymnogramme leptophylla a fern, which is sometimes met with in the localities where this plant grows.

The perianth arises in the form of several bracts, which do not grow simultaneously. Gradually the bracts fuse and all of them are then carried upwards by basal growth. Sometimes fusion can not take place at one or two places, the bracts being at a distance from each other. In such cases the perianth shows one or two splits extending to the base. As the bracts do not arise in a regular ring but some towards the outside and others towards the centre nearer the archegonia we find that in the ripe perianth these may be fused to both the inner and the outer surface of the perianth. Sometimes the number of these bracts is so great that the perianth has the appearance of a double flower.

The morphology of the involucre and the perianth in the Codoniaceae requires further investigation. As pointed out above, in the genus Sewardiella in the young condition, the archegonia are surrounded by a number of bracts, and these later on, by basal zonal growth, are carried upwards and a more or less bell-shaped structure is produced which has got these bracts on the margin or on the sides. The whole structure may as well be called an involucre. The time of formation does not seem to be a sufficiently important character to make a distinction between the involucre and the perianth.

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XXVII. PETALOPHYLLUM Gottsche.


Plants small and slender with a short basal cylindrical stalk-like portion and a fan-like expansion, simple or furcate, with parallel erect lamellae on the dorsal surface. Antheridia scatter-
PLATE XXII.

PETALOPHYLLUM INDICUM. 1--5.

1. A male plant.
2. A female plant.
3. Perianth with the sporogonium.
4. An elater.
5. Two spores.

SEWARDIELLA TUBERIFERA. 6—10.

6. A forked male plant from above (left), and from below (right). Note tubers in the latter.
7. Female plants. In the specimen to the left the wing has been removed on one side to show the sporogonia. Note the bends in the stem indicating the growth of several years.
8. A perianth cut open.
9. A spore. 10. An elater.

FOSSOMBRONIA HIMALAYENSIS. 11—15.

11. A male plant.
12. Two female plants. In the specimen to the right note the characteristic bend in the stem and the apical tuber.
13. A spore.
15. Portion of the capsule wall.
ed on the dorsal surface, spherical with a short pedicel, accompanied by scales. Archegonia in groups on the dorsal surface, surrounded by scales, and enclosed at maturity by the tubular perianth. Calyptra free, large. Capsule rather shortly pedicellate, spherical, dehiscing irregularly. Wall of 3 or 4 layers of cells, the inner with incomplete annular bands. Spores reticulate-lamellate. Elaters long, more or less attenuate, 2-3-spiral.

59. Petalophyllum indicum Kashyap.


Dioecious. Plants simple or furcate, growing singly or in patches of 3 or 4, up to 12 mm. long and 7 mm. broad. Basal portion cylindrical and wingless. Wing many-layered at the base, gradually becoming one-layered, wavy along the margin. Lamellae one-cell thick and 15 to 24 cells high, running outwards and forwards from the midrib, not always parallel. Antheridia in groups behind the apex, protected by scattered scales. Archegonia in groups of 4-7 on the midrib, protected by a bell-shaped perianth with a lacerated margin, often with 2 or 3 splits along the whole length. Sporogonia 1-4, usually one, in each perianth. Seta usually 10 to 20 mm. long, sometimes very short, occasionally up to 25 mm. Capsule 2 mm. in diameter, spherical, dark brown. Capsule wall usually 3-layered; cells of the outer layer thin-walled, sometimes with thick radial walls; those of the inner layers with thick annular or sometimes semi-annular bands. Spores dark brown, about 40 μ in diameter, spherical, with a membranous wavy margin reticulate-lamellate, 3-4 reticulations in the diameter, reticulations pentagonal or hexagonal, 8-10 μ, marginal wing 14-17 μ. Elaters trispiral, lightly coloured, spirals very distinct, brown and lax, 280-400 μ long, 8-10 μ broad, simple or occasionally branched, attenuated towards both ends. A few elaters are short and about 16 μ broad.

Hab. Moist places.

Distrib. Lahore, Ravi banks.

Note.—At the end of the season the apex becomes thickened, forming a tuber, and becomes buried underground. The dorsal vertical lamellae easily distinguish this plant from other liverworts.

Thallus several times dichotomously branched, with a broad midrib passing into 1-layered lobes (leaves). Under-leaves in one row on each side of the midrib. Leaf-auricles containing *Nostoc* colonies present at the base of the lobes usually in pairs. Male plants smaller, antheridia oval, with a short pedicel, immersed singly in small chambers. Archegonia at first naked, after fertilisation becoming enclosed by a fusiform thick involucre with a constricted mammillate apex. Calyptra free, thin and membranous. Capsule rather longly pedicellate, oval, with a collar at the base. Dehiscence by 4, rarely 5-6 valves. Capsule wall of 3-4 layers of cells, those of the outer layer with thick radial walls, those of the inner layers smaller and tender without bands and soon becoming disorganised. Elaters bispiral, spirals often splitting. A few rudimentary elaters fixed at the base of the capsule. Gemmae of two kinds.

60. *Blasia pusilla* L.


Dioecious. Plants rather fleshy, dichotomously branched, lobed, lobes (leaves) rather shallow not extending to the midrib, very leaf-like at the apex. Thallus up to 30 mm. long and up to 5 mm. broad. Midrib broad, projecting ventrally, gradually passing into the wings, about 10 cells thick in the middle. Upper and lower epidermal cells small, middle ones large. Under-leaves in two rows, one on each side of the midrib, distant, small, hyaline, ovate to subrotund, irregularly toothed, peltate. *Nostoc* auricles usually two at the base of each lobe. *Nostoc* colonies rounded or oval, seen from the dorsal side through the thallus, appearing as if embedded in the thallus. Star-shaped gemmae generally present behind the apex, easily detached and scattered. Flask-shaped gemmae receptacles rare. Male plants smaller, antheridia few, oval. Pedicel of the capsule 2 cm. long. Spores 33-43 μ, rounded, yellowish brown, granular. Elaters paler in colour, about 27 μ long.

Hab. Moist rocks.
Distrib. Kulu (6,000 ft.), Nagar, Karon: Garhwal, Gangotri Road.

Note.—The sterile plants resemble Anthoceros superficially, especially on account of the Nostoc colonies. They can be easily distinguished by the star-shaped gemmae on the dorsal surface, just behind the apex, which are almost always present.

The plant is intermediate between the thalllose and the foliose forms. The lobes in the posterior part are quite shallow, but at the apex they are very leaf-like. They are regarded as lobes or leaves variously by different writers. In addition to these lobes the plant has other appendages on both the ventral and dorsal surface. On the ventral surface are the under-leaves and Nostoc auricles. On the dorsal surface are found two kinds of gemmae. Just behind the apex naked star-shaped gemmae are met with in almost all plants. These scale-like gemmae are met with loosely attached singly to the dorsal surface behind the apex and are attached at the base, unlike the amphigastria which they resemble in shape but which are peltate. The gemmae begin to grow while still attached to the plant and are usually detached in the form of a tuft. They are easily detached and are seen scattered on the dorsal surface. Other gemmae are met with in flask-like cavities on the dorsal side. Sometimes archegonia occur in these receptacles along with the gemmae.

I have so far come across no ripe sporogonia and the description of the sporogonium is after Macvicar and Stephani.

* * * * * *

XXIX. PELLIA Raddi.

PELLIA Raddi, Mem. Soc. Ital. Mod. 18 p. 49 (1820).

Thallus thin, prostrate, dichotomously branched, with a broad midrib, slightly projecting below, gradually passing into the wings; wing many-layered towards the midrib, becoming 1-layered towards the margins. Internal cells wider than the epidermal cells. Scales absent; club-shaped mucilage hairs present at the apex. Antheridia globular, shortly stalked, immersed singly in the cavities on the dorsal side of the midrib in 2 to several rows. Archegonia on the dorsal surface of the
thallus in a pit surrounded by a complete or incomplete (open in front) tubular involucre, capsule with a long seta, globular, wall 2 or more cells thick, dehiscing by 4 valves up to the base. Spores large, germinating within the capsule. Elaters 2- or 3-spiral, many fixed to the base of the capsule.

*Note.*—The Himalayan *Pellias* require further observations. All the three species of the genus are said to occur in the Himalayas. Unfortunately fertile plants with ripe sporogonia are rarely met with. *P. calycina* as described here is exceedingly common throughout the Western and the Kumaon Himalayas from 5,000 to 8,000 feet. What looks like *P. epiphylla* has been met with occasionally, but I have not come across specimens, which could be certainly referred to *P. Neesiana*.

*Note.*—Stephani does not mention the presence or absence of fibrous bands as a distinguishing feature of the species. All the specimens described here under *Pellia calycina* are without such fibres, though the involucre in these forms is more like that described by others for *P. Neesiana*.

**Key to the species** (after Macvicar)

1. Thallus without fibrous bands on the cells as seen in cross section of the thallus. *P. calycina*.
   1. Thallus with brown bands, calyptra exserted, inner wall of the capsule with bands. *P. epiphylla*.
   2. Monoecious; involucre hood-like posteriorly, wanting in front. *P. Neesiana*.
   2. Dioecious; involucre complete, tubular. *P. Neesiana*.


Dioecious. Plants green, growing among moss and grass, or in dense patches of overlapping individuals under flowing water, dichotomously or more or less pinnately divided, lobes quadrate to oblong-linear, about 5 mm. broad, often with a dark streak along the middorsal line, margin undulate, apex slightly notched. Midrib conspicuous, slightly projecting ventrally.
gradually passing into the many-celled lamina, which becomes one-layered towards the margin, one-celled portion from a few to 15 cells broad, greatest thickness in the middle about 10 cells, no thickened bands on the cells. Antheridia conspicuous, in 2 or 3 rows on the dorsal side of the midrib. Archegonia in a cluster. Involucre tubular, directed forwards, posterior wall long, anterior short, mouth shortly irregularly dentate. Calyptra included. Rest not seen.

Hab. On moist soil among moss and grass, or actually under flowing water.

Distrib. Exceedingly common in the Kumaon and the Western Himalayas, becoming less frequent to the west up to Kashmir; 5,000 to 8,000 feet. Mussoorie; Kulu; Simla; Dalhousie; Pangi; Murree; Jummu, Patni Pass; Verinag; Kaghan valley (N. A. Qizilbash), etc.

*Note.*—The plant forms large patches of overlapping individuals under flowing water, usually accompanied by *Dumortiera hirsuta*, and often by *Conocephalum conicum*. It can easily be recognised from the former by its smaller size and lighter colour and from the latter by the absence of reticulations, pores and scales. It varies greatly in length, breadth and thickness of the lobes. In very moist and shady places the lobes are long, narrow and thin; in other places they are broader and thicker, with a conspicuous dark middorsal streak. During the growing season the plants form a very characteristic tuft of small lobes at the apex owing to the rapid and repeated dichotomy.


*Pellia epiphylla* Lindb., Hep. in Hib. p. 534 (1874).

Differs from the above in the following characters (after Stephani):

1. Monoecious.
2. Involucre incomplete in front, merely a flap on the posterior side of the cavity containing the calyptra.
3. Calyptra much exerted. Capsule globose, wall 2-3 layers of cells thick. Outer cells with nodular
thickenings, inner cells with semi-annular bands. Free elaters mostly bispiral, fixed elaters trispiral. Macvicar describes also the interlacing thick bands on the walls of the cells of the midrib as a character of this species. Hab. Near flowing water. Distrib. Pangi, near Shuichu; beyond Narkanda. Note.—The plants are monoecious but the material is otherwise unsatisfactory.


Differ from *P. calycina* in the following characters (after Stephani):

1. Less robust, narrow, often yellowish brown.
2. Involucre forming a short complete cylinder, occasionally split on the dorsal side, mouth truncate, subdenticulate.

Macvicar describes also the interlacing thickened bands present on the cells of the midrib as a character of this species. Note.—The involucre in *P. calycina* as given under that species has a subdenticulate mouth, thus resembling the involucre of *P. Neesiana* as given above. My specimens referred to *P. calycina* show no trace of the interlacing bands on the cells of the midrib. It is desirable that a large number of specimens of *Pellia* from various localities in the Himalayas be examined in order to settle the question how far the various forms are different from each other.

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XXX. *CALYCULARIA* Mitt.


Dioecious. Plants large or medium, gregarious, prostrate, light or deep-green. Thallus dichotomous or innovating from the apex, rarely so from the ventral surface; wings ascending, canaliculate; midrib rather broad, gradually passing into the wings. Wings gradually attenuated from a thick base and one
cell thick towards the margins. Amphigastria always present, aggregated towards the apex of the lobes, lanceolate or subulate. Androecia on the dorsal side of the midrib, bracts more or less aggregated, each with one antheridium, erect, hoodlike, apex lacerated. Archegonia aggregated towards the apex on the dorsal side. Bracts long, lanceolate, strongly laciniate, or distantly spinous, united at the base into a ring. Perianth large, broad at the base, infundibuliform, campanulate or inflated-cylindrical, more or less folded, often with longitudinal folds; opening broad, spinous or lacerated. Calyptra large, base more or less thick. Capsule on a short pedicel, broadly oval, wall many-layered, cells of the external layer small, brown and equally thickened, cells of the inner layers delicate. Dehiscence by 4-7 valves. Spores small, papillate or echinate. Elaters short, fusiform, bispiral.

Key to the species.

Plants long, in tufts..................................................\textit{C. crispula}.
Plants short, compact and solitary........................................\textit{C. compacta}.

64. \textit{Calycularia crispula} Mitt.


Dioecious. Plants large, strong, growing in tufts with mosses, pale green, simple or branched, ventral shoots present, up to 20 mm. long and 4 mm. broad, lobes broadly ligulate, margins crisped. Midrib conspicuous from above, 15 cells thick in the middle, broad, projecting ventrally and gradually passing into the wings, wings about half the width of the frond. Amphigastria linear or linear-lanceolate, ending in a few-celled filament, with one- or more-celled filamentous projections ending in rounded mucilaginous cells arising from the margin. Archegonia in a cluster on the dorsal side. Rest not seen.

\textbf{Hab.} Mixed with mosses.

65. **Calycularia compacta** Kashyap N. S.

Dioecious. Plants small, dark-green, occurring singly among moss and grass, slightly branched, with ventral shoots, 12 mm long and up to 6 mm broad. Rhizoids from the ventral surface of the midrib, numerous, simple, yellowish. Midrib conspicuous as seen from above, projecting below, up to 16 cells thick; wing thin, crisped, occasionally crenate, one cell thick throughout its greater portion. Amphigastria long linear, bent towards the dorsal side at the apex or merely filamentous, of a few cells each (6-10 cells). Bracts on the male plants many, laciniate, with long, linear or filamentous processes. Anthidia aggregated along the midrib throughout the length of the plant, globular, shortly stalked, accompanied by bracts. Bracts on female plants more or less ovate, laciniate or occasionally simply acuminate. Involucre erect, 1 to 2 mm. long, thick at the base, narrow below, broad above, thin, plicate, mouth shortly lobed, lobes irregularly spinous, denticulate. Rest not seen.

**Hab.** On moist earth among moss and grass, mixed with Aneura indica.

**Distrib.** Lahul, Kyelang, 11,000 feet.

**Note.**—A small, delicate and very compact plant with very closely crisped margins. Older parts of the midrib mycorrhizal.

Possibly a compact form of *C. crispula* adapted to the dry climate of Lahul. In the present species the plants occur singly and not in tufts as in *C. crispula*. The plant grows up from a cylindrical basal portion, then horizontally, and at the end of the season bends down again.
Thallus fleshy or membranous, in *Metzgeria* with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells, of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end with one broad spiral band, or fixed, short and obtuse with an indistinct spiral band and persistent as erect tufts at the apex of the valves.

**XXXI. ANEURUA Dum.**


Thallus fleshy, often pinnately branched, with usually a broad midrib. Epidermal cells usually smaller than the inner cells. Sex organs on short lateral branches. Male branches with a more or less circular outline, distinct, margin more or less papillate; antheridia usually biseriate. Female branches very short, margin laciniate, enclosing 2-8 biseriate archegonia. Perianth absent. Calyptra large, cylindrical or clavate, fleshy, always with papillae at the apex. Capsule longly pedicellate, oblong-cylindric, opening by four valves to the base, wall of 2 layers of cells, cells with semi-annular bands. Spores small. Elaters short, attenuate, mono-spiral. Fixed elaters persistent as erect tufts on the apex of valve.

*Note.*—The capsule has a columella-like structure projecting from the apex into the cavity of the capsule and bearing a number of fixed-elaters. On dehiscence this structure also divides into 4 pieces along with the 4 valves and the fixed-elaters remain attached to them sticking outwards.

Gemmae are not uncommon in some species. They are usually 2-celled and are formed endogenously in the cells of the uppermost layer of the thallus, becoming free by the rupture of the cell wall.
Key to the Species.

Thallus lobes broad, usually fleshy,  
plants occurring singly or in patches .................  A. indica.

Thallus lobes long and very narrow,  
Plants densely overlapping ......................... A. Levieri.

66. Aneura indica St. (Ms.).


Dioecious. Thallus simple or irregularly pinnately branched or forming rosettes, loosely attached to the humus or closely attached to the soil. Lobes up to 3 cm. long and 5 mm. broad, thick or thin, margin undulate, slightly raised or firmly fixed to the soil. No distinct midrib, thallus gradually thinning towards the margins; greatest thickness in the middle 8-13 cells. Cells of dorsal epidermis flat, convex, or strongly papilliform. Male plants smaller, irregularly branched, branches rather long and narrow, thick, fleshy, margin turned upwards. Antheridia on small branches with a circular outline, restricted to the central part of the dorsal surface. Archegonia with filamentous or small flat green scales. Sporogonium (from the South Indian Specimens): seta 6 mm. long; capsule shortly cylindrical, 2.5 mm. long. Both layers of the capsule wall with thick brown annular bands. Spores lamellate, with a broad margin, 20-30 μ. Elaters monospiral, 190 μ long.

Hab. Moist rocks, among grass and moss in the hills, or on moist earth in the plains.

Distrib. Common. W. Himalayas, Dalhousie (7,000 feet), Sahasar Dhara (3,000 feet), Mussoorie (6,000 to 7,000 feet), etc.: Lahul, Kyelang (10,000 feet). Occasionally occurs in the Punjab plains also, Lahore, Sialkot. South India (Rangachariar).

Note.—This plant is extremely variable. In moist shady places in the hills the plants remain thin and light green, only loosely attached to the soil; while in exposed places (in the plains) the plants are thick, fleshy, deep green, and firmly fixed to the soil. Dorsal epidermal cells of plants from moist places are flat, and of those from exposed places are convex to
PLATE XXIII.

ANEURA INDICA. 1.—6.
1. A sterile plant.
2. A male plant.
3. A female plant.
4a. Portion of above magnified to show epidermis.
5. T.S. of thallus from Chamba valley specimens.
5a. Portion of above magnified to show epidermis.
6. T.S. of thallus from Sialkot specimens.
6a. Portion from a similar section to show epidermis.

ANEURA LEVIERI. 7.
7. A plant.
distinctly papillate. The dorsal epidermal cells of the male plants are always papillate. As a consequence the length of the upper epidermal cells is very variable.

67. **Aneura Levieri** Schiff. (Ms.).


Plants brownish, densely overlapping in thick patches, very much branched in an irregularly pinnate manner, up to 10 mm. long. Lobes linear or linear-oblong, ultimate branches quadrate or obovate-oblong, or linear in very moist places. No distinct midrib. Main shoot up to 8 cells thick, biconvex in cross-section; cells all alike or epidermal cells rather small. Rest not seen.

Hab. Moist rocks.

Distrib. Chamba-Chauri Road, 6,000 feet: Pangi, in running water, near *Shaichu*, 8000 feet.

*Note.*—The Pangi specimens are much longer, up to 40 mm., but the older parts are dead. They are also thinner and the ultimate lobes are oblong or linear-oblong.

XXXII. **METZGERIA** Raddi.

*Metzgeria* Raddi in *Att. Soc. Scient. Mod. 18* p. 34 (1918).

Thallus membranous, usually dichotomously or sometimes pinnately branched, with ventral innovations arising from the sides of the midrib. Midrib slender, sharply defined from the wings, wing of one layer of cells. Sex organs on greatly reduced ventral branches. Antheridia few, shortly pedicellate, globose. Female branch curved into an obcordate involucre furnished with hairs. Perianth absent. Calyptra thick, fleshy, clavate, hairy. Capsule shortly pedicellate, oblong-oval, 4-valved, wall of 2 layers of cells, the outer with nodular thickenings, the inner with indistinct annular bands. Spores small, spherical, smooth or minutely papillate. Elaters long, attenuate, monospiral, the spiral band broad, reddish brown. Fixed elaters partly persistent as erect tufts on the apex of the valves. Gemmae discoid to linear.
Note.—The genus is at once recognised by the distinct midrib and 1-layered wing.

Key to the species.

Plants with straight bristles all over the surface and the margins.................................$M. \text{ pubescens}$.
Plants with long slender hairs only on the under surface of the midrib and along the margins...............$M. \text{ himalayensis}$.

68. Metzgeria pubescens Raddi.

_Metzgeria pubescens_ Raddi in Att. Soc. Scient. Mod. 18 p. 46 (1918).

Dioecious. Plants forming rather large patches on rocks, or thin layers on mosses, etc., yellowish green. Thallus up to 50 mm. long and 2 mm. broad, irregularly pinnate or more or less distinctly dichotomous, margin undulate, wing sometimes interrupted; thickly beset on both surfaces and margins with straight bristles. Ventral innovations very common. Midrib subterete, highly and almost equally arched on both surfaces. Cells of the wing 5-6-sided, not elongate, 32-40 µ. in diam., walls thin, angles hardly thickened. Male branch with hairs only on the postical surface. Female branch with hairs on both surfaces.

Hab. Moist shady rocks.

Distrib. Common 7,000—10,000 feet. Dalhousie-Chamba road; Chamba-Pangi road; Kulu, _Bhaboo pass_; Kumaon. _Mussoorie_, near Gangotri, etc.

Note.—The plant can be very easily recognised by the densely arranged bristles on both surfaces of the thallus (midrib as well as the wings) and along the margins. The plant varies greatly in size and mode of branching. Some plants are long and robust extending up to 50 mm. in length, and up to 2 mm. in breadth of lobes, and are always pinnate. Others are much smaller, delicate, not exceeding 1 mm. in breadth and they are more or less distinctly dichotomous. Intermediate forms are also met with.
METZGERIA PUBESCENTS. 1—2.

1. Four plants showing habit.
2. Two T.S. of thallus.

METZGERIA HIMALAYENSIS. 3—5.

3. A plant. 4. T.S. of thallus. 5. Part of the wing in surface view, with marginal hairs.

BLASÍA PUSILLA. 6—10.


PELLIA CALYCINA. 11—12.

11. A male plant.
69. **Metzgeria himalayensis** Kashyap.


Monoecious. Plants deep green. dichotomous, up to 15 mm. or more long. Lobes up to 4 mm. long and up to 1 mm. broad. Midrib biconvex, lamina plane or undulate, occasionally interrupted. Long hairs present on the undersurface of the midrib and along the margins, the rest naked. Midrib 4 to 6 cells thick and 3-4 cells broad through the centre. Epidermal cells of the midrib 2/2. Lamina in older parts up to 14 cells on each side; cells 32 µ x 30 µ. Male branches without hairs. Female branches with numerous hairs.

Hab. Moist places.

Distrib. Fairly common from 5,000—9,000 feet. Dalhousie; Kulu, Bhaboo pass; Mussoorie; etc.

Note.—The number of hairs on the thallus in this species varies very greatly. Sometimes there is a regular fringe all along the margin and many hairs may be met with on the ventral side of the midrib. In other cases only a few hairs are met with, here and there, on the margin, and none may occur on the midrib. The hairs may be straight, long and slender, or hamate.
Order IV.

SPHAEROCARPALES.


Family VI. RIELLACEAE

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.

XXXIII. RIELLA Mont.


Plants thallose. small or medium, delicate, light green, erect or ascending, with thin-walled rhizoids at the base, under water, occasionally on moist soil when water has flown away. Midrib in section elliptical, central cells elongated, cortical cells parenchymatous. Branching furcate. Wing arising from the dorsal side of the midrib, 1-layered, delicate, narrow at the base, well developed above, falcate-rotund at the apex; margin entire, or slightly lobed or incised, plane or slightly undulate. Leaves on the dorsal side, on the right or left of the wing, rudimentary or well developed. Antheridia on the margin of the wing, immersed, in rows, shortly pedicellate, ovoid, each surrounded by an envelope, papillae inconspicuous. Archegonia from the dorsal side of the midrib, each surrounded by an involucre, involucre large, 1-layered, ovoid, in the upper portion

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PLATE XXV.

RIELLA INDICA.

Four plants showing habit.
more or less inflated, opening small. Calypttra strong, 2-layered. Capsule spherical, wall 1-layered, pedicel short, foot thick. Spores large, tetrahedral, minutely reticulate-lamellate. Sterile cells a little smaller than the spores, hyaline, without any spiral bands.

Note.—The dorsal wing distinguishes this genus from all other liverworts, and the plants of this genus are always aquatic. The sterile cells are disorganised when the spores are ripe.

70. **Riella indica** St. (Ms.)


Plants submerged, erect or ascending, firmly fixed to the mud by the rhizoids, often in dense patches, light green, simple or once or twice forked, up to 10 mm. long. Often many branches are given off from the base and plants have a tufted habit. Wing well developed in early stages, up to 2 mm. broad, in the fertile portion small and interrupted. Lateral leaves (bracts) long and narrow, linear, conspicuous. Involucres up to 6 on each plant, densely situated, cylindrical, pointed, up to 2 mm. long, cells papilli-form. Spores reticulate on the convex side, 7-8 reticulations in the diameter, the angles projecting as spines, merely spinous on the flat sides, 60-70 μ.

Hab. In shallow water in a water channel of the Shalamar Garden, Lahore; occasionally on mud.

Note.—The plants were first found in the months of February and March of 1913 and 1914. This is the only species of the genus so far found in India.
SYNOPSIS.

(Species restricted to India only are marked with an asterisk*)

Phylum:—BRYOPHYTA.

Class:—HEPATICACEAE.

Order 1, ANTHOCEROTALES.

Family 1, ANTHOCEROTACEAE.

Genus I, ANTHOCEROS

Species 1, A. erectus *
2, A. himalayensis *
3, A. chambensis *
4, A. Gollani *
5, A. Longii *

Genus II, NOTOTHYLAS

6, N. indica *
7, N. Levieri*

Order II, MARCHANTIALES

Family II, MARCHANTIACEAE

Genus III, MARCHANTIA

8, M. polymorpha
9, M. palmata
10, M. nepalensis*
11, M. simlana*

Genus IV, PREISSIA

12, P. quadrata

Genus V, WIESNERELLA

13, W. denudata

Genus VI, DUMORTIERA

14, D. hirsuta

Genus VII, CONOCEPHALUM

15, C. conicum

Genus VIII, LUNULARIA

16, L. cruciata

Genus IX, EXORMOTHECA
SYNOPSIS

17, E. tuberifera *
Genus X, STEPHlNSONIELLA
18, S. brevipedunculata *
Genus XI, AITCHISONIELLA
19, A. himalayensis *
Genus XII, CYATHODIUM
20, C. tuberosum*
Genus XIII, TARGIONIA
21, T. hypophylla
Genus XIV, CRYPTOMISTRUIUM
22, C. himalayense *
Genus XV, MASSALONGOA
23, M. tenera *
Genus XVI, FIMBRIARIA
24, F. Blumeana
25, F. angusta*
26, F. pathankotensis *
27, F. mussuriensis *
28, F. reticulata* 
29, F. maculata*
30, F. nepalensis*
31, F. parvipora*
32, F. sanguinea*
33, F. multiflora*
34, F. Gollani*
35, F. papulosa*
Genus XVII, GRIMALDIA
36, G. indica *
Genus XVIII, REBOULIA
37, R. hemispherica
Genus XIX, PLAGIOCHASMA
38, P. articulatum *
39, P. appendiculatum
40, P. simlensis *
41, P. intermedium
42, P. cordatum*
43, P. quadricornutum*
SYNOPSIS

Genus XX, SAUCHIA
44, S. spongiosa *

Genus XXI, SAUTERIA
45, S. alpina

Genus XXII, ATHALAMIA
46, A. pinguis *
47, A. dioica *
48, A. pusilla *

Family III, RICCIACEAE
Genus XXIII, RICCIOCARPUS
49, R. natans
Genus XXIV, RICCIA
50, R. pathankotensis *
51, R. himalayensis *
52, R. melanospora *
53, R. robusta *
54, R. cruciata *
55, R. sanguinea *
56, R. fluitans

Order III, JUNGERMANNIALES

Family IV, CODONIACEAE
Genus XXV, FOSSOMBRONIA
57, F. himalayensis *
Genus XXVI, SEWARDIELLA
58, S. tuberifera *
Genus XXVII, PETALOPHYLLUM
59, P. indicum *
Genus XXVIII, BLASIA
60, B. pusilla
Genus XXIX, PELLLIA
61, P. calycina
62, P. epiphylla
63, P. Neesiana
Genus XXX, CALYCLULARIA
64, C. crispula *
65, C. compacta *
### SYNOPSIS

**Family V, ANEURACEAE**

Genus XXXI, ANEURA

- 66, A. indica *
- 67, A. Levieri *

Genus XXXII, METZGERIA

- 68, M. pubescens
- 69, M. himalayensis *

**Order IV, SPHAEROCARPALES**

**Family VI, RIELLACEAE**

Genus XXXIII, RIELLA

- 70, R. indica *

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<th>Total number of Genera</th>
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<td>Genera restricted to India</td>
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<tr>
<td>Total number of species</td>
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<tr>
<td>Species restricted to India</td>
<td>50</td>
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Species restricted to the Himalayas including the foot of the hills, rarely in the plains

Species met with in the hills as well as the plains. Nos. 1, 17, 20, 38, 51, 53, 57, 68

Species restricted to the plains up to the foot of the hills. Nos. 6, 26, 50, 52, 54, 55, 59, 70
ALPHABETICAL INDEX TO GENERA,
SPECIES AND SYNONYMS.
(Synonyms are in italics)

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<thead>
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<tr>
<th>AITCHISONIELLA Kash.</th>
<th>Himalayensis Kash.</th>
<th>51</th>
<th>tuberifera Kash.</th>
<th>47</th>
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APPENDIX I.

CLIMATIC DETAILS OF SOME IMPORTANT PLACES.

LAHORE.

Height above sea level ... ... 700'.
Average annual rainfall ... ... 19'58".

In summer the temperature goes up to 115° F. or sometimes even more. In winter during the nights the temperature on the grass falls below 32° F. and for a couple of months there is hoar frost of 5° to 10°. The rain falls mostly in July and August, but a small amount falls in winter also. The summer is very hot and dry being quite hostile to the growth of tiny and delicate plants like Liverworts.

SIMLA.

Height above sea level ... ... 6,000' to 8,000'.
Average annual rainfall ... ... 63".

The mean maximum temperature in winter (December to February) ranges between 49°.4 F. and 44°.5 F. and the mean minimum temperature between 39°.1 F. and 34°.5 F. The mean maximum temperature in summer (in June, the hottest month) is 74°.4 F. and the mean minimum is 61°.0 F.

Snow falls in winter which is the resting season. The rain chiefly falls from July to September.

MUSSOORIE.

Height above sea level ... ... 6,000 to 8,000'.
Average annual rainfall ... ... 109'69".

The climate is very much like that of Simla. As the station has got a moist and humid climate the Hepatic flora is very rich.

DALHOUSSIE.

Height above sea level ... ... 6,000 to 8000'.
Average annual rainfall ... ... 83'88".
Being further north west to the above mentioned stations the climate is not as suitable as that of the two stations, given above, therefore, the vegetation is a little less luxuriant.

KULU.

Height above sea level ...........(Nagar) ............5,780'.
Height above sea level ...........(Sultanpur) ............4,000'.
Average annual rainfall...........(Nagar) ............49.74”.
Average annual rainfall...........(Sultanpur) ............39.74”.

Snow falls in winter at Nagar and the winter is severe in the higher lying tracts of Kulu, and in sheltered places snow lies well till April. The mean temperature from June to August at Sultanpur is about 75° F. Mean minimum from January to February 41° F. (Kulu Gazetteer).

CHAMBA.

Height above sea level ....... 3,027'.
Average annual rainfall ........ 47.6”.
Mean maximum temperature .... 77.7° F.
Mean minimum temperature .... 56.5° F.

In the Ravi Valley the climatic conditions vary with the altitude. In the lower portion of the Valley, from the capital downwards they are of a semi-tropical character. The heat is great and rainy season well marked, while the winter is mild and the snowfall light. In the capital the maximum temperature recorded is 108.3° F. and the minimum 30°.3 F. From the capital upwards the conditions are more severe, and vary from temperate to semi-arctic. Arctic conditions prevail along the high ranges for several months in winter. In the Brahmaur Wizarat the summer is mild, but winter is severe. (Chamba Gazetteer).

KYELANG.

Height above sea level .......... 10,000'.
Average annual rainfall including winter
(melted) snow ................. 23”.
Average annual rainfall not including winter snowfall ........ 6”.
The climate of Lahul is most bracing. The air is crisp and keen especially in the Valley of the Chandra; that of the Bhaga Valley at Kyelang has not quite the same vigorous quality. The maximum temperatures at Kyelang range from 33\(^\circ\) F. in February to 73\(^\circ\) F. in August, the minimum from 13\(^\circ\) F. in February to 50\(^\circ\) F. in July. Lahul is set in a basin, the edge of which consists of enormous mountain ranges. These barriers keep off the monsoon currents, causing the rain to spend itself on their south and west faces. In consequence the summer rainfall in Lahul is scanty, affecting on the average no more than three days in each month. The total rainfall during the whole season from June to September is about 6". On the other hand nearly three times as much precipitation occurs during the period of December to May, and is then associated mainly with storms of high elevation which traverse Northern India from west to east and pass over the mountains which obstruct the monsoon in summer. (Kulu Gazetteer).

In the Chandra Bhaga Valley the climate is temperate in summer and semi-arctic in winter. As the lowest altitude in the Pangi Valley is 7,000 feet, no great heat is felt. The summer is exceedingly mild and pleasant, while owing to the scanty rainfall the degree of humidity is always low. The winter, however, is very severe. Snow commences to fall in October but does not lie permanently till December, after which the whole valley is under snow till March or April. (Chamba Gazetteer).

LEH (LADAK).

Height above sea level ................................................................. 11,000'.
Average annual rainfall ................................................................. 3".

Winter is very severe. Cold and dry winds are prevalent in the whole of Ladak. Trees are met with only in low lying sheltered places. In Rupshu the altitude of the plateau is from 13,000 feet to 16,000 feet at different places, and the climate is extremely rigorous there are absolutely no trees there.
APPENDIX II.

Liverworts of certain localities.

(Species of the Acrogyrous Jungermanniales are not included).

1. Panjab plain (Lahore, etc.).

1. Anthoceros himalayensis, Lahore.
2. Anthoceros chambensis, rare, Sialkot.
3. Marchantia palmata, common, everywhere.
4. Marchantia nepalensis, common, everywhere.
5. Cyathodium tuberosum, rare, Jullundur.
6. Fimbriaria pathankotensis, fairly common, Lahore.
7. Grimaldina indica, rare, Amritsar.
8. Plagiochasma appendiculatum, common, Lahore.
10. Riccia pathankotensis, rare Lahore.
11. Riccia himalayensis, rare, Lahore.
12. Riccia robusta, common, Lahore.
13. Riccia cruciata, rare, Lahore.
14. Riccia sanguinea, very common along rivers everywhere.
15. Aneura indica, rare, Sialkot, Lahore.
16. Fossombronia himalayensis, rare Lahore.
17. Petalophyllum indicum, fairly common on riverside, Lahore.
18. Riella indica, rare, Lahore.

The number of species becomes larger and individuals of each species more numerous as we go to the foot of the hills. The two species of Plagiochasma, Grimaldina indica, Fimbriaria pathankotensis, Riccia pathankotensis and Riccia himalayensis become particularly common. Ricciocarpus natans and Riccia fluitans are met with at Peshawar.

2. Pangi and Lahul (Chandra-Bhaga Valley) 8,000 to 10,000 ft.

1. Marchantia polymorpha, fairly common.
2. Preissia quadrata, very common.

The following have been met with in the Chandra Valley above 13,000.

*Sauclia spongiosa*, Dokpo Gongma, about 15,000 feet, and just below the top of the Manh pass.
*Riccia robusta*, Chandra Dal.

3. Spiti.

*Reboulia hemispherica.*
*Riccia robusta.*

Specimens were collected only between the Manh pass (coming from the Chandra Valley) and Losar.

4. Transhimalayan region (Ladak etc.)

1. *Marchantia polymorpha*, beyond the Baralacha pass near Kinlung, about 15,000 feet; Kargil, Leh, etc.
2. *Preissia quadrata*, beyond the Baralachapass near Kinlung, about 15,000 feet.
3. *Sauclia spongiosa*, beyond the Baralacha pass near Kinlung, a little below 15,000 feet.

Only a foliose acrogyrous species has been found in Zanskar, at about 14,000 feet. Only the upper part of the Valley above Tangse has, however, been visited. More species may be expected in the lower parts.

The list is very incomplete, specially as there is a great range of altitudes.

1. *Marchantia palmata.*
2. *Marchantia nepalensis.*
5. *Plagiochasma appendiculatum.*
8. *Pellia calycina.*
LIVERWORTS OF THE WESTERN HIMALAYAS AND THE PANJAB PLAIN

PART I
Supplement

BY
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1972
SUPPLEMENT TO PART I OF LIVERWORTS OF THE
WESTERN HIMALAYAS AND THE PANJAB
PLAIN.

Since the publication of Part I of this book the writer has
examined a large number of specimens either collected by himself
or sent by correspondents. These observations have considerably
increased our knowledge of these plants. Only the more impor-
tant facts, however, relating to the various species are given here
and a few corrections are noted.

Page 6. After the para. on Anthocerotales. The genus
Anthoceros is at a higher level than the genus Notothylas in
the size of the thallus and the size and structure of the capsule
but it is on a lower level as regards the dorsal position of the
sporogonium. In the genus Notothylas the thallus is smaller
and the capsule has a much simpler structure but the capsule
is marginal (i.e. terminal), and Notothylas, therefore, is higher
in this respect than Anthoceros. The sporogonium in
Notothylas indica is often exserted and dehisces by two valves.

Page 7. At the end. In the present state of our knowledge it is
not possible to indicate clearly the inter-relationships between
the various Orders of the Bryophyta and the Pteridophyta,
still a working hypothesis relating to the gametophyte like
the one outlined below may possibly be helpful in clearing
these relationships.

It may be accepted that the ancestral gametophyte of both
these groups was an erect, leafy, branched, radial plant.
The nearest approach to such a type in the living plants is
seen among the mosses. The moss gametophyte is
probably the least modified from the ancestral type. In
types like Lycopodium cernuum the gametophyte is very
much condensed, the lobes representing the leaves (or perhaps
the shoots), and the whole structure is so abbreviated that
the growing points of the branches are replaced by a marginal
meristem. The erect form of Anthoceros erectus bears a
striking resemblance to such a prothallus. A stage in this process is seen in the compact antheridal rosettes in the higher mosses. The gametophyte at this stage is still erect and radial. In the genus *Equisetum* the lower vertical part is eliminated and the gametophyte becomes a hemispherical cushion, otherwise resembling the *Lycopodi um cernuum* type. In this genus the starved prothalli remain small, are distinctly dorsiventral and possess a single growing point. The last stage is seen in the ordinary fern prothallus where the growing points are gradually separated, coming from the ancestral type perhaps along a different line and leading to a dichotomous and ultimately to an unbranched definitely dorsiventral prothallus. The homology of the air-chambers in the *Marchantiales* is not very clear but it is possible that the walls of the air-chambers correspond to the lobes of the prothallus of *Equisetum* and *Lycopodium cernuum*. In another line leading to the leafy liverworts the process of condensation is preceded by the prostrate habit which leads to a dorsiventral structure. Traces of the original radial structure are sometimes seen in the fertile part even in forms which are definitely dorsiventral in the vegetative part, in the similarity of bracts and bracteoles. In the Anacrogynæ subsequent condensation of the shoot leads gradually to the formation of a thalloid body in place of a leafy shoot. Thus the fern prothallus and a thalloid liverwort like *Aneura* or *Pellia* are the last terms in two distinct series of reduction and have come to resemble each other by convergent evolution. Similarly a type like *Riccia* is the last term in another series of reduction.

It is clear from the above that there can be no connection whatever between the *Bryophyta* and the Green Algae and in spite of careful investigations by numerous workers who believe in the origin of the lower liverworts from some algal types the gap between the two is as great as ever. The Pteridophyta and *Bryophyta* are, however, intimately connected and must have ultimately come from some common ancestors.
Page 20. RIELLACEAE should be RIELLACEAE.


Spores from some specimens from Mussoorie collected in 1927 are a little longer than broad, 58 μ × 49 μ, minutely crenulate on the margin. Some, which have not become perfectly opaque, show a fine reticulation on the convex side. Reticulations faint and very small.

Page 26. *Anthoceros himalayensis* should be *Anthoceros himalayensis*. Collected by Blatter near Bombay with tubers; also found at Dehra Dun.

Page 27. *Anthoceros chambensis*. Collected from Bhimtal by Mr. S. K. Pande of the Lucknow University, October 1929. Spores densely and finely muricate, spherical or slightly longer than broad, 50 μ or 52 μ × 43 μ. Mr. Pande says that the capsule may be as much as 2·8 in. (7 cm.) and in specimens from Almora as much as 3·8 in. (9·5 cm.). Specimens from Wah near Hassanabad, collected by Dr. Stewart, November 1929, are dark green, almost blackish, and only about 8 cells in thickness.

Page 28. *Anthoceros Longii*. The specimens collected by Mr. S. K. Pande of the Lucknow University in October 1929 at Nainital, 7,500 ft., answer to the description of *Anthoceros Longii* St., but they are undoubtedly *Anthoceros erectus* Kash. *A. Longii*, therefore, is merely a form of *A. erectus*.

Page 29. *Notothyulas indica*. Specimens collected from the Residency Gardens, Lucknow, have capsules 1·2 mm. long, exserted, about 1 mm. being outside the involucr. The capsules dehisce distinctly by two valves. Similarly specimens from Parachinar (R. L. Badhwar, 1930) have exserted capsules. The involucr is decayed at maturity and the capsule dehisces by two valves almost to the base. Mr. S. K. Pande finds that this species is monoecious and protandrous. Collected also at Nagpur by Mr. R. L. Nirula.

Page 38. *Preissia quadrata*. Specimens from Gurez (Kashmir) about 7,500 ft., collected by Mr. A. C. Joshi, have 1 to 4 sporogonia in each involucre. One receptacle had 16 sporogonia. One of the specimens had a thick stalk with four rhizoid furrows in two pairs and two receptacles at the top. Compare *Marchantia palmata*.

Under distribution, add Spiti, foot of Manih Pass.

Page 44. For *Conocephalum conicum* read 15. *Conocephalum conicum*. Pores on male and female receptacles barrel-shaped.


Page 53. *Cyathodium tuberosum*. Specimens from Mt. Abu collected by Mr. Apte. Spores up to 75 μ or more. Elaters up to 200 μ. Other specimens from the same locality had the spores and elaters of the usual size, though spores in some cases were dark brown, nearly opaque. Also collected at Nagpur by Mr. R. L. Nirula, 1931, and at Karwar by Prof. Ajrekar.

Page 63. *Fimbriaria pathankotensis*. Under distribution, add Pusa, collected by Mr. Akhtar, February 1931; Bhagirathi valley.

Page 64. *Fimbriaria mussuricensis*. Specimens from Jhelum collected by Mr. Rafi, February 1932. Some specimens have terminal male and female receptacles in addition to the usual mixed receptacles on short ventral shoots. In such cases the apical part of the main shoot is narrow and the shoot is a little constricted behind the apex. Thus they resemble the short shoots. In one case a short ventral male shoot was seen with a short ventral female shoot on its under-surface. It
appears, therefore, that the main shoot can behave like a short ventral shoot and the latter like the main shoot.

Page 65. Add—

**Fimbriaria gangetica** Sp. Nov.

 Dioecious. In dense patches of greyish-green colour. Thallus closely creeping, simple, oblong or obovate, up to 12 mm. long and up to 4 mm. broad, dorsal surface flat, smooth, stomata inconspicuous; margins entire or only slightly wavy, wings ascending, apex rounded. Dorsal epidermal cells polygonal, walls slightly thickened, trigones thickened, pores bounded by two rings of 6 or 7 cells each. Air-chambers empty, in several layers. Midrib about as broad as high and about half as broad as the whole thallus, ventrally convex or flat, gradually passing into the wings, ventral surface (midrib) purple, wings green, scales overlapping, lunate, purple, appendaged, appendage hyaline, large, linear lanceolate, entire, acuminate, or occasionally unequally bifid. Antheridia in a cluster near the apex of the thallus. Female receptacle (only young specimens) terminal, stalk thick, short.

Hab. On rocks.

Distrib. Garhwal, near Gaurikund; Pipal Koti; Bhuki; common in the Bhagirathi valley above Bhatwari.

**Note.**—The species described above is very near *F. Gollani* St., and may be the same.

Page 69. Add—

**Fimbriaria Calciatii** Gola.


Dioecious, small, brownish green, margin almost black, thick. Thallus up to 8 mm. long and 4 mm. broad, often smaller, simple or rarely furcate at the apex, with postical innovations; dorsal surface canaliculate, ventral broadly convex, midrib broad plano-convex, half as broad as the thallus, wings attenuated. Dorsal layer in the middle of the thallus as high as the midrib, chambers small, with short free filaments below the pores. Pores large (30 μ), slightly convex,
bounded by 2 series of 7–9 cells. Epidermal cells high; trigones large acute. Ventral scales large, blackish purple, thin, appendaged; appendage lanceolate acuminate, apex entire. Stalk of the female receptacle short, 3–8 mm., base weak, paleaceous, paleæ setaceous, appressed to the thallus, rest everywhere naked. Capsule (female receptacle?) (quite ripe) spherical, plano-convex, centre large, papillose, lobes obliquely spreading, inflated, small, usually connate up to the apex. Perianth hyaline, capsule brownish-yellow, spores 54 µ, (immature yellowish) red, wing narrow, strongly papillose. Elaters 300 µ, red, bi-spiral, long acuminate. Androecia not seen.

Hab. Kashmir.

Page 70. Grimaldia indica. Under distribution, add Hoshiarpur (A. C. Joshi, January 1930) and Miranshah, Waziristan (Blatter, April 1930).

Page 72. Reboulia hemispherica. Lawrence Gardens, Lahore, February 1931. Some plants were seen with an apical adventitious shoot formed in front of a terminal female receptacle. Plants small, involucres 1–3, pores with 2–3 rings of 7–9 cells each. There can thus be no question that Mindal pangiensis is merely a form of Reboulia hemispherica. Under distribution, add Punch (Stewart, 1931). These specimens also possessed apical adventitious shoots after the formation of the terminal female receptacles.

Page 75. Plagiochasma articulatum. Under distribution, add Khandwa (Blatter) and Darjeeling. Darjeeling specimens large and rather thin and delicate, in enormous quantities, forming very large patches on the walls of a house; stalk of the female receptacle up to 10 mm. long; elaters bi-spiral.

Page 76. Plagiochasma appendiculatum. Under distribution, add Mount Abu (Apte); Royal Botanic Gardens, Calcutta (R. L. Badhwar, Calder, December 1929); Dalhousie (Blatter); Miranshah, Waziristan (Blatter, April 1930).

Page 79. Plagiochasma simiensis. Specimens from Panchgani, 3,000 ft., collected by Blatter, April 1909. Thallus 30 mm.
x 5 mm. Appendage of scales strongly constricted at the base, otherwise like the type. Ootacamund, collected by Mrs. Robinson, November 1929. Trigones very thick. Also Bhagirathi valley.

Page 82. For Sauchia Spongiosa read Sauchia spongiosa.

Konsa Nag, Kashmir, 12,000 ft. (A. C. Joshi, August 1929). Stalk of carpocephalum up to 16 μ, seta up to ½ mm., capsule brown, 1½ mm. in diameter, wall-cells of capsule with complete or incomplete annular bands. Spores brownish yellow and with large rounded tubercles on the surface so that the margin with its narrow wing appears to be crenate, 64 μ in diameter. Elaters rather closely tri-spiral, yellowish, 160 μ - 192 μ long.

Page 87. 5th line from the top. For ‘Jor’ read ‘Jour’.

Page 89. Ricciocarpus natans. Specimens from Bhim Tal (Nainital) collected by Mr. S. K. Pande, October 1929. Plants both floating in the lake and fixed on the mud but never on dry soil. Both floating and fixed forms are alike with numerous long scales. Both kinds fertile and bear sporogonia in all stages of development. Margins purplish; scales numerous, narrow, serrate, light violet; neck of archegonium purple, capsules white when young, black when ripe, in two zigzag rows in a deep and wide continuous median groove, very close to each other. Spores perfectly opaque (black), tetrahedral, margins irregularly slightly lobed-crenate, 40μ in diameter.

Page 92. 2nd line. After ‘Monoeious,’ add ‘or dioecious’.

Page 93. Riccia himalayensis. Line 14 from above. For description of spores substitute the following:—‘Spores reticulate, with usually 5-8 reticulations in the diameter, dark brown, margin usually with long processes which are prolongations of the walls of the reticulations, diameter 90-110μ.’ The figure of the spore in Plate XX is incorrect. Substitute the following:—
Specimens from Negapatam (South India), collected by Mrs. Robinson in October 1929, have flask-shaped apothecia but no asci are present. Lobes in some plants up to 8–10 mm. long and 2 mm. broad. Spores in some plants were more or less oblong, up to 132 μ in length. Under distribution, add Spiti above Losar, 14,000 ft., near foot of Manh Pass. Spores mostly opaque, reticulations faint. Specimens from Calcutta collected by Prof. Bose have opaque spores with as few as six reticulations in the diameter and the plants are monoeious. Near Hoshiarpur (A. C. Joshi, June 1930); Calcutta, December 1929; Alwar (R. L. Badhwar, July 1929).

Page 94. *Riccia melanospora*. Can be distinguished from *Riccia himalayensis* particularly by the presence of thick, short, blunt, hyaline or purplish hairs along the margin near the apex. The hairs are, however, sometimes not very conspicuous but as a rule they can be always seen with a little careful observation. Specimens from the Residency Gardens, Lucknow, collected in August 1929, have lobes up to 4 mm. long; scales well developed, present even in the posterior part, over-lapping; rhizoids mostly hyaline, smooth, perfectly ripe spores quite opaque, margin crenate, 90 μ in diameter. Spores not fully ripe are dark brown and show 4-5 clear reticulations in the centre and about 8-9 reticulations in the full diameter. Specimens from near Hoshiarpur, collected by Pt. B. R. Vashisht, have spores perfectly opaque when ripe; in earlier stages less opaque, reticulate with 10-12 reticulations in diameter, about 8 reticulations being clear in the middle; margin crenate; 85–100 μ in diameter. Specimens from Konsa Nag, 12,000 ft., Kashmir (A. C. Joshi, August 1929). Plants are smaller than the type; scales hyaline, small, not projected beyond the margins; archegonial neck projecting; spores 90–
100 μ in diameter, not quite ripe, dark brown, reticulate, about 12 reticulations in the diameter, winged in the young condition but the wing gradually disappears and its only indication in the ripe condition is the crenate margin, wing thin, yellowish brown, 8 μ.

Page 94. *Riccia robusta*. Plants sometimes yellowish green or reddish.

Page 96. *Riccia sanguinea*. Male rosettes up to 12 mm. in diameter and female up to 30 mm. Under distribution, add near Hoshiarpur (A. C. Joshi, June 1930); Pusa, bank of Gandok river, February 1931 (Akhtar).


Page 127. The following additions make the list of various localities complete including the Acrogynous Jungermanniales also.


15. *Madotheca Gambleana*.
17. *Madotheca gracillima*.
18. *Chilosepyphus inflatus* from Chandra Dal by Gamble.

Page 128. Under Spiti

Before *Reboulia hemispherica* add—
Marchantia polymorpha (probably). Preissia quadrata.

Page 128. Under Transhimalayan region (Ladak, etc.)

After 4. *Plagiochasma articulatum*, Ladak, add—
5. *Madotheca ovalis* (Stephani Sp. Hep.).

Last paragraph, for ‘Only a foliose acrogynous species has’ read—
Page 129. Add the following species to the list:

1. Anthoceros sp.
3. Conocephalum conicum.
4. Fimbriaria sp.
5. Sauchia spongiosa.
6. Riccia sp.
7. Frullania pyriflora.
8. Madotheca platyphylla.
10. Madotheca trigonifolia.
11. Scapania parva.
13. Plagiochila himalayensis.
15. Plagiochila cavifolia.
17. Fimbriaria Calciatii.
18. Metzgeria conjugata.
19. Metzgeria pubescens.
20. Lophozia Piacenzai.
22. Plagiochila asplenioides.
23. Lepidozia reptans.
25. Madotheca Borellii.

Species Nos. 10–16 are reported by Stephani (Species Hepaticarum, vols. I–VI).

LIVERWORTS OF THE WESTERN HIMALAYAS
AND THE PANJAB PLAIN
(ILLUSTRATED)

PART II

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PREFACE.

The first part of this book appeared in 1929 and dealt with the Anthocerota, the Marchantiales, the Anacrogynous Jungermanniales, and the Sphärocarpales. The present volume was intended to deal with the Acrogynous Jungermanniales only, but in order to bring together the Jungermanniales, the Anacrogynæ and the closely allied order Sphärocarpales have also been included. These latter have also been brought up to date.

In addition to the specimens in the Panjab University herbarium a collection of Liverworts at the herbarium of the Forest Research Institute, Dehra Dun, has also been examined by Mr. R. S. Chopra through the courtesy of Mr. C. E. Parkinson, Forest Botanist.

The species described by Stephani from the Western Himalayas in his ‘Species Hepaticarum’ but not seen by the author and a few similar species given by Gola have been included as was done in the previous volume. The chief reason for this procedure is to enable future investigators to identify these species if met with within the area or as is likely to reduce at least some of the species as synonyms. As was pointed out in the Introduction to Part I of this work the very great variability of many of the Liverworts must always be taken into consideration in deciding the limits of various species.

The author’s thanks are due to Mr. F. Verdoorn for the determination of the Frullanias in the Panjab University herbarium, to Prof. Herzog for the determination of a few species of Lejeunea and to Mr. W. E. Nicholson for determining a number of species of other genera. He is greatly indebted to Mr. R. S. Chopra for his untiring and energetic help in the preparation of this book. All the diagrams have been drawn by him. The book would not have been out for a long time but for his enthusiasm and energy.
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CONSPECTUS.

JUNGERMANNIALES.

Gametophyte a thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Archegonia usually arranged in groups but never on stalked receptacles, antheridia superficial, occasionally immersed in cavities, globular, on slender stalks. Sporogonium with foot and seta. Capsule wall two or more cells thick. Elaters present. Dehiscence usually by four valves.

Suborder Acrogyneæ.

Gametophyte with stem and two rows of lateral and frequently a third row of ventral leaves (amphigastria). Archegonia usually in a cluster, terminal.

The relative position of the families in the Acrogyneæ is by no means clear and much more work shall have to be done before it is possible to put them in their proper places. It should not be understood, therefore, that the families in this book have been placed in the order of evolution. They have been arranged more on the basis of practical convenience and according to the order followed by Cavers (The Inter-relationships of the Bryophyta, New Phyt. Rep., No. 4, 1911).

Family I. LEJEUNEACEÆ.

Leaves alternate, incubous, complicate-bilobed, postical lobe (lobule) small, commonly inflated or saccate. Amphigastria usually present. Rhizoids arising from the base or the middle of the amphigastria. Male shoots (androæcia) lateral; antheridia one or two in the axil of each bract. Archegonia terminal, one or more in a cluster. Perianth free from the involucral bracts, 3–12-plicate, rarely terete, the apex constricted into a short tubular beak.
Capsule on a short pedicel, globose, 4-valved for \( \frac{2}{3} \) of its length, the lower third solid. Elaters few, monospiral, attached to the inside of the capsule wall by their upper pointed ends, the lower free trumpet-shaped ends reaching the floor of the capsule.

**Family II. MADOTHECACEÆ.**

Plants large. Stems usually regularly bi- or tri-pinnate. Rhizoids scarce, arising from the base of the amphigastria. Leaves incurvous, complicate-bipartite almost to the base, antical lobe large, postical (lobule) flat, much smaller, nearly parallel to the stem. Amphigastria resembling the lobules but broader, frequently decurrent at the base. Andrœcia short, lateral, bracts nearly equally bilobed, opposite; antheridia solitary. Archegonial cluster terminal on very short lateral branches; bracts usually a single pair. Perianth suboval, more or less compressed dorsi-ventrally in the anterior portion, mouth becoming bilabiate or campanulate by the extrusion of the capsule. Calyptra of several layers of cells. Capsule shortly pedicellate, globose, 4-valved, the valves often irregularly split and rarely separating down to the base. Elaters short, 2-3-spiral. Only genus *Madotheca*.

**Family III. PLEUROZIACEÆ.**

Plants generally of medium size, closely attached to the substratum. Stems laxly pinnate or subpinnate. Leaves incurvous,
complicate-bilobed, the postical lobe (lobule) smaller with its free margin generally appressed to the under side of the antical lobe; rhizoids arising from the under surface of the lobule. Amphi gastria absent. Andrœcia terminal, bracts with 1 or 2, rarely 3, antheridia. Archegonial cluster terminal on the main stem generally, frequently with 1-2 sub-involucral innovations. Perianth usually strongly dorsi-ventrally compressed, rarely suberete, very rarely plicate, the mouth wide, truncate, bilabiate. Capsule shortly and stoutly pedicelled, generally oval-cylindrical. 4-valved to the base, the wall of two layers of cells. Only genus Radula.

Family V. SCAPANIACEÆ.

Plants usually large. Branches usually lateral. Leaves alternate, complicate-bilobed, the antical lobe smaller than the postical lobe (lobule). Amphigastria usually absent. Andrœcia terminal, spicate; bracts di-poly-androus. Perianth free, dorsi-ventrally compressed, or subinflated and 4-pluri-plicate. Capsule 4-valved to the base.

Family VI. PTILIDIACEÆ.

Plants of medium size, branched, branches lateral or postical. Leaves inebulous or transverse, seldom succuous, bi-multi-fid, frequently ciliate or ending in hair-like points. Amphigastria always present and nearly resembling the leaves in shape and size. Andrœcia terminal, spicate, bracts 1-3-androus. Archegonia terminal on main stem or lateral branches but never on postical branches, bracts many. Perianth absent, or when present 3-10-plicate, contracted or truncate at the mouth, free or adnate to the inner-most bracts. Capsule usually shortly pedicellate, ovate with straight valves, or cylindrical with twisted valves.

Family VII. CEPHALOZIACEÆ (TRIGONANTHEÆ Spr.).

Plants large or small. Stem prostrate or procumbent, branching generally pinnate, postical flagellæ often present. Leaves
alternate, rarely opposite, usually incubous, usually lobed or toothed, rarely entire. Amphigastria usually present. Male bracts mon-androus, rarely di-androus. Bracts of the female inflorescence tristichous, in a few distichous. Perianth usually free, somewhat elongated and narrow, trigonous, the third angle postical, rarely (by intercalation of secondary angles) 4–6-gonous. Calyptra free, narrow. Capsule oblong or cylindrical, wall of two layers of cells, in a few genera of four or five layer of cells, valves straight.

FAMILY VIII. LOPHOZIACEÆ. (EPIGONANTHEÆ Spr.).

Plants usually medium or small. Stem irregularly branched, very rarely pinnate, branches almost always lateral. Leaves succubous or transversely inserted, entire or 2-lobed, seldom 3–5-lobed. Amphigastria generally absent or very small, very rarely large. Inflorescence generally terminal on the main shoots. Male bracts 1–10-androus. Perianth (when present) compressed from the sides, cylindrical, ovate or trigonous with the third angle always antical. Capsule mostly ovate or cylindrical, 4-valved to the base.

SUBORDER Anacrogyæ.

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the antical (dorsal) side. Archegonia generally in groups.

FAMILY IX. CALOBRYACEÆ.

Stems erect, arising from a fleshy rhizome-like basal portion. Leaves arranged radially and more or less regularly in three rows, simple. Rhizoids absent. Female inflorescence on the upper part of the stem, without any involucre. Calyptra large, cylindrical. Capsule cylindrical, the wall of one layer of cells except at the apex, with longitudinal annular thickenings. Elaters bispiral.

Not represented by any species in this area.
FAMILY X. CODONIACEÆ.

Thallose or more or less foliose. In the foliose forms the leaves in two rows, parallel to the stem or obliquely inserted and succubous. Archegonial group surrounded by a perianth (involucre). Capsule usually with a long seta, globose or oval, dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells, well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base of the capsule or partly free, more rarely altogether free, 2–4-spiral.

FAMILY XI. BLYTTLIACEÆ.

Thallus with a distinct and usually sharply defined midrib, male and female inflorescence on the dorsal surface of the thallus, not on special branches, the archegonia in groups. Involucres double or single. Capsule generally cylindrical, usually dehiscing incompletely by 2–4 valves, the inner wall without semi-annular thickenings.

Not represented by any species in this area.

FAMILY XII. ANEURACEÆ.

Thallus fleshy or membranous, in Metzgeria with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, wall usually composed of two layers of cells of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end, with one broad spiral band; or also fixed, short and obtuse with an indistinct spiral band, and persistent as erect tufts at the apex of the valves.

SPHAEROCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed
in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on the cells. No definite elaters, only sterile cells which are thin-walled and disappear at maturity. Dehiscence irregular.

**FAMILY XIII. RIELLACEÆ.**

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters same as those of the order.

**FAMILY XIV. SPHAEROCARPACEÆ.**

Thallus without a distinct midrib, of one layer of cells towards the margin, entire or lobed, involucres of sex organs closely grouped, pear-shaped or conical. Spores usually permanently united in tetrads.

Not represented by any species in this area.
KEY TO THE GENERA DESCRIBED IN THIS BOOK.

1 { Plants aquatic with a median-dorsal wing . . Riella
   { Plants terrestrial or aquatic, no median-dorsal wing
     { Plants with a midrib and lateral wings, not divided into leaf-like lobes . . . . 3
     { Plants with leaf-like lateral lobes . . . . 8
   { Plants with tuber at the apex . . . . 4
   { Plants without apical tubers . . . . 5

2 { Plants with dorsal lamellae . . . . Petalophyllum
   { Plants without dorsal lamellae . . . . Sewardiella

3 { Plants with a midrib and lateral wings, not divided into leaf-like lobes . . . . 3

4 { Plants with tuber at the apex . . . . 4

5 { Plants without apical tubers . . . . 5

6 { Plants with a midrib and lateral wings, not divided into leaf-like lobes . . . . 3

7 { Plants with dorsal lamellae . . . . Petalophyllum

8 { Plants with tuber at the apex . . . . 4

9 { Plants without apical tubers . . . . 5

10 { Plants with dorsal lamellae . . . . Petalophyllum

11 { Plants with tuber at the apex . . . . 4

12 { Plants without apical tubers . . . . 5

13 { Plants with dorsal lamellae . . . . Petalophyllum

14 { Plants with tuber at the apex . . . . 4

15 { Plants without apical tubers . . . . 5
Amphigastria present (absent in one species of Lejeunea) ... 14
- Amphigastria absent ... 20
- Amphigastria small, deeply bilobed ... 15
- Amphigastria large, entire or toothed ... 16
  Leaves strongly spreading, gemmae absent, archegonia on short lateral shoots ... Chiloscyphus
  Leaves usually erect, gemmae very frequent, archegonia on main shoots ... Lophocolea
- Leaves not complicate-bilobed ... 17
- Leaves complicate-bilobed ... 18
- Leaf apex toothed, flagellae frequent ... Mastigobryum
- Leaf apex entire, flagellae absent ... Calypogeia
- Lobule flat, more or less parallel to the stem ... Madotheca
- Lobule saccate to galeate, at right angles to the stem ... 19
- Lobule galeate (rarely evolute) ... Frullania
- Lobule saccate (rarely obsolete) ... Lejeunea
- Leaves complicate-bilobed ... 21
- Leaves not complicate-bilobed ... 23
  Lobule smaller than the lobe, with rhizoids arising from its under surface ... Radula
  Lobule larger than the lobe ... 22
- Perianth contracted at the mouth ... Diplophyllum
- Perianth not contracted, mouth wide ... Scapania
- Plants thin, pellucid ... Cephalozia
- Plants not thin and pellucid, but robust ... 24
- Leaves oblique, 2-3-lobed or toothed ... 25
- Leaves transverse, entire ... 26
- Leaves 2- or 3-lobed, lobes usually entire ... Lophozia
- Leaves not lobed, toothed, rarely almost entire ... Plagiochila
- Leaves opposite ... Southbya
- Leaves alternate ... 27
- Bracts and bracteoles lacinate ... Jamesoniella
- Bracts entire, bracteoles absent or small ... 28
KEY TO THE GENERA

\[
\begin{align*}
&\text{Mouth of perianth contracted, more or less beaked} \quad \text{Solenostoma} \\
&\text{Mouth of perianth wide} \quad \text{Jungermannia}
\end{align*}
\]

Note.—Many of the thallose genera including *Fossonbronia* and *Blasia* can be distinguished very easily. *Riella* is wholly aquatic and is unique in having a dorsal wing. It has so far been found only in Lahore. *Petalophyllum* can readily be distinguished on account of its dorsal lamellae and apical tubers; also found only in Lahore and along the river bank at Beas. *Sewardiella* and *Fossonbronia* are easily recognised by their apical tubers; the former being thallose and the latter possessing beautifully curled leaves. *Blasia* has a superficial resemblance with *Anthoceros* on account of its Nostoc colonies but can be easily distinguished by its leaf-like lobes, the ventral scales and the dorsal gemmae. *Metzgeria* has a distinct midrib with a one-layered wing on each side. *Aneura*, *Pellia*, and *Calycularia* have some resemblance in the sterile condition. In a patch of *Pellia* it is generally always possible to find some sex organs which are always on the main shoot, the antheridia being sunk in pits. In *Calycularia* the antheridia, which here also are on the main shoot, are superficial and accompanied by scaly bracts. *Aneura* has its sex organs on short lateral shoots.

The foliose forms require a more careful investigation before they can be named by the beginner. Among these also several genera can be recognised at sight. *Frullania* is characterised by the possession of bladders in place of the lobules. *Lejeunea* has a saccate lobule which is often represented merely by the incurved postical margin of the lobe. *Madotheca* can be distinguished by the large lobe and the small lobule and conspicuous amphigastria. *Radula* has no amphigastria and the rhizoids arise from the undersurface of the lobule. In *Scapania* and *Diplophyllum* the lobe is smaller than the lobule. The habit of *Plagiochila* is also very peculiar in that the leaves are not complicate and there are no amphigastria.

With a little practice many of the other genera also can be made out readily but a few require the presence of sex organs and the perianth to distinguish them from the allied forms.
Suborder

ACROGYNÆ.

Gametophyte with stem and two rows of lateral and frequently a third row of ventral leaves (amphigastria). Archegonia usually in a cluster, terminal.

Family I. LEJEUNEACEÆ.

Leaves alternate, incubous, complicate-bilobed, postical lobe (lobule) small, commonly inflated or saccate. Amphigastria usually present. Rhizoids arising from the base or the middle of the amphigastria. Male shoots (androœia) lateral; antheridia one or two in the axil of each bract. Archegonia terminal, one or more in a cluster. Perianth free from the involucral bracts, 3–12–plicate, rarely terete, the apex constricted into a short tubular beak. Capsule on a short pedicel, globose, 4-valved for ⅓ of its length, the lower third solid. Elaters few, monospiral, attached to the inside of the capsule wall by their upper pointed ends, the lower free trumpet-shaped ends reaching the floor of the capsule.

Key to the genera.

Lobule always distinct, galeate, sometimes evolute

Lobule saccate, sometimes obsolete

Frullania

Lejeunea

* * * *

I. FRULLANIA Raddi.


Plants medium, rarely small, green to dark brown, pinnately branched, branches axillary. Leaves imbricate, incubous, almost transversely inserted, complicate-bilobed, antical lobe larger, obliquely ovate to suborbicular, convex, apex decurved, margin entire; lobule cucullate, galeate, occasionally evolute and then
ovate-lanceolate. Amphigastria always present, large, usually smaller than the leaves, base cordate, apex bifid or retuse. Androecia terminal on short lateral branches, rarely hypogynous, narrowly capitate or spicate, bracts closely imbricate, di-androus. Sub-involucral innovations absent. Archegonia 2–4, rarely more, bracts in 2–5 pairs, usually dentate or lacinate, the innermost generally adnate to each other and the bracteole. Perianth tri- or pluri-keeled.

*Note.*—The lobule in several species has a tendency to remain open instead of forming the typical bladders. In such cases the lobule is long and narrow, with revolute margins so that the underside is concave.

**Key to the species.**

1  
\{ Antical base appendaged  ....  ....  \   2  
\{ Antical base not appendaged  ....  ....  \   3  

2  
\{ Leaves distinctly convex on the dorsal side  ....  \  *F. Grevilleana*  
\{ Leaves not convex  ....  \  *F. squarrosa*  

3  
\{ Amphigastria entire or retuse  ....  \  *F. retusa*  
\{ Amphigastria bilobed  ....  \  4  

4  
\{ Leaves up to 1 mm. long  ....  \  *F. pyriflora*  
\{ Leaves up to 0.5 mm. long  ....  \  5  

5  
\{ Perianth papillose  ....  \  \  \  *F. gracillima*  
\{ Perianth smooth  ....  \  \  \  *F. muscicola*  

*Note.*—Verdoorn has given *Frullania himalayensis* St. and *F. chinensis* St. as synonyms of *F. muscicola* St. (Vide Symbolae Sinicæ, V. Teil., Hepaticæ, p. 5, 1930). While naming a specimen of *Frullania* from Mussoorie he says, 'I think *Frull. squarrosa* Nees might be also a form of *F. muscicola* St.' From this it would appear that *F. squarrosa* Nees and *F. muscicola* St. are closely allied and possibly identical. In the latter case all the four species could be reduced to one, i.e. *F. squarrosa* Nees.

1. *Frullania squarrosa* Nees.


Dioecious, medium, green to deep brown, epiphytic or terrestrial, in dense depresso-caespitose patches or hanging, pure or
mixed with other foliose forms. Stem 3-4 cm. long, irregularly pinnate. Rhizoids rare, brown, small, arising from the middle of the amphigastria. Leaves oblique, imbricate, spreading, sub-orbicular, 0.7 mm. x 0.4 mm. to 1.1 mm. x 0.7 mm., base cordate, antical basal portion distinctly crossing the stem, auricled, auricle reflexed and overlapping the base of the leaf, margin entire or wavy, apex rounded. Upper cells 18 μ, a few basal cells 45 μ x 27 μ, rest smaller; trigones thickened throughout the leaf but more so near the base; walls thick, nodulose, towards the base often uniformly thick. Lobule galeate, mouth narrow or wide, or sometimes evolute, triangular with a blunt apex, about twice as broad as the thickness of the stem. Amphigastria large, about 4 times the lobule and half that of the lobe, very broadly ovate to subrotund, base narrow, margin entire or apical portion toothed, apex bilobed, notch broad, deep, extending to about ⅓ of the length, lobes deltoid, acute, rarely the amphigastria entire. Sex organs cladogenous. Andróecia capitate, bracts in 3-4 pairs. Involucral bracts usually longer than the leaves; lobe ovate, entire, obtuse; lobule ovate-lanceolate, with margins sparsely toothed, inner strongly so. Bracteoles ovate, deeply bifid, margin dentate, lobes long acuminate. Perianth large, obovate-oblong, depressed below the terminal beak, strongly 3-keeled, often with additional less marked carinae, odd angle postical, carinae dentate, surface more or less papillate. Calyptra free, fleshy, obovate. Seta thin, delicate, up to 5 mm. long; capsule globose, dark brown. Spores yellowish, spherical, areolate, 4-6 areoles in the diam., 25-40 μ. Elaters yellowish, trumpet-shaped, monospiral, 275-325 μ, rarely as short as 130 μ.

Plate I, figures 1-5.

Hab. Moist rocks and bark of trees.

Distrib. Common in the Western Himalayas, especially Garhwal and Kumaon, Mussoorie, etc.; Chamba-Chuari Road; Nilgiris (Sedgwick).

This is the commonest species of the genus and is met with in most places at about 6,000-7,000 ft.

Note.—Mr. Verdoorn distinguishes one form and one variety (1929, de Frullan. IV, Ann. Bryol. II : 134).
1. *F. squarrosa* fo. *ericioides* (Nees) Verd., distinguished by its evolute lobules which are lanceolate and flat or concave.

2. *F. squarrosa* var. *planescens* Verd., which he characterises as follows:—

Leaves subplane, spreading, amphigastria often large. Postical margin less rounded, large, less cordate. Auricle beaked (beak distinct, frequently curved) or subbeaked.

*Note.*—Typical specimens can be distinguished very readily by the leaf form. The anterior margin of the leaf is usually bent upwards so that the upper surface becomes depressed and the leaf has a saddle-shaped appearance. In other cases the leaves have a tendency to become flat or even slightly convex on the dorsal side. In the typical form again the leaves are patent whereas in other cases they have a tendency to be arranged at right angles to the stem.


Sterile, light brown to almost black, on rocks or on bark, in dense extended patches in the former case and hanging down in the latter. Stem about 5 cm. long, irregularly shortly pinnate, pinnæ up to 4 mm. long. Rhizoids absent. Leaves more or less imbricate, horizontal, distichous, quadrate-rounded to ovate-oblong, up to 0·9 mm. long and 0·8 mm. broad, antical basal portion crossing over the stem, margin entire, apex rounded, sometimes recurved. Upper cells 20 ì, basal cells 28 ì × 19–23 ì; walls and trigones very thick, nodulose. Lobule galeate, anterior margin strongly convex, posterior side concave, rarely evolute. Amphigastria transversely inserted, suborbicular, margin entire, apex retuse, sometimes rounded.

Plate I, figures 6–9.

*Hab.* On the bark of trees and on rocks.

*Distrib.* Garhwal, *Mussoorie*; *Dalhousie*.
3. Frullania muscicola St.


Dioecious, light or brownish green, closely applied to bark. Stem about 1 cm. long, simple or slightly pinnately branched. Rhizoids dark brown. Leaves distant or slightly imbricate, horizontal, suborbicular, 0.7 mm. long and 0.5 mm. broad, sometimes less. Base narrow, antical basal portion rounded, crossing the stem, apex rounded or obtuse, recurved. Cells in the greater part of the leaf of the same size, those near the base larger; upper cells 17 μ x 11–14 μ, trigones small; basal cells 26–34 μ x 21 μ, sometimes only 17 μ broad, trigones rather thick; walls nodulose. Lobule on the older parts galeate, on the younger branches often ovate-oblong to oblong with margins rolled back and near the apex sometimes flat. Amphigastria about twice as large as the lobule and about ⅓ of the lobe, obovate to suborbicular, apex notched to about ⅓ of the length. Androcia ovate. Involutral bracts longer than the leaves; lobule ovate-lanceolate, obtuse, margins revolute. Bracteoles ovate-oblong, bilobed to ⅔ at the apex, lobes entire, acute. Perianth obovate, dorsi-ventrally compressed, 4-keeled, keels unequal, smooth all over.

Plate I. figures 10–12.

Hab. Epiphytic.

Distrib. Mussoorie.

4. Frullania gracillima St.


Dioecious, small, slender, generally green, sometimes reddish brown, closely applied to bark. Stem about 1 cm. long, distantly pinnate, pinnæ small. Rhizoids rare, just below the apical notch of the amphigastria. Leaves distant or imbricate, suborbicular, about 0.5 mm. in diameter, base cordate, antical basal portion rounded, covering and crossing the stem, margin entire, apex rounded, recurved. Cells except the few basal ones of the same size, walls thin, sometimes nodulose, trigones small; upper cells 15–18 μ, basal cells 26–30 μ x 17–27 μ. Lobule galeate, mouth
broad. Amphigastria of the same size as the lobule, obovate, margins entire or sometimes with single cells projecting here and there; apex notched to about ¼, notch triangular, lobes deltoid, acute. The leaves on the female branches larger and obovate. Bracts ovate-oblong, margin entire, apex rounded or acute; lobule lanceolate, acute, margins entire. Bracteoles quadrate, divided to one half by a narrow slit, lobes acute. Perianth oblong, 6-plicate (all the carinae not well developed) surface papillate, carinae denticulate.

Plate I, figures 13–15.
Hab. On bark of trees.
Distrib. Outer Himalayas, Chamba; Murree; Garhwal.

Note.—The leaves on some of the branches towards the upper end sometimes remain very small so that these branches look like flagellæ.

The leaves are usually convex on the dorsal side. Occasionally, however, they are directed slightly upwards, just showing a slight resemblance to the condition met with in F. squarrosa.

The perianth has two small ventral keels, two large lateral keels and generally three dorsal keels, the two dorso-lateral keels being very small.

5. Frullania pyriflora St.


 Dioecious, small, light green to deep brown, closely applied to bark. Stem about 1·5 cm. long, irregularly pinnate. Rhizoids from the base of the amphigastria. Leaves distant to slightly imbricate, patent, suborbicular, 0·75–1 mm. × 0·5–0·75 mm., antical basal portion rounded, covering and crossing the stem, margins entire, apex broad, rounded. Upper cells 15 μ, median cells 24–28 μ and basal cells 30–32 μ in diameter, some elongated and longer; walls thin, slightly thick near the base, trigones slightly thick. Lobule large, about one and a half times as broad as the stem, strongly galeate, mouth truncate or often near the apex of the shoot oblong with margins rolled back. Amphigastria small, somewhat broader than the stem, obovate to obovate-oblong, divided to about ¼ the length, notch obtuse, lobes acute. Androecia
spicate, oblong. Bracts broadly obovate, about twice as large as the leaves; lobule lanceolate, free, entire, but with a tooth towards the bracteole. Bracteoles obovate-oblong, with a tooth at the middle on each side, apex bifid up to the middle, sinus acute, lobes lanceolate, acute. Perianth pyriform, dorsally triplicate, ventrally biplicate, smooth.

Plate II, figures 1–3.

Hab. On bark.

Distrib. Khajiar (beyond Dalhousie), 6,000 ft.; Masrund (Chamba State), 4,000 ft.; Kashmir.

Note.—Some specimens from Dalhousie are separated by Mr. Verdoorn as var. Kashyapii. These plants are more delicate, the leaves are more transparent and the lobule is evolute practically all over the plant. The perianth is rather compressed and has five ridges, of which the two ventral ones are small, the two lateral ones are the largest, and the third median dorsal is the smallest.


Dioecious, large, reddish purple. Stem about 6 cm. long, bipinnate, pinnae regular, alternating, 5–8 mm. long, more or less attenuated. Leaves imbricate, patent-divergent, convex, ovate-elliptical, 1 mm. × 0.75 mm., antical base covering and crossing the stem, rounded, appended, appendage narrow, entire, decurrent, margin entire, apex rounded. Upper cells 12–20 μ, trigones thick, walls also thickened; basal cells 32–40 μ × 16 μ, trigones and walls thick. Lobule narrow, more or less appressed to the stem, twice as long as broad, mouth oblique, truncate. Amphigastria large, broadly ovate, base deeply cordate, margin entire, recurved, apex notched to about 1/5, notch acute, lobes obtuse. Androecia capitate. Perianth and bracts not seen.

Plate II, figures 4–7.

Hab. Terrestrial and epiphytic.

Distrib. *Kidar Kanta* (Duthie, 1879); *Kurseong, Sikkim* (Bretaudeau, 1894), (Herb., F.R.I., Dehra Dun).
Note.—The West Himalayan plants are terrestrial growing among mosses. They are smaller and compact; but the Sikkim specimens are epiphytic, larger and lax.

The following species of Frullania are described by Stephani but have not been seen by us.

7. Frullania Gollani St.


Sterile, olive green, flaccid, on bark. Stem up to 3 cm. long, shortly and remotely pinnate. Leaves slightly imbricate or contiguous, strongly spreading, plano-distichous, ovate-elliptic, 0·8 mm. × 0·65 mm., apex broadly rotundate, antically broadly covering the stem, antical base rotundate, appendiculate. Upper cells 18 μ, basal 27 μ × 18 μ, trigones large, walls rigid. Lobule large, twice as broad as the stem, contiguous, erect, symmetrical, about twice as long as broad, apex truncate-rotundate, constricted below the mouth, mouth also truncate. Amphigastria large, transversely inserted, obovate-obcuneate, angular on both sides, apex about 1⁄3 inciso-bilobed, sinus pretty straight, lobes triangular acute.

Hab. Himalaya, Simla.

8. Frullania himalayensis St.


 Dioecious, medium, dark brown, dense depresso-caespitose. Stem up to 4 cm. long, irregularly branched, primary branches 2 cm. long, mixed with smaller branches, irregularly shortly pinnate, sometimes bipinnate. Leaves imbricate, spreading, broadly obovate, antically covering the stem, antical base circinate-appendaged. Upper cells 18 μ, basal 36 μ × 27 μ, trigones large, at the base larger. Lobule large, twice as broad as the stem, strongly cucullate, slightly longer than broad, lightly nodding, apex obtuse, mouth truncate. Amphigastria large, about thrice as broad as the stem, transversely inserted, subrotund, apex about 1⁄3 exciso-bilobed, sinus wide, lobes triangular, obtuse. Female inflorescences terminal on short branches. Involucral bracts in three pairs, obovate, apex rounded; lobule slightly smaller; broadly
lanceolate, deeply canaliculate-concave, entire, acute. Bracteoles free, ovate-oblong, about \( \frac{3}{4} \) inciso-bifid, notch narrow, lobes lanceolate, spreading, acuminate, acute, entire.

Hab. Himalaya (Mussoorie).

Note.—We have not seen the plants described by Stephani but from his description *F. himalayensis* St. does not appear to be specifically distinct from *F. squarrosa* Nees and is very likely a form of the same.

9. *Frullania Duthiana* St.


Dicocious, small, deep brown, rigid, among mosses. Stem up to 2 cm. long, deep brown, sparsely shortly pinnate. Leaves patent, strongly concave, apex broadly decurved, broadly obovate, 0.86 mm. long. Upper cells 18 \( \mu \), basal 36 \( \mu \) x 18 \( \mu \), trigones large, acute. Lobule small, about as broad as the stem, more or less strongly cucullate, mouth oblique, truncate, compressed, narrow, distinctly but briefly coalesced with the lobe. Amphigastria almost as large as the leaves, circular, base deeply cordate, apex entire. Involutural bracts close, twice as long as the leaves, ovate, obtuse, entire. Bracteoles small, obtuse, free, about \( \frac{3}{4} \) inciso-bilobed, lobes lanceolate, acute.

Hab. Himalaya (Kidar Kanta).

* * * * * * *

II. *LEJEUNEAE Libert.*


Plants minute and delicate, medium, or large and robust. Stem pinnately branched. Leaves alternate, complicate-bilobed, incubous, oblique or almost longitudinally inserted, margin entire or more or less toothed. Lobule inserted in the same plane, incurved or ventricose, rarely plane or obsolete. Amphigastria entire or bifid, rarely absent. Monoecious or dioecious. Androeia usually on short branches, occasionally on the main stem; bracts
subequilobed, di-androus, in rare cases tri-androus or mon-androus. Female branch with a single archegonium; usually with sub-involucral innovations. Bracts more or less different from the stem leaves, one to several pairs; bracteoles about the same size. Perianth free from the bracts, plicate, rarely perfectly terete, sub-cylindrical or plano-compressed, usually pyriform, frontally compressed; angles smooth or variously armed, apex usually produced into a beak. Capsule pedicellate, globose, hyaline or pale brown, dividing to about \( \frac{3}{4} \) into four valves; wall of two layers of cells, inner spongy. Elaters fixed to the apex of the valves, monospiral.

The genus *Lejeunea* (in the wide sense) is nowadays usually split up into a large number of sub-genera or genera. Since the number of species included here is very small it has been thought best to put them in the genus *Lejeunea* in the comprehensive sense, especially as most of them are met with generally only in the sterile condition. The narrower generic name is given within brackets.

**Key to the species.**

1. \{ Amphigastria absent, lobule flat \} \{ Sp. E. \\
   Amphigastria present, lobule saccate \} \{ 2 \\
     Amphigastria not bilobed (Holostipæ), plants \} \{ 3 \\
     medium or large \} \{ 3 \\
   Amphigastria bilobed (Schizostipæ), plants small \} \{ 5 \\
   Leaves very closely imbricate \} \{ Sp. A. \\
   Leaves not very closely imbricate \} \{ 4 \\
   The apex of the lobe and the amphigastrium with several teeth \} \{ \emph{L. Perrottetii} \\
   The apex of the lobe and the amphigastrium entire \} \{ \emph{L. chinensis} \\

4 \{ Lobule with a tooth on the anterior margin \} \{ Sp. D. \\
   Lobule without a tooth on the anterior margin \} \{ 6 \\
   Leaves large, slightly overlapping, more or less crisped \} \{ Sp. C. \\
   Leaves smaller, closely overlapping, flat \} \{ Sp. B. \\

10. Lejeunea (Ptychanthus) Perrottetii St.


Diocious, large, robust, green or brown, in dense patches on rocks, or bark of trees. Stem procumbent, more or less regularly repeatedly pinnate, 15 cm. or more long; pinnae 1–3 cm. long. Rhizoids absent. Leaves imbricate, horizontal, oblique, oblong-ovate, up to 1·5 mm. × 1 mm., insertion narrow, antical base rounded, covering and crossing the stem, appendaged, appendage rounded and not sharply marked off, postical slightly decurrent, antical margin convex, postical margin revolute, sub-apical portion of the postical margin and often of the antical margin also with a few 1-celled teeth, occasionally the whole margin entire, apex acute, often acuminate, or rarely obtuse or rounded. Upper and median cells 12–18 μ in diameter, walls and trigones somewhat thickened, conspicuous; basal cells 32–54 μ × 22–30 μ (usually 45 μ × 27 μ), walls thick, trigones large, nodulose. Lobule saccate, minute, twice as long as broad, not toothed, often obsolete. Amphigastria large, a little more than twice as broad as the stem, quadrate, base cordate, more or less parallel to the stem, not much spreading, margins entire, often somewhat irregular, apex broad, truncate, with numerous 1-celled teeth, occasionally entire. Androecia intercalary, ovate-oblong; bracts about 6 pairs, lobule well-developed, ½ as long as the lobe and about ½ as broad; amphigastria small, entire. Female inflorescence cladogenous, unilaterally innovating, innovations simple or once floriferous. Involutural bracts and bracteoles like the leaves and the amphigastria, bracteoles rather long. Perianth pyriform, much narrowed below, pluri-plicate, carinae smooth, inflated, mouth beaked. Elaters laxly monospiral, 320–370 μ. Spores light yellowish, finely punctate, 30 μ in diameter.

Plate II, figures 8–12.

Hab. On rocks and bark of trees.

Distrib. Garhwal; Kumaon, 6,000–7,000 ft. Very common. Common also in Eastern Himalayas, Darjeeling, etc.

Note.—The plant varies very greatly as regards the margin of the leaf; generally there are several teeth near the apex of the
lobe and that of the amphigastrium, sometimes the apex ends in a single tooth, occasionally there is no trace of any teeth on the lobe or the amphigastrium, the whole margin is absolutely entire, the apex of the lobe is rounded, and that of the amphigastrium is truncate.

II. Lejeunea (Ptychanthus) chinensis St.


Dioecious, medium, light green or brownish, up to about 5 cm. long, regularly pinnate and irregularly bipinnate. Leaves oblique, horizontal, distichous, imbricate, oblong-ovate, up to 1.5 mm. x 1 mm., antical base rounded, covering and slightly crossing the stem, postical decurrent, margins entire, antical convex, postical revolute, markedly concave in the natural condition but quite straight when the leaves are spread out, apex rounded or obtuse. Upper cells 14–18 μ, basal cells 36–43 μ x 25–28 μ; trigones large, conspicuous, walls thick, occasionally nodulose. Lobule obsolete. Amphigastria distant, spreading (not appressed), suborbicular to reniform, inserted by a notched base, entire, rounded or retuse. Andaecia intercalary, ovate to oblong-ovate, bracts 4–6 pairs, smaller than the leaves, lobule large, strongly saccate; amphigastria a little longer than those on the vegetative parts. Female inflorescence unilaterally innovating, innovation once floriferous. Bracts like the leaves, bracteoles large, more or less oblong or obovate-oblong. Perianth oblong-oblanceolate, narrowed at the base, pluri-plicate, carinæ smooth.

Plate II, figures 13–15.

Hab. On rocks.

Distrib. Almora and Mussoorie.

Note.—The plant is very similar in habit to the foregoing species, L. Perrottetii; and sometimes occurs mixed with it. It is distinguished from that species by the absolutely entire leaves and the amphigastria; there being no trace of any teeth anywhere, and the markedly concave postical margin of the lobe in nature. The amphigastria also in this species are more spreading, bending away from the stem.
12. Lejeunea Sp. A.

Dioecious, light green, closely attached to bark. Stem about 3 cm. long, irregularly bipinnate. Rhizoids short, brown, in tufts from the bases of the ampligastria. Leaves closely imbricate, orbicular-ovovate, with a very narrow base, convex above, about 1 mm. long \( \times \) 1 mm. broad, antical base appendaged, covering and very much crossing the stem, margins entire, apex rounded. Upper cells 32 \( \mu \times 20 \) \( \mu \), basal cells larger, 40-60 \( \mu \times 29-36 \) \( \mu \), walls rather thin, sometimes somewhat nodulate, trigones thickened, acute. Lobule very much inflated through its greater part, anterior part flat, quadrate-oblong, margin entire, apex truncate. Ampligastria large, suborbicular, rather broader than long, margin entire, apex rounded, slightly revolute. Sub-involucral innovations two, equally or unequally developed, or only one, not floriferous. Bracts and bracteoles like the leaves but larger; lobule flat. Perianth obovoid, pluriplicate, carinae smooth, beak not prominent. Seta 2 mm. long, pellucid. Spores 60-65 \( \mu \), golden yellow, mammillate and echinate, winged, wing 4 \( \mu \), crenulate. Elaters concolorous, laxly monospiral, spiral broad, 400-560 \( \mu \).

Plate III, figures 1-7.

Hab. Closely attached to bark, often mixed with Frullania squarrosa and others.

Distrib. Almora, 6,000 ft.; Garhwal, Mussoorie, 6-7,000 ft.

Note.—The plant can be easily distinguished by its habit, being closely applied to bark, and its closely imbricate entire leaves.

13. Lejeunea Sp. B.

Sterile, small, light green or whitish green, in dense tufts. Stem pauci-pinnate, 5-6 mm. long. Leaves imbricate, planodistichous, suborbicular, up to 0.33 mm. \( \times \) 0.25 mm., base as broad as the stem, almost flat, antical basal portion rounded, covering the stem, margins entire, apex rounded. Cells rectangular, polygonal or circular, walls and trigones slightly and equally thickened, often trigones indistinct; marginal cells smaller, upper cells 16 \( \mu \times 12 \) \( \mu \), median cells 18 \( \mu \), basal a little larger, 24 \( \mu \times 18 \) \( \mu \). Lobule ovate, 0.12 mm. \( \times \) 0.08 mm., inflated, often
very small and rarely obsolete. Amphigastria imbricate, sub-orbicular, margin entire, apex about \( \frac{1}{2} \) bifid, lobes acute, converging at the apex. Perianth obovate-oblong, 5-carinate, surface and carina smooth.

Plate III, figures 8–11.
Hab. On rocks and bark.
Distrib. Garhwal; Western Himalaya; Simla; Khajiar; Mussoorie.


Sterile, small, delicate, in dense tufts of prostrate plants on rocks. Stem pellucid, simple or with a few branches, 6-12 mm. long. Leaves distant or only slightly imbricate, patent, convex, often crisped, oblique-ovate, up to 0.7 mm. \( \times \) 0.6 mm., base narrow, clasping half the stem, antical basal portion rounded, covering and slightly crossing the stem; margin entire, apex rounded. Upper cells 18 \( \mu \), median cells 25 \( \mu \), basal cells 29–36 \( \mu \); walls thin, trigones slightly thickened, distinct. Lobule equilateral-triangular, 0.13 mm. \( \times \) 0.13 mm. Amphigastria twice as broad as the stem, sub-orbicular, entire, about \( \frac{1}{2} \) bifid, lobes acute, converging at the apex. Rest not seen.

Plate IV, figures 1–4.
Hab. On rocks.
Distrib. Kumaon; Simla, 6-7,000 ft.; Khajiar, 6,000 ft. Alwas-Silrundi Road, 8-10,000 ft.; Garhwal, Mussoorie, 6-7,000 ft.

*Note.*—Resembles *Lejeunea* B. very much, but can be distinguished on account of its fewer branches, and more lax leaves, which are also generally larger, less overlapping, and often wavy. The leaves in the former species are almost flat and much smaller. Occasionally the leaves in this species also are very small. In both the species there is a constriction (something like a notch) at the junction of the lobe and the lobule at the margin. Probably the two are not specifically different. The reproductive organs are, however, not known in this species and the two may be kept separate provisionally.
15. *Lejeunea* Sp. D.

Dioecious, small. On rocks and bark, mixed with *Pt. Perrottetii* and others. Stem irregularly and slightly branched, about 10 mm. long. Leaves distant or slightly overlapping, patent or almost horizontal, distichous, oblique, slightly convex on the dorsal side, ovate-oblong, 0.5 mm. long and 0.3 mm. broad, margin entire, apex rounded. Walls thin, trigones indistinct or absent; upper cells 18 μ, median cells 35 μ × 25 μ or polygonal with a diameter of 25 μ, basal cells like the median cells. Lobule inflated, 0.15 mm. long and 0.12 mm. broad, nearly triangular, anterior margin with a more or less distinct tooth at its outer end at a distance of 0.05 mm. from its junction with the postical margin of the leaf. Amphigastria 2½ times the thickness of the stem, distant, suborbicular, about ½ bifid, lobes triangular, more or less divergent, subacute or obtuse. Androecia on short branches, subcapitate, flattened, bracts about 4 pairs. Perianth obovate, beak conspicuous, 5-plicate, upper surface flat, ventral with two or three small keels, the two lateral keels largest, surface and carinae smooth. Subfloral innovation single, fertile.

Plate IV, figures 5–7.

Hab. On rocks and bark.

Distrib. Garhwal; Mussoorie.

*Note.*—This species in its typical form can be easily distinguished from the two foregoing species by the presence of a tooth on the anterior margin of the lobule. The tooth, however, is sometimes very small; on the same branch some lobes may have a very distinct tooth, in others the tooth may be very faint or even wholly absent. It can also be distinguished by the divergent lobes of the amphigastria; the lobes are usually divergent but occasionally they are more or less convergent.

16. *Lejeunea (Physocolea)* Sp. E.

Monoecious, small, closely pressed on bark, delicate, pale greenish yellow to dark brown, mixed with other hepatics. Stem branched, about 12 mm. long. Leaves slightly or not at all imbricate, horizontal, oblique, broadly ovate to ovate-orbicular,
up to 1·0 mm. long and up to 0·75 mm. broad, inserted by a narrow non-decurrent base, margins entire, apex rounded. Upper cells 14–18 µ, median 18–25 µ, basal 40–45 µ × 30 µ, walls and trigones thin. Lobule deltoid, up to 0·33 mm. long and 0·1 mm. broad, margin entire, apex rounded. Amphigastria absent. Androecia spicate, oblong, bracts 6 to 8 pairs. Female inflorescence with one sub-involucral innovation, innovation repeatedly floriferous. Bracts like the leaves; bracteoles absent. Perianth pyriform, compressed, dorsal with or without one faint carina, ventral with two or three faint carinae, lateral wings conspicuous. Mouth beaked when young, but later on becoming bilabiate. Capsule long exserted, opening by 4 valves up to 3, lower part part solid.

Plate IV, figures 8–11.

Hab. On bark.

Distrib. Mussoorie.

Note.—The plant is very near Ph. madothecoides St. (Sp. Hep., Vol. V, p. 898) and Ph. producta (Mitt.) St. (Sp. Hep., Vol. V, p. 902).

The following species of Ptychanthus is reported by Mitten (Jour. Proceed. Linn. Soc., Vol. V, p. 109) from Kumaon but we have not seen it. The description is after Stephani (Sp. Hep., Vol. IV, p. 753).

17. Ptychanthus striatus (L. et L.) Nees.


Monoeious, large, light brown, rigid, hanging from the branches of trees. Stem up to 20 cm. long, regularly bipinnate, primary branches up to 4 cm. long, spread out, shortly and sparsely pinnulate. Leaves contiguous, strongly spreading, slightly concave, postical margin narrowly incurved, broadly ovate, subsymmetrical (2·4 mm. long, in the middle 1·6 mm. broad), apex acute, strongly toothed below the apex, inserted by a narrow base, antical base coarsely rotundate-appendiculate. Upper cells 27 µ × 18 µ, trigones large; basal cells 36 µ × 18 µ, walls interruptedly trabeculate. Lobule small, ¾ the lobe, invisible in situ, oblong, apex half as broad as the base, oblique-truncate, angle acute. Amphigastria large, breadth 4 times the thickness of the stem, subrotund, inserted by
a notch, base cordate, ampliate. Perianth clavate, thrice as long as broad, 10-plicate, carinae inflated, beak long. Bracts slightly smaller than the leaves, similarly armed; lobule narrow, ⅓ of the lobe, oblong, apex shortly truncate, acute. Bracteole as long as the bracts, obovate, apex broadly emarginate, angle acute. Androecia more or less spicate, bracts 6–15 pairs.

Hab. Bark of trees.
Distrib. Kumaon (Strachey and Winterbottom); Nepal (Wallich); Sikkim, 7–10,000 ft. (J. D. Hooker); Khasia (J. D. H. and T. T.); Assam (Simons, Griffith).

FAMILY II. MADOTHECACEÆ.

Plants large. Stems usually regularly bi- or tri-pinnate. Rhizoids scarce, arising from the base of the amphigastria. Leaves incisuous, complicate-bipartite almost to the base, antical lobe large; postical (lobule) flat, much smaller, nearly parallel to the stem. Amphigastria resembling the lobules but broader, frequently decurrent at the base. Androecia short, lateral, bracts nearly equally bilobed, opposite; antheridia solitary. Archegonial cluster terminal on very short lateral branches; bracts usually a single pair. Perianth suboval, more or less compressed dorsi-ventrally in the anterior portion, mouth becoming bilabiate or campanulate by the extrusion of the capsule. Calyptra of several layers of cells. Capsule shortly pedicellate, globose, 4-valved, the valves often irregularly split and rarely separating down to the base. Elaters short, 2-3-spiral.

* * * * *

III. MADOTHECA Dum.

Bellincinia et Antoiria Raddi in Mem. Soc. Ital. Mod. 18 pp. 18, 19 (1820).

Only genus in the family. Characters of the family.
Key to the species.

1 Margin of the lobe toothed in the upper part, or only acute (acutifolii) .. .. 2

Margin of the lobe entire (obtusifolii) .. 7

Inner base of the lobule longly decurrent along the stem .. .. .. 3

Inner base of the lobule not decurrent .. .. 4

Outer base of the lobule appended .. .. M. appendiculata

Outer base not appended .. .. M. Gollani

Lobe apex simply acute, margin strongly twisted .. .. .. M. acutphylla 5

Lobe apex broad, with teeth .. .. 6

The lobe, lobule and amphigastria coarsely toothed .. .. .. M. denticulata

The lobe with small teeth, the lobule and amphigastria entire or with a few teeth .. 6

Lobes with numerous teeth, amphigastria large .. .. .. .. M. campylophylia

Lobes with 1–3 teeth, amphigastria small .. .. M. plumosa

Plants delicate, lobe entire, rarely with 1 or 2 teeth, lobule and amphigastria small, distant .. .. .. .. *M. variabilis

Plants not so delicate, lobes never toothed, lobule and amphigastria quite large, approximate .. .. .. .. .. 8

Antical basal portion decurrent on the stem .. 9

Antical basal portion not decurrent .. 11

Lobule appendaged on both sides of the base .. 10

Lobule decurrent on the inner base, not appended at the outer base .. .. .. .. M. Gambleana

* Sometimes the apex of the lobule has got 1 or 2 faint teeth and the amphigastria are large, toothed at the apex or at the base also.
Lobe ovate, antical basal portion rounded and slightly crossing the stem ... \( M. \) platyphylla

Lobe broadly ovate, antical basal portion much larger and crossing far beyond the stem ... \( M. \) decurrens

Lobule very large ... ... \( M. \) macroloba

Lobule smaller ... ... 12

Postical base decurrent on the stem, antical crossing far beyond the stem ... \( M. \) gracillima

Postical base not longly decurrent, antical not or only slightly crossing the stem ... \( M. \) obtusifolia

18. \( Madotheca \) appendiculata St.


Large, flaccid, light or deep green, on rocks. Stem up to 15 cm. long, regularly 2-4-pinnate. Leaves imbricate, horizontal, oblique-ovate-oblong, up to 2 mm. long and 1.25 mm. at the broadest point, antical base ampliate, rounded, covering the stem and often slightly crossing it, decurrent on the stem, wing linear acute, postical base wavy, margins entire, apex acute, acuminate or bi- or tri-dentate. Upper cells 15-22 \( \mu \) (mostly 18 \( \mu \)), walls and trigones equally thickened; basal cells 40-47 \( \mu \times 21-27 \mu \) (some smaller), walls thinner, trigones large, sometimes nodulose. Lobule large, oblong to ovate-oblong, 1.0 mm. \( \times \) 0.5 mm., slightly imbricate, appendaged on both sides of the base, appendages crisped, apex rounded or obtuse. Amphigastria shorter and broader than the lobules, 0.75 mm. long and 0.75 mm. at the broadest point, fixed by a broad sinus, unequally decurrent on both sides, margin crisped in the lower part, apex rounded, reflexed. Involucral bracts slightly narrower than the leaves, margins spinous. Bracteoles ovate to quadrate, larger than the amphigastria, margin entire or toothed, apex broad spinous. Perianth large, campanulate, divided irregularly into a number of lobes, lower portion of the lobes toothed, upper with long spines. Spores golden-yellow, muriculate, 47-55 \( \mu \). Elaters concolorous, long or short, bi- or tri-spiral, spiral lax, broad, 220-240 \( \mu \) (some only 133 \( \mu \)).
Plate V, figures 1–7.

Hab. On rocks.

Distrib. Pangi, Kilar-Sach Road; Dalhousie; Mussoorie.

19. Madotheca campylophylla L. et L.


Jungermannia neckeroides Griff., Notulae 1849 c. icona.

Large, brownish green, stem shortly pinnate. Leaves distant or slightly imbricate, horizontal, oblong or ovate-oblong, up to 2·25 mm. × 1·50 mm., base broad, antical basal portion entire, rounded, covering the stem, anterior margin entire, convex, posterior slightly twisted, lower part concave, apex usually acute or long acuminate, subapical portion with several coarse teeth. Upper cells 18–27 μ, basal cells 72 μ × 30 μ; walls thin in the upper part. thick in the lower part, trigones conspicuous in the lower part. Lobule ligulate, up to 0·50 mm. long and 0·25 mm. broad, usually smaller, outer base entire, inner base decurrent, margin entire, apex rounded or obtuse. Amphigastria slightly larger than the lobules, ovate, ovate-oblong or subquadrate, unequally decurrent on both sides of the base; margin entire, apex reflexed, acute, truncate, retuse or pluridentate. Bracts about half the size of the leaves, lanceolate, entire or subapically dentate, obtuse or acute; lobule broadly ligulate, almost entire, obtuse or truncate. Bracteoles oblong, almost entire, blunt, unequally bilobed, one lobe often obsolete, the other lobe acuminate.

Plate V, figures 8–11.

Hab. On rocks.

Distrib. Mussoorie, 6–7,000 ft. (Duthie, 1895); Kurseong (Sikkim) 5,000 ft. (Breteaudc, 1894) (Herb. F.R.I., Dehra Dun); Garhwal, Kauria, 7,000 ft.

20. Madotheca Gollani St.


Large, deep green, on rocks or bark. Stem up to 10 cm. long, irregularly pinnate, long branches mixed with short branches and
bi- or even tri-pinnate. Leaves slightly imbricate, horizontal, ovate-oblong to lanceolate, up to 2.50 mm. x 1.25 mm., inserted by a narrow base, antical basal portion entire, rounded, covering and often slightly crossing the stem, postical not de-current, anterior margin convex, posterior twisted, concave in the lower part and bent upwards in the upper part, margins entire throughout the greater part, subapical portion usually coarsely toothed, apex usually with a long spine, often only acute. Upper cells 20 μ, walls and trigones equally thickened; basal cells 47–53 μ x 29–33 μ, walls slightly thickened, trigones large, prominent. Lobule narrow, oblong-ligulate to linear, 0.75 mm. long and 0.25 mm. broad, inner base decurrent on the stem, margin entire, apex rounded, truncate or bidentate. Amphigastria about the same size as the lobules, ovate or subrectangular, base slightly decurrent on both sides, margins entire, apex truncate or bidentate. Bracts like the leaves but much smaller, long acuminate, coarsely toothed to lacerate in the upper part; lobule also coarsely toothed to lacerate at the apex. Bracteoles large, broadly ovate, more or less entire.

Plate VI, figures 1–5.

Hab. On rocks and bark.
Distrib. Garhwal, above Kauria, 7,000 ft., Mussoorie; Dalhousie-Khajiar Road.

Note.—Resembles M. appendiculata. It can be distinguished by the posterior twisted margin of the leaf. In the other species the margin is simply convex. Moreover the lobule in M. appendiculata is appendaged on both sides.

The specimens from Dalhousie-Khajiar Road have more numerous and coarser teeth in the upper part of the leaf. Even the lower part of the anterior margin has a few teeth. Some plants show a peculiarity in that their basal branches have absolutely entire suborbicular leaves which gradually become longer and the teeth also become gradually coarser in the upper part.


Light green. Stem about 6 cm. long, shortly and irregularly pinnate, some pinnae 1-2 cm. long, others longer and again pinnate. Leaves more or less imbricate, almost horizontal, ovate-oblong, up to 1.25 mm. x 0.75 mm., base narrow, antical basal portion entire, rounded, covering but not crossing the stem, anterior margin convex, posterior twisted, entire or with a few teeth, apex generally acute, rarely obtuse, occasionally with two or more teeth. Upper cells 20 μ, basal cells (only a few of the largest cells) 48-52 μ x 20-26 μ; walls thin, trigones acute, conspicuous. Lobule small, ovate to ovate-oblong, up to 0.3 mm. long and 0.2 mm. broad, inner base auriculate, margin entire, apex obtuse. Amphigastria slightly larger than the lobules, ovate-oblong, base broad, margin entire, apex truncate or retuse bilobed. Bracts smaller than the leaves, ovate to ovate-lanceolate, acute or acuminate, lobules and amphigastria (bracteoles) similar but smaller.

Plate VI, figures 6-10.

Hab. Terrrestrial or epiphytic.

Distrib. Mussoorie; Dalhousie; Chamba, 4,000 ft.

Note.—There is a specimen of this species at the herbarium of the Forest Research Institute, Dehra Dun, labelled M. plumosa Mitt. and determined by Stephani. The description given in Stephani, Sp. Hep., Vol. IV, p. 308, however, differs in several respects from the above description which has been drawn up from the Dehra Dun specimens and other plants from our own Himalayan collection.


Light green, on rocks. Stem about 5 cm. long, 2-3-pinnate, pinnae long. Leaves slightly imbricate, horizontal, ovate to oblong, up to 2.0 mm. x 1.25 mm., base narrow; antical basal portion entire, rounded, covering but not crossing the stem, postical decurrent, margins wavy, antical margin convex, posterior twisted, lower part concave, incurved, apex and the upper portion of the margins with several long or short spreading teeth. Upper cells 27 μ, basal up to 50-55 μ x 27-40 μ; walls thin and narrow, trigones large. Lobule linear-oblong, 1.0 mm. long and 0.25 mm.
broad, inner base longly decurrent on the stem, margin and apex irregularly toothed, rarely entire. Amphigastria a little broader, ovate-oblong, unequally and longly decurrent on both sides of the base, margin and apex irregularly and coarsely toothed. Female shoots (only young seen) substipitate. Bracts like the leaves; bracteoles like the amphigastria but much smaller.

Plate VII, figures 1–4.

Hab. On rocks.
Distrib. Dalhousie–Khajiar Road, 6-7,000 ft.


Brownish green, dense, depresso-cæspitose, on rocks. Stem about 6 cm. long, rigid, dark brown, bi- to tri-pinnate. Leaves imbricate, patent-divergent to horizontal, oblique, ovate, 2-0 mm. × 1.25 mm., base narrow, antical basal portion decurrent, covering but scarcely crossing the stem, postical decurrent, margins entire, crisped, anterior slightly convex, posterior straight when flattened, apex usually acute, rarely bidendate or obtuse. Upper cells 24-30 μ, basal cells up to 60 μ × 27 μ; walls rather thickened, trigones small in the upper part, larger in the basal part. Lobule linear, 0.50 mm. long and 0.13 mm. broad, falcate, inner base appendaged, appendage free, margins generally entire, apex broad. Amphigastria a little broader than the stem, ovate oblong, base auriculate on both sides, margins entire, apex obtuse, acute or truncate. Female shoot (only young ones seen) on a short stalk. Bracts like the leaves but much smaller; bracteoles narrower than the amphigastria.

Plate VII, figures 5–9.

Hab. On rocks.
Distrib. Mussoorie; Chamba, 4,000 ft.

Note.—The plants described above are very near M. acutifolia L. et L.

Specimens from Chamba show some difference from the description given above. The leaves usually possess several coarse teeth below the apex and the anterior margin of the leaf has a few faint irregular teeth. The female branch is quite sessile and the bracts are narrower and longer.

Brownish green. Stem about 5 cm. long, pinnate, pinnae sometimes again bearing pinnules. Leaves slightly imbricate, horizontal, ovate to ovate-oblong, 1.5 mm. × 1.00 mm., antical basal portion entire, rounded, ampliate, covering and crossing the stem, postical basal portion decurrent along the stem, anterior margin convex, posterior straight, apex usually rounded. Upper cells 18–22 μ, basal cells up to 45 μ × 27 μ; walls rather thick, trigones not conspicuous in the apical region, distinct, sometimes nodulose in the basal portion. Lobule small, distant, triangular-ligulate to sagittate, 0.55 mm. long and 0.25 mm. broad at the base and 0.11 mm. in the upper part, base auriculate, on the inner side with a large rounded auricle, often with a tooth-like appendage on the outer side also, margins entire, apex obtuse. Amphigastria distant, oblong-ligulate to quadrate, ordinarily up to 0.5 mm. long and 0.35 mm. broad at the base, 0.18 mm. at the apex, base hardly decurrent, slightly auriculate on each side, margin entire, apex usually truncate, occasionally rounded, obtuse, rarely retuse; sometimes on the same branch much larger (about three times as long and three times as broad as the other amphigastria), margin entire, apex entire or toothed. Female shoot with a short leafless stalk. Bracts (only young specimens seen) a little smaller than the leaves, unequal, ovate, entire, or with a few inconspicuous teeth here and there in the upper part; lobule ovate-ligulate. Bracteole large, quadrate, apex broad, faintly toothed.

Plate VIII, figures 1–5.
Hab. On rocks.
Distrib. **Mussoorie**.

*Note.*—The plant resembles *M. Porella* (Dicks.) Nees closely but differs from that in exhibiting a great variability. The leaf apex is rounded or has one or two teeth. The lobule has an auriculate base. The amphigastria are often very large and then generally toothed at the apex and sometimes even at the base. The trigones may be inconspicuous or well-marked and nodulose.
25. **Madotheca platyphylla** (L.) Dum.


Green, on rocks and bark. Stem up to 10 cm. long, closely and regularly bipinnate, lower pinnæ short, upper long, patent (in specimens from Lahul). Leaves closely imbricate, patent-divergent, slightly convex, oblique, ovate-cordate, up to 2·25 mm. × 1·55 mm., fixed by a deep base, antical basal portion rounded, covering and slightly crossing the stem, decurrent, wing triangular, acute, margin crisped, directed upwards, postical basal portion crisped, ampliate to auriculate, margin entire, apex incurved, obtuse or rounded. Upper cells 20–32 μ, basal cells slightly larger, some up to 45 μ × 32 μ; walls and trigones equally thickened. Lobule ovate, up to 1 mm. long and 0·50 mm. broad at the base, inner base longly decurrent on the stem, outer base appendaged, margins entire, sometimes revolute (in young branches), apex obtuse or rounded. Amphigastria lunate, inserted by a deep notch, longly decurrent on both sides, margin entire, apex rounded, revolute. Andraecia spicate, elliptic to oblong, bracts 4–6 pairs, closely imbricate. Involucral bracts appressed, smaller than the leaves, margins toothed or entire, apex acute; lobule broadly lanceolate. Bracteoles appressed, broadly ovate, as large as the bracts, margin entire, apex narrowed, recurved, obtuse. Perianth pyriform, mouth truncate, more or less coarsely dentate. Capsule large, globose. Spores golden-yellow, 40 μ. Elaters closely bispiral, 200 μ.

Plate VIII, figures 6–10.

Hab. On rocks and bark.

Distrib. Kagan Valley (Inayat, 1896); Liddar Valley (Kashmir), 6-7,000 ft. and 10,000 ft. (Duthie, 1893); Gulmarg (Kashmir), 8-9,000 ft. (Duthie, 1893) (Herb., F.R.I., Dehra Dun); Ravi Valley; Lahul.

26. **Madotheca decurrens** St.


Light green, on rocks. Stem about 6 cm. long, bipinnate, pinnæ close. Leaves imbricate, horizontal, oblique, broadly ovate,
2.0 mm. × 1.5 mm.; base small, antical basal portion covering the stem and crossing far beyond it, decurrent, margins entire, apex rounded, margins and apex recurved. Upper cells 20 μ, walls slightly thickened, trigones small; basal cells 36–48 μ × 28–35 μ, walls slightly thickened, trigones acute. Lobule oblong, 0.75 mm. long and 0.25–0.50 mm. broad, inner base longly decurrent on the stem, external base with a rounded auricle, margin revolute, apex recurved, rounded. Amphigastria suborbicular-quadrate, 0.75 mm. × 0.75 mm., base longly decurrent on both sides, margins crisped, incurved, apex crisped, recurved, truncate or rounded. Andræcia spicate, oblong, bracts about 5 pairs. Rest not seen.

Plate IX, figures 1–4.

Hab. On rocks.

Distrib. Decota (Tehri. State), 8,000 ft. (Gamble, 1892); Kagan Valley (Inayat, 1896) (Herb., F.R.I., Dehra Dun); Western Himalayas locality not noted; Mussoorie; Bhagirathi Valley, above Bhatwari, 4,900 feet.

Note.—The Kagan specimens are more green. The plants are a little larger and so are the leaves (antical lobe). The leaves are not recurved. The lobule is smaller. The lobules and amphigastria are not so strongly overlapping as in the Tehri specimens.

This species resembles M. platyphylla very greatly. It can, however, be distinguished by the following characters:—Leaves horizontal, lobe very broadly ovate, the antical basal portion being much larger, lobule broader and oblong, and the amphigastria longer with strongly crisped margins and apex.

27. Madotheca Gamleana St.


Green, stem 6 cm. or more, rigid, brownish green, densely bi- to tri-pinnate, primary pinnae 3–5 cm. long. Leaves imbricate, patent-divergent, oblique-ovate, 1.5 mm. × 1.0 mm., margins undulate, antical basal portion covering and crossing the stem, rounded, decurrent on the stem, postical base much twisted, lower half of the margin curved inwards and very concave in situ, apex
rounded or obtuse. Upper cells 18–20 \( \mu \), walls and trigones equally thickened; basal cells 44–48 \( \mu \times 32–36 \mu \), trigones rather large. Lobule oblong, about 0.5 mm. long and 0.25 mm. broad, inner base appendaged, appendage long linear, undulate, margins revolute, apex obtuse or rounded. Amphigastria oblong, base unequally longly decurrent on both sides, margin crisp, apex revolute, truncate, notch obtuse or acute. Androcia spicate, oblong, bracts about 6 pairs. Involucral bracts appressed, as large as the leaves and similar, margin entire or toothed, apex obtuse or acute; lobule long, upper part and apex denticulate. Bracteoles appressed, ovate-oblong, upper part of the margin faintly toothed or entire, apex broad. Perianth compressed, suborbicular. Spores brown, punctate-muriculate, with a broad wing, 40 \( \mu \). Elaters concolorous, laxly bispiral, 340 \( \mu \), some smaller (120 \( \mu \)) with close spirals. Some elaters branched.

Plate IX, figures 5–9.

Hab. On bark of trees.

Distrib. Tehri Garhwal, 4,000 ft. (Gamble, 1835) (Herb., F.R.I., Dehra Dun); Kulu Valley, 6,000 ft.; Ravi Valley, 6,000 ft.; Pangi; Kumaon; Bhagirathi Valley, Bhatwari, 4,900 ft.

Note.—Some short elaters, 80–120 \( \mu \), are always fixed to the base and apex of the capsule.

28. **Madotheca macroloba** St.


Brownish green, dense depresso-caespitose. Stem about 8 cm. long, pinnate and irregularly bipinnate. Leaves imbricate, patent-divergent to horizontal, oblique, broadly ovate to subrotund, 2.25 mm. \( \times \) 1.5 mm., attached by a broad base (as broad as the stem), antical basal portion entire, rounded, covering and slightly crossing the stem, postical slightly or not at all decurrent, margins entire, apex rounded, slightly recurved. Upper cells 18–20 \( \mu \), basal cells 40–45 \( \mu \times 25–30 \mu \); walls thin, trigones large. Lobule large, broadly ovate, 1.5 mm. long and 1.25 mm. broad, outer base entire, inner base appendaged, appendage decurrent along the stem,
margins entire, apex rounded or obtuse. Amphigastria orbicular, 0.75 mm. long (including the decurrent portion) and 1.0 mm. broad, inserted by a broad base, longly decurrent on both sides, margins incurved, apex rounded, incurved.

Plate IX, figures 10–13.

Hab. On rocks and trees.

Distrib. Kumaon; Garhwal; Pangi; Kulu Valley; Chamba; Barnaur Road; Alwas, 6,000 ft.

29. Madotheca gracillima Mitt.


Green. Stem about 6 cm. long, irregularly bipinnate. Leaves closely imbricate, horizontal, apex strongly decurved, broad, rounded, ovate-oblong to oblong, up to 1.5 mm. × 1.0 mm., fixed by a broad base, antical base entire, rounded, covering the stem and crossing it, postical slightly decurrent, margins entire or posterior margin with a tooth near the base. Upper cells 12–18 μ, median cells 16–20 μ, basal cells 24–32 μ × 16–20 μ; walls uniformly thick, trigones not distinct. Lobule oblong-ligulate, 0.75 mm. long and 0.25 mm. broad, slightly decurrent on the inner side, more or less toothed, outer base appendaged with one or a few coarse teeth, margins more or less recurved, entire, apex obtuse. Amphigastria quadrate-oblong, up to 0.6 mm. × 0.5 mm., base decurrent on both sides, margin especially its lower portion generally coarsely denticulate, apex strongly recurved, rounded.

Plate X, figures 1–5.

Hab. On rocks, on soil, or on bark.

Distrib. Moral (beyond Simla), 12,500 ft. (Brown, 1888) Mundali (Jaunsar), 8,000 ft. (Gamble, 1892); Kagan Valley, 14,400 ft. (Inayat, 1896) (Herb., F.R.I., Dehra Dun); Dalhousie; Pangi; Kumaon; Mussoorie.

Note.—In the specimens from Dalhousie the upper cells are rather smaller and some of the basal cells a little longer.
30. **Madotheca obtusifolia** Sp. Nov.

Sterile, green, brown in older parts, among and on mosses. Stem about 4 cm. long, bipinnate. Leaves horizontal, ovate to ovate-oblong, up to 1.75 mm. long and 1.25 mm. broad, base narrow, antical basal portion entire, rounded, covering and often slightly crossing the stem, margins entire, apex rounded, recurved. Upper and median cells 12–18 μ, walls slightly thickened, trigones indistinct; basal cells 24–36 μ × 18–24 μ, walls thick, trigones distinct. Lobule oblong-ovate, 0.50 mm. long and 0.25 mm. broad, outer base with or without a small appendage, inner base slightly decurrent on the stem, margins entire, apex obtuse or rounded. Amphigastria quadrate to quadrate-oblong, base decurrent on both sides, margin entire, apex rounded; often, however, with one or two teeth on each side just above the base.

Plate X, figures 6–10.

Hab. On rocks.
Distrib. Kashmir; Garhwal, above Kauria, 7,000 ft.

*Note.*—The plant differs from *M. gracillima* St. in nearly always having entire lobes, lobules and amphigastria, and is near *M. angusta* St.

The following species of *Madotheca* have been described by Stephani but have not been seen by us.

31. **Madotheca angusta** St.


Sterile, medium, light green, flaccid. Stem up to 5 cm. long, dark brown, weak, irregularly remotely bipinnate. Leaves contiguous, strongly spreading, broadly ovate, apex decurved, entire, dorsal covering the stem (1.8 mm. long and 1.2 mm. broad). Upper cells 18 μ, basal 27 μ × 18 μ, trigones small. Lobule oblique, spreading, base plano-appressed, oblong-triangulate, 1.2 mm. long, base 0.8 mm. broad, acute or obtuse, entire or external base hastate-spinose. Amphigastria remote, appressed to the stem, narrowly ovate, twice as broad as the stem, entire, decurrent on one side, the decurrent portion shortly crispatelaciniate.

Hab. Himalaya.
Note.—Stephani in a note to this species says that this plant has been wrongly identified by Mitten as *M. laevigata* Dum.


In Himalayæ et Tibetæ occidentalis reg. temp., Kashmir, alt. 6,000 ped., T.T. (No. 1564); Nubra, alt. 11,000 ped., T.T. (No. 1571); Simla, 7,000, T.T. (No. 1569); Kumaon, *Strachey et Winterbottom*.

32. *Madotheca hastata* St.


Sterile, large, robust but also flaccid, brown turning green towards the apex. Stem up to 8 cm. long, irregularly densely pinnate, pinnae contiguous, long and short, obliquely spreading, sparsely pinnulate. Leaves slightly imbricate, strongly spreading, strongly concave, broadly ovate (2·6 mm. long, base 2·2 mm. broad), entire, margin frequently irregularly incurved, subcrispate, antical basal portion transversely inserted, covering the stem. Upper cells 27 μ × 18 μ, trigones large, subnodulose; basal cells 45 μ × 27 μ, trigones narrow. Lobule small, ovate, apex obtuse, external margin strongly incurved, internal angle of the base with a long appendage, appendage hardly smaller than the lobule, decurrent on the stem, linear, margin crisped. Amphigastria as broad as the thickness of the stem or less, subquadrate, apex truncate, entire, margins recurved, nude or pauci-dentate, base hastate-spinous, longly decurrent, wing linear, nude or sparsely toothed.

Hab. Himalaya (*Mussoorie*).

33. *Madotheca ovalis* G. Ms.


Dioecious. pale yellow, delicate. Stem thin, deep brown. Leaves imbricate, strongly spreading, apex decurved, broadly ligulate (2·4 mm. × 1·6 mm.), apex broadly truncate, rotundate, inserted by a small base, antical basal portion strongly ampliate, broadly covering the stem, entire. Upper cells 18 μ, median 27 μ, basal
36 $\mu \times 27 \mu$, trigones small. Lobule obliquely spreading, ovate acuminate, acute, external base ampliate, rounded, entire. Amphigastria twice as broad as the stem, ligulate, twice as long as broad, apex broadly rotundate, base unequally decurrent, wings narrow, entire. Bracts intimate, as long as the leaves, ovate-elliptic, apex acuminate, acute, base strongly narrowed, inserted by a narrow base, antical margin strongly dentate, the rest entire; lobule about half the size of the bract, obovate, coarsely dentate, mostly free. Bracteoles intimate, obovate, above the middle remotely dentate.

Hab. Himalaya et Tibetia occidentali temperata. Simla, 7-8,000 ped., T.T. (Nos. 1562, 1568); Nubra, alt. 11,000 ped., T.T. (No. 1572).

34. Madotheca trigonifolia St.


Dicocious, medium, brown, flaccid, on rocks, dense depresso-cespitose. Stem up to 5 cm. long, thin, brown, weak, regularly remotely pinnate, pinnae 5 mm. long, obliquely spreading, simple, rarely pinnulate, pinnules small. Leaves strongly imbricate, highly decurved, strongly spreading, broadly rotundate (3–6 mm. long and broad), apex broadly triangular, obtuse, inserted by a narrow base, above the base on both sides pauci-dentate, teeth remote, small, strong. Upper cells 27 $\mu$, basal cells 36 $\mu \times 27 \mu$, trigones large, acuminate. Lobule narrow, upper half triangular repand, apex obtuse, base decurrent on both sides, wings broadly linear, unequal, external wing entire, internal wing regularly dentate. Amphigastria suborbicular, inserted by a sinus, longly decurrent on one side, wing narrow, lanceolate, acuminate, as long as the amphigastrium, margin repando-dentate or ciliate. Involucral bracts as long as the leaves, oblong, broadly acuminate, acute, dorsal base strongly obtusely dentate; lobule small, ovate-oblong, free for a long distance, entire, apex subacute. Bracteoles intimate, suborbicular, densely and regularly denticulate. Perianth cupulate, mouth broadly truncate, strongly lobed, lobes triangular, acuminate, entire.

Hab. Himalaya (Kashmir, Liddar Valley).
35. Madotheca virens St.


Sterile, small, green, flaccid, dense-caespitose. Stem up to 5 cm. long, deep green, weak, densely pinnate, pinnae up to 15 mm. long, lower pauci-bipinnate. Leaves imbricate, strongly decurved, ovate (2·8 mm. long, middle 2·4 mm. broad), inserted by a narrow base, antical base armed with large teeth, the rest entire. Upper cells 18 μ, median 27 μ, basal 27 μ x 18 μ, trigones absent. Lobule distinctly coalesced with the leaf, carina arcuate, canaliculate concave, ovate, subacute, margin repand, internal basal angle longly appendiculate, appendage slightly decurrent, long attenuate, denticulate. Amphigastria broadly triangular, obtuse or truncate, decurrent on both sides, wing unequal, in some short entire, in others shortly decurrent sublobate.

Hab. Himalaya (Kagan).

36. Madotheca densiramea St.


Diecious, small, yellowish green, flaccid. Stem up to 5 cm. long, regularly pinnate, pinnae approximate, long, some pinnulate. Leaves imbricate, delicate, rather spreading, convex, some crisped, broadly ovate (2·4 mm. long, middle 2 mm. broad), asymmetrical, apex obtuse, inserted by a small base, and on both sides cordate-rotundate, antical margin strongly arcuate. Upper cells 27 μ, median and basal cells 30 μ x 27 μ, trigones everywhere large, acute. Lobule very concave, ovate-oblong, on both sides longly and narrowly decurrent, apex shortly acuminate, obtuse, entire. Amphigastria rectangular [10·8 mm. broad (1·08 ?) and 1·2 mm. long], apex truncate-rounded, base briefly decurrent on both sides, entire. Andrecia few, shortly spicate, bracts four pairs.

Hab. Himalaya (Chamba).

37. Madotheca densifolia St.

Sterile, large, very robust, light or deep green, mixed with mosses, on bark. Stem up to 8 cm. long, thick and hard, irregularly pinnate. Leaves imbricate, strongly spreading, plano-distichous, ovate-oblong (3.2 mm. long, base 2 mm. broad) asymmetrical, postical margin entire, antical covering the stem, arcuate, apex narrow acute or acuminate, occasionally oblique truncate-tridentate. Upper cells 18 μ, trigones absent, median 27 μ × 18 μ, trigones small, basal scarcely larger, trigones large. Lobule large, ovate-oblong or ligulate, apex rounded, base on both sides appendiculate, external appendage rounded, entire, internal covering the stem, long ligulate, apex plurilobate, crisped. Amphigastria ovate-triangular, apex obtuse, base on both sides narrowly decurrent, wing inciso-lobate, margin crisped.

Hab. Himalaya (Kumaon).

The following species of *Madotheca* has been described by Gola but we have not seen this.


Dioecious, medium, lower dark green, upper light green or olive green, flaccid, caespitose. Stem up to 5 cm. long, weak, irregularly bipinnate, the branches occasionally flagelliferous. Leaves strongly contiguous, imbricate, obliquely spreading, sub-symmetrical (2 mm. long and in the middle 2 mm. broad), strongly decurved, broadly ovate trigonous, apex rotundate-obtuse, entire, inserted by a narrow subcordate base, antical base shortly appendaged, appendage ovate, acuminate, margins everywhere entire or the antical margin at the base angulate or 1-2-denticulate. Upper cells 23 μ, median 30 μ, basal 25 μ × 18 μ, walls thick, trigones minute. Lobule small, ligulate, canalicate, entire, slightly appendaged. Amphigastria twice as broad as the stem, semi-circular, apex strongly decurved, broadly rotundate, entire, on both sides longly and broadly decurrent. Bracts closely appressed to the perianth, as large as the leaves, much smaller than the perianth, entire. Bracteole broadly ovate, entire. Perianth compresso-campanulate,
mouth narrow, truncato-lobate, lobes ciliolate. Male plants delicate. Androecia small, subglobose, bracts about three pairs.

Hab. Kashmir, Sind Valley.

Note.—Gola says in a note that the plant is allied to *M. decurrens* St. from which it differs in the position of the leaves which are oblique and not patent, the dimensions of the cells of the leaf, and the form of the lobule and its small appendages. It differs from *M. ovalis* Gott. in the form of the leaf, the lobule, and the bracts being not toothed. Similarly from *M. densiramea* St. it is quite distinct specially in the position of the leaves.

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**Family III. PLEUROZIACEÆ.**


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**Pleurozia** Dum.

*Pleurozia* Dum., Rec. d'obs., p. 15 (1835).

Characters same as those of the family. Not represented by any species in this area.

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**Family IV. RADULACEÆ.**

Plants generally of medium size, closely attached to the substratum. Stems laxly pinnate or bipinnate. Leaves incubous,
complicate-bilobed, the postical lobe (lobule) smaller with its free margin generally appressed to the underside of the antical lobe; rhizoids arising from the under surface of the lobule. Amphigastria absent. Androecia terminal, bracts with 1 or 2, rarely 3, antheridia. Archegonial cluster generally terminal on the main stem, frequently with 1-2 sub-involucral innovations. Perianth usually strongly dorsi-ventrally compressed, rarely subterete, very rarely plicate, the mouth wide, truncate, bilabiate. Capsule shortly and stoutly pedicelled, generally oval-cylindrical, 4-valved to the base, the wall of two layers of cells. Only genus Radula.

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IV. RADULA Dum.


Stephanina O. Kuntze, Rev. Gen. Pl., p. 839 (1891); Schiffn. in Engl. und Prantl, Nat. Pflanz. 13, p. 113 (1895).

Characters same as those of the family.

Note.—There is no difficulty in recognising this genus, because of its peculiar yellowish green colour, quadrate lobule, the absence of amphigastria, and the rhizoids arising from a mammillate protuberance of the lobule.

39. Radula complanata (L.) Dum.


In thin, pale yellowish green or whitish green patches, closely attached on rocks or bark of trees, usually mixed with Mosses and other Liverworts. Stem up to 2 cm. long, laxly and irregularly pinnate, or even bipinnate. Leaves imbricate, inserted by a broad base, strongly spreading, quadrate to suborbicular, up to 0·75 mm. × 0·5 mm., antical basal portion rounded, not or very slightly crossing over the stem, margins entire, apex rounded. Cells mostly alike, 18–24 μ, walls and angles thin. Lobule half as long as the
lobe, closely appressed to the lobe and the stem, quadrate, not
crossing the stem, the angle acute or obtuse. Bracts like the leaves.
Perianth tubular, dorsi-ventrally compressed, mouth bilabiate,
entire. Gemmae marginal, multicellular.

Plate XI, figures 1–4.

Hab. Rocks and trees.

Distrib. Widely distributed. Patni pass, Jummu; Alvars-
Silrundi Road, Silrundi, 8–10,000 ft.; Pangi
Road; Khajiar; Dalhousie (very common);
Simla; Garhwal, Mussoorie; Kumaon; Sikkim;
Kotagiri, 7,000 ft. (Sedgwick, 1916).

The following species of Radula have been described by
Stephani but have not been seen by us.

40. **Radula grandifolia** St.


Sterile, large, pale green, rigid, on bark, mixed with mosses.
Stem up to 3 cm. long, shortly remotely pinnate, pinnae with small
leaves. Leaves large, imbricate, strongly spreading, concave,
apex strongly decurved, broadly ovate. 2·4 mm. long, middle 1·8
mm. broad, apex rounded, base to about the middle accrete, upper
half free, ampliate, covering the stem. Marginal cells 13 μ, upper
cells 18 μ, basal 27 μ, trigones absent. Lobule large, subrectang-
ular (1 mm. long and 0·8 mm. broad), apex strongly truncate, angle
acute, base long accrete (about ⅔), upper quarter free, shortly
ampliate, slightly covering the stem, carina somewhat spreading,
substrict, the angle excurrent from the leaf margin.

Hab. Himalaya (_Simla_).

41. **Radula Douleana** St.


Sterile, medium, flaccid, light green, on bark. Stem about
3 cm. long, regularly densely pinnate, pinnae small. Leaves im-
bricate, strongly spreading, concave, apex decurved, broadly
elliptic, dorsal and apical part equally broad, truncate-rotundate
and up to ⅔ accrete with the stem, upper ⅔ free, covering the stem,
1.46 mm. long and 1.06 mm. broad. Upper cells 15 μ, median cells 18 μ, basal 27 μ × 18 μ, trigones usually small. Lobule large, sub-quadrate, 0.65 mm. long and broad, apex rather strongly truncate, angle subacute, base up to ½ accrete, upper ½ ampliate, covering the stem, carina strongly sinuate, longly decurrent, excurrent from the leaf margin.

Hab. Himalaya, Simla, 7,000 ft.

Gola (Atti Della R. Accad. Delle Sci. Di Torino, Vol. XLIX, 1914), has reported *Radula Lindembergiana* G. from Kashmir, but we have not seen any specimens of this species. Stephani has described the same plant as *Radula Lindbergii* G. in Species Hepaticarum but he does not mention any part of India under its distribution. The following description is after Stephani.

### 42. Radula Lindbergii G.

*Radula Lindbergii* G., in Jack Flora, 1881.

Dicæious, medium, green or yellowish green, on bark or rocks. Stem up to 3 cm. long, primary branches few, densely and shortly pinnate. Leaves more or less erecto-patent, plano-distichous or slightly concave, apex decurved, broadly elliptic, 1.46 mm. long and middle 0.93 mm. broad, apex rounded, lower half of the base united with the stem, upper half free, ampliate, crossing the stem. Upper cells 18 μ, basal 27 μ × 18 μ, walls thin. Lobule subrectangular, 0.65 mm. long and middle 0.53 mm. broad, apex strongly truncate, angle obtuse and prominent, lower half of the base united with the stem, upper half free, slightly ampliate, slightly crossing the stem. Carina almost straight, obliquely spreading. Perianth unilaterally innovating, oblong, 3 mm. long, mouth entire. Bracts as long as the leaves, falcate, spathulate; lobule similar but smaller. Andræcia numerous on slender plants, terminal on branches, bracts about 10 pairs, highly saccate, upper conduplicate, bilobed, lobes rounded, postical smaller.

Hab. Kashmir.
Family V. Scapaniaceæ.


Key to the genera.

Mouth of the perianth contracted . . . . . . Diplophyllum
Mouth not contracted, wide . . . . . . . . . . . . Scapania

* * * * *

V. Diplophyllum Dum.


Plants small or medium. Stems arising from a creeping rhizome, branches few, lateral. Leaves semi-amplexicaul, distichous, more or less deeply complicate-bilobed, keeled, antical lobe smaller than the postical lobe. Amphigastria absent. Androceia terminal or intercalary, base of the bract saccate, inflated, bracts mon-androus, rarely bi- or tri-androus. Involucral bracts usually in three pairs, similar to the leaves, large. Perianth ovate, inflated, pluripllicate, mouth contracted, armed. Capsule longly pedicellate, 4-valved, wall of many layers of cells, cells of the innermost layer with semi-annular bands. Gemmæ often present on tips of the leaves.

43. Diplophyllum orientale St.


Dicæious, small, dense depresso-caespitose. Stem up to 3 cm. long, brown, simple or sparsely branched. Rhizoids numerous, from the ventral side of the stem. Leaves small below gradually becoming larger, imbricate, patent-divergent; antical lobe ovate to
reniform, broader than long, 1·25 mm. \times 1·0 mm., inserted by a broad base, free margin longly decurrent, crossing the stem, basal portion of the margin entire, rest usually regularly armed with 1-2-celled teeth or with a few teeth or entire, apex acute, occasionally entire, rounded; carina (commisure) not winged, arched; postical lobe quadrate to orbicular-ovate, up to 1·75 mm. \times 1·5 mm., inserted by a deep narrow notch, free margin decurrent, margins remotely and often irregularly toothed, rarely entire, teeth sharp, apex usually with a short tooth. Upper cells 16–20 \( \mu \), basal cells 44–56 \( \mu \times 20–28 \mu \); walls thin, trigones thick. Involucral bracts similar to the leaves. Perianth obovate-oblong, inflated, mouth contracted plicate, ciliate.

Plate XI, figures 5–9.

Hab. On soil.

Distrib. Above Jalla (Ganges Valley), 11,000–12,000 ft., (Duthie, 1881), Herb., F.R.I., Dehra Dun.

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VI. SCAPANIA Dum.


Stems arising from a creeping rhizomatous portion, branches few, lateral. Leaves transversely inserted, distichous, complicate-bilobed, nearly always keeled, the antical lobe smaller than the postical lobe. Amphigastria absent. Andreea spicate, rarely hypogynous, bracts nearly equally bilobed and generally with entire margins, 2-3-androus. Involucral bracts similar to the stem leaves. Perianth terminal, longly exserted, inflated below, dorsi-ventrally compressed above, decurved, mouth wide, truncate, usually dentate. Capsule longly exserted, oval to globose, 4-valved, wall of two layers of cells, cells of the inner layer with semi-annular thickening bands.

Key to the species.

Cuticle smooth or granulose
Cuticle verrucose

\[ \ldots \] \[ \ldots \]

\[ \ldots \] \[ S. purpurea \]
\[ \ldots \] \[ S. verrucosa \]
44. *Scapania verrucosa* Heeg.

*Scapania verrucosa* Heeg., Revue Bryol., 1893, p. 81.

Sterile, small, brownish green to dark brown, laxly caespitose. Stem up to 3 cm. long, deep brown below, light brown above, simple or sparsely branched. Rhizoids fairly numerous, in some plants none. Leaves more or less imbricate, patent, decurved, amplexicaul, antical lobe rhomboid-oblong, up to 1·3 mm. x 1·0 mm., base broad, oblique, non-decurrent, margins with a few or many small unicellular teeth, apex rounded, obtuse or acute; comissure narrow, arched, not winged; postical lobe obliquely elliptic-oblong, up to 2 mm. x 1·25 mm., base narrow, free margin longly decurrent on the stem, margins with numerous small unicellular teeth, apex acute, sometimes rounded. Cells (of the lobule): upper 12-16 μ, walls thick, trigones not conspicuous; median 18 μ, walls thick, trigones well marked; basal up to 36 μ x 18 μ, walls thick, trigones nodulose; cuticle verrucose, the surface appearing to be covered with numerous circles in surface view.

Plate XII, figures 1-7.

Hab. On moist rocks.

Distrib. *Dalhousie*; above *Alwas*, 8,000 ft.

Note.—The size of the leaves is very variable, the figures given in the description apply to the largest leaves.


Dicæious, small, erect, lower half brown or reddish brown, upper half more or less purplish. Stem about 1·5-3 cm. long, simple or sparsely branched. Rhizoids scarce, confined to the base. Leaves increasing in size towards the apex, imbricate, patent, amplexicaul, antical lobe quadrate-oblong to oblong-reniform, up to 1 mm. x 0·70 mm., transversely inserted by a narrow base, widely crossing the stem, free margin longly decurrent, margins entire or with small unicellular teeth, apex rounded, obtuse, or acute; comissure long, arched, not winged; postical lobe up to 1·5 mm. x 1 mm., subrectangular, base narrow, longly decurrent on the stem, margins wavy with numerous short teeth, apex rounded, obtuse or acute. Cells (of the lobule): upper
10–15 $\mu$, walls thickened, trigones somewhat prominent; median 15–20 $\mu$, walls thin, trigones rather thick; basal 36–48 $\mu \times 12–20 \mu$, walls and trigones generally thickened, often the walls thin and the trigones absent; cuticle smooth. Involucral bracts like the leaves but larger. Perianth very broad, subquadrate, highly compressed, mouth wide, margins toothed.

Plate XII, figures 8–13.

Hab. On rocks under snow.

Distrib. Above Silrundi, foot of the Sach Pass, 12,000 ft.

The following species of the genus has been described by Stephani but has not been seen by us.

46. Scapania parva St.


Diocious, small or medium, pale yellowish green or brown, commonly growing mixed with mosses on bark. Stem up to 5 cm. long, thin, brown, rigid, almost simple. Lobe remote, oblique, spreading, more or less decurved, oblong-elliptic, 1.86 mm. long and in the middle 0.93 mm. broad, apex broadly triangular, acute, base shortly decurrent, margin with small unicellular teeth; commissure short, 0.4 mm. long, narrow; lobule subrhombooidal, 1.06 mm. long and 0.8 mm. broad, base longly decurrent, ampliate, crossing well beyond the margin of the lobe, rest similarly toothed, apex truncate, angle acute. Upper cells 13 $\mu$, median 18 $\mu$, trigones absent; basal 36 $\mu \times 15 \mu$, trigones large, attenuated; cuticle coarsely verrucose. Perianth ovate, mouth repando-lobate, denticate.

Hab. Kashmir.

**Family VI. PTILIDIACEÆ.**

Plants of medium size, branched, branches lateral or postical. Leaves incubous or transverse, seldom succubous, bi-multi-fid, frequently ciliate or ending in hair-like points. Amphigastria always present and nearly resembling the leaves in shape and
size. Androecia terminal, spicate, bracts 1–3-androus. Arche-gonia terminal on main stem or lateral branches but never on posti-cal branches, bracts many. Perianth absent or when present 3–10-plicate, contracted or truncate at the mouth, free or adnate to the innermost bracts. Capsule usually shortly pedicellate, ovate with straight valves, or cylindrical with twisted valves.

Key to the genera.
Leaves and amphigastria deeply bilobed, lobes
broad . . . . . . . . Anthelia

Leaves and amphigastria divided almost to the
base into 3–5 uniseriate segments . . Blepharostoma

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VII. ANTHELIA Dum.

Anthelia Dum., Rec. d'obs., p. 18 (1835).


47. Anthelia julacea (L.) Dum.


Anthelia julacea Dum., Rec. d'obs., p. 18 (1835).

 Dioecious, small, in small thick patches, green when fresh and dark brown in the dried condition. Stem up to 1 cm. long, irregularly branched. Rhizoids hyaline, from the under side of the stem throughout its greater part. Leaves usually closely imbricate and appressed, incurved, almost transversely inserted, ovate, up to 0.4 mm. long, 3 subequally bilobed, sinus narrow, acute, lobes spreading, ovate-lanceolate, entire or faintly and
irregularly or more or less strongly toothed, apex acute. Cells squarish, 18-29 μ, those in the middle of the lobe oblong, trigones not distinct. Amphigastria resembling the leaves, equal to or slightly smaller than the leaves. Involutcal bracts and bracteoles much larger than the leaves and amphigastria otherwise similar, margins entire or faintly denticulate. Perianth oblong-ovate, very slightly or rarely fairly exserted beyond the bracts, pluriplicate, mouth narrowed, ½-⅔-lobed, lobes unequal, mostly ovate, entire, acute, some with secondary lobes.

Plate XIII, figures 1-2.

Hab. On rocks.
Distrib. Zanskar, 12,000 ft.; Kulu Valley, Rotang-Koti Road, 11,000 ft.

Note.—Specimens from the Kulu Valley show some synthetic characters. The leaves are described as crenate-dentate in A. Julacea and less dentate or entire in A. Juratzkana but in these specimens entire as well as distinctly toothed leaves occur. Usually the perianth is also intermediate between the two but is more like the latter in not being exserted in many specimens. In a few, however, it is fairly exserted. Unless the present specimens are different from the above two species, the two species are probably not distinct.

VIII. BLEPHAROSTOMA Dum.

Blepharostoma Dum., Rec. d’obs., p. 18 (1835).

Plants small, delicate, frequently mixed with mosses and other liverworts. Stem thin, delicate, sparsely branched. Leaves succulent, more or less remote, almost transversely inserted, divided almost to the base into 2-5 fine segments composed of a single layer of cells throughout. Amphigastria resembling the leaves but slightly smaller. Androecia spicate, terminal on branches, bracts large, complicate-concave, with the segments often fucate, usually mon-androus. Involutcal bracts similar to the leaves, larger, appressed to the perianth, laciniate-furcate or spinous. Perianth oblong to cylindrical, trigonous with the third angle
postical, mouth contracted, ciliate. Capsule oval, 4-valved, wall of two layers of cells, the inner with semi-annular thickenings. Spores narrow, rough. Elaters bispiral.

48. **Blepharostoma trichophyllum** (L.) Dum.


*Blepharostoma trichophyllum* Dum., Rec. d'obs., p. 18 (1835).

Dioecious. In small compact patches or scattered among mosses and other liverworts, green when fresh, dark brown when dry. Stem up to 1 cm. long, ascending or procumbent, sparsely branched. Rhizoids long, hyaline. Leaves small and distant on the lower part of the stem, becoming larger and more imbricate higher up on the stem, divided almost to the base into 3–5 setaceous segments (some segments with small secondary segments near the base) composed of a number of cells arranged in one row. Cells near the base 28–36 μ x 18–25 μ, gradually becoming narrower towards the apex, terminal cells generally small, narrow, with an obtuse apex; walls thickened. Amphigastria similar, often slightly smaller. Involucral bracts larger than the leaves, coalesced with the bracteoles, divided nearly to the base into several branched segments which are 1–3 cells broad at the base, otherwise of one row of cells. Perianth longly exserted, cylindrical-clavate, trigonous, mouth contracted, slightly lobed, lobes ciliate.

Plate XIII, figures 3-4.

Hab. On rocks, soil or wood.

Distrib. *Koksir*, 10,000 ft.; *Silrundi*, 10,000 ft.; *Gurdhar Pass*, 14-15,000 ft.; Kumaon; above *Jalla* (Ganges Valley), 11,000 ft. (Duthie, 1881) (Herb., F.R.I., Dehra Dun).

*p*.—In the specimens from Koksir the leaves are directed forward, closely packed and thus form terminal buds.
Family VII. Cephaloziacae. (Trigonantheæ Spr.).

Plants large or small. Stem prostrate or procumbent, branching generally pinnate, postical flagellae often present. Leaves alternate, rarely opposite, usually incubous, usually lobed or toothed, rarely entire. Amphigastria usually present. Male bracts mon-androus, rarely di-androus. Bracts of the female inflorescence tristichous, in a few distichous. Perianth usually free, somewhat elongated and narrow, trigonous, the third angle postical, rarely (by intercalation of secondary angles) 4-6-gonous. Calyptra free, narrow. Capsule oblong or cylindrical, wall of two layers of cells, in a few genera of four or five layers of cells, valves straight.

Key to the genera.

1. Plants thin, pellucid, amphigastria absent or small
   Cephalozia

2. Plants robust, not thin, amphigastria quite large
   2. Leaves and amphigastria alike, 3-5-lobed
      Lepidozia

3. Amphigastria different from the leaves and smaller
   3. Leaf apex rounded, postical flagellae absent
      Calypogeia

4. Leaf apex usually tri-dentate, postical flagellae present
   Mastigobryum

IX. Lepidozia Dum.


Plants rather large, rarely small, pale or yellowish green to dark green, caespitose, seldom erect. Stems pinnate or bipinnate, the branches lateral, sometimes flagelliferous and rooting at the ends, frequently also with postical flagelliferous small leaved branches. Leaves incubous, generally remote, small, convex,
oblique, usually decurved, palmate or quadrifid, more rarely 2-3 or 5-6-fid, the segments acute and more or less subulate. Amphigastria resemble the leaves, but generally slightly smaller. Androcia on short postical branches, seldom terminal on lateral branches, shortly spicate. Female inflorescence on short ventral branches. Bracts appressed, strongly concave, apex armed. Perianth ovate-subulate or fusiform, obtusely trigonous above with the mouth entire, denticulate or ciliate-laciniate. Capsule oblong-elliptic, 4-valved to the base, wall of two layers of cells, inner layer with semi-annular bands. Spores small, rough. Elaters bispiral.

Gola (Atti Della R. Accad. delle Sci. di Torino, Vol. XLIX, 1914) has reported Lepidozia reptans (L.) Dum. from Kashmir. It has also been reported by Mitten from Sikkim and by Stephani from Himalaya. We have, however, not seen any species of Lepidozia in our collections from the W. Himalayas. The description of this species is given after Stephani.

49. Lepidozia reptans (L.) Dum.


Monœcious, medium, strong, rigid, dense pulvinate, in extended patches. Stem up to 3 cm. long, strong, base flagelliferous, slightly branched, branches dense pinnate, pinnae slightly spreading, small, frequently attenuated and branched. Leaves contiguous, oblique, spreading, decurved, 0.68 mm. long and broad, asymmetrical, 4-lobed, lobes triangle-lanceolate, extended or slightly divergent, base 4-5 cells broad, basal disc oblique truncate, antical 0.53 mm., postical 0.27 mm. high, antical margin gently arcuate, postical straight. Cells 27 μ, in the disc slightly larger, basal few large, 45 μ; cuticle smooth; trigones large. Amphigastria large, subcontiguous, spreading, normally broader than long, up to the middle 4-lobed, lobes triangle, base 4 cells broad, apex obtuse, basal disc obcuneate, narrow. Perianth large, base thick, upper part thin, apex shortly inciso-lobate, lobes truncate, spinulose. Bracts appressed, broadly elliptic, apex 4-toothed, concave, antical base slightly coalesced, postical more or less highly
connate with the bracteole to about the middle. Capsule elliptic, cells of the inner layer with semi-annular bands, external of large quadrate thin cells. Spores 13 μ, rough. Elaters 300 μ, bispiral, spirals loose. Androecia terminal on lateral branches, bracts overlapping, homomalous, concave, bilobed, mon-androus; bracteoles smaller than the bracts.

Hab. On soil.
Distrib. Himalaya, Kashmir, Sikkim.

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X. MASTIGOBRYUM Nees.


Diœcious, mostly robust, caespitose, generally olive green, sometimes yellowish or reddish. Stem rigid, forked, with small-leaved ventral flagellœ arising from the angles of the amphigastria. Leaves incubous, alternate or opposite, dorsally convex, more or less decurved, apex generally tridentate to trilobed, in a few cases entire or bidentate. Cells very unequal. Amphigastria large, in a few species small, free or fused with the leaves, spreading or recurved, apex often dentate, truncate or bilobed. Sexual branches postical, from the axils of the amphigastria. Androecia on short amentiform or capitate branches, bracts 4 to 5 pairs, imbricate, complicate-concave, antheridia in pairs, long-stalked. Involucral bracts and bracteoles subequal to the leaves and amphigastria, in a few pairs, complicate-concave, recurved above, more or less long armed. Perianth fusiform, base many layered, fleshy, apical portion deeply triplicate, odd fold postical, mouth narrow, many-lobed, lobes ciliate or hairy. Capsule longly pedicellate, dehiscing to the base by four valves, wall many-layered, inner layer with semi-annular bands. Spores small. Elaters bispiral.

50. *Mastigobryum triangulare* (Schleicher) St.

Jungermannia triangularis Schleicher, Crypt. exsicc, 1803; Cent. II, No. 61.


Sterile, reddish brown or purplish, medium, caespitose, mixed with other liverworts. Stem up to 3 cm. long, ventral flagellæ long and slender, with numerous minute leaves and many rhizoids. Rhizoids long, in tufts, from the under side of the amphigastria near the base. Leaves almost horizontal, convex above, ovate, up to 1 mm. long and 0.75 mm. broad, obliquely inserted by a broad base, antical basal portion ampliate, rounded, covering and crossing the stem, margin entire, apex decurved, with two or three coarse teeth, acute or rounded. Upper cells 16-20 μ, basal cells 24-30 μ; walls and trigones uniformly thickened. Amphigastria distant, large, quadrate-orbicular, 0.25 mm. broad, entire, slightly notched or bilobed, notch acute, extending to about the middle, lobes again crenate-lobulate, sometimes the whole amphigastrium uniformly lobulate.

Plate XIII, figures 5-9.

Hab. On rocks.

Distrib. Above Jalla (Ganges Valley), 11,000 ft. (Duthie, 1881) (Herb., F.R.I., Dehra Dun).

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XI. CALYPOGEIA Raddi.


Plants small or medium, closely appressed to the bark or rarely terrestrial, normally dense depresso-caespitose, frequently broadly extended, pale or sometimes reddish brown. Stem thick, prostrate or procumbent, simple or with a few branches from the axils of the amphigastria. Rhizoids fasciculate, usually numerous, long, from the bases of the amphigastria. Leaves incubous, alternate, contiguous or imbricate, plane or convex, oblique or patent-divergent, obtuse, acute or shortly bidentate. Amphigastria large, roundish or reniform, frequently inserted by a deeply sinuous base, apex entire or bilobed. Antheridia and archegonia on very short branches from the axils of the amphigastria. Androecia
spicate, bracts in 3-5 pairs, much smaller than the leaves, ventricose, bilobed and with 2 or more teeth at the apices, mon- or diandrous. Involucral bracts in 2 to 3 pairs, much smaller than the leaves, subrotund, oval or lanceolate, entire or 2-4-fid. Perianth absent. Perigynium (marsupium) with rhizoids, fleshy, pendulous, cylindrical, bearing persistent scale-like bracts at the top and with a layer of papilliform cells on the inner surface. Capsule longly pedicellate, cylindrical, 4-valved, the valves erect and spirally twisted, the wall of two layers of cells, the inner layer with semi-annular bands. Spores small, smooth. Elaters bispiral.

51. Calypogeia renistipula St.


Sterile, medium, light green or reddish brown. Stem prostrate, about 2 cm. long, simple or sparingly branched. Rhizoids long, hyaline, few, arising from the bases of the amphigastria. Leaves more or less imbricate, patent, convex above, decurved, ovate, up to 0.75 mm. x 0.5 mm., margins entire, apex rounded or obtuse, rarely bidentate. Cells large and small mixed, upper cells 18-27 μ, basal cells 22-44 μ; walls thickened, trigones distinct, large in the basal region. Amphigastria distant, orbicular to orbicular-reniform, broader than long, up to 0.5 mm. broad, base slightly decurrent, margins entire, apex entire, emarginate, or with a distinct notch, lobes when present obtuse or rounded.

Plate XIII, figures 10-13.

Hab. On rocks.

Distrib. Alwas-Silrundi Road, 8-10,000 ft.

*Note.*—Sometimes the leaves and the amphigastria bear long tail-like processes consisting of bundles of fine fibres arising from the apical cells.

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XII. CEPHALOZIA Dum.

*Cephalozia* Dum., Rec. d'obs., p. 18 (1835).

Plants usually small, pale to dark green or brownish. Stem simple or with a few branches, the branches all postical, flagellæ frequently present. Leaves distant, obliquely inserted, succubous,
flat or somewhat channelled, generally 2-lobed, the margins entire. Amphigastria absent or small. Androecia spicate or amentiform, bracts longer than the leaves, mon-androus. Female inflorescence generally on short branches, occasionally at the apex of the main stem, bracts larger than the leaves, three pairs; bracteoles always present, free or connate only at the base with the bracts. Perianth elongate, tri- or pluri-plicate, in the former case odd angle postical, the mouth contracted, shortly lobed, lobes variously armed. Capsule longly exserted, the wall of two layers of cells, inner layer with semi-annular bands. Pedicel of the capsule usually composed of 8 outer cells and 4 smaller inner cells. Spores small, reddish brown. Elaters short, bispiral.

52. Cephalozia Gollani St.


Monœcious, small, tufted, in light green or reddish patches on rocks. Stem 8–12 mm. long with postical branches and small-leaved flagellæ. Rhizoids long, hyaline. Leaves imbricate, obliquely inserted by a long base, patent, directed upwards, dorsally concave, quadrate-ovate, 0·6 mm. long and 0·6 mm. broad at the base, $\frac{1}{3}$–$\frac{1}{4}$ bilobed, notch obtuse or rounded, broad or narrow, lobes convergent, usually unequal, especially the posterior one, tapering from a broad base, entire, acute. Upper cells 50–68 $\mu \times 36–45$ $\mu$, basal cells 72–79 $\mu \times 50–65$ $\mu$, often the cells polygonal, isodiametric; walls slightly thickened, trigones not at all thickened. Amphigastria absent. Androecia terminal, compact, elliptic, bracts about five pairs. Involucral bracts closely applied to the perianth, three pairs, lowermost small like the leaves, middle ones larger, uppermost much larger than the leaves, outline and lobing like the leaves. Bracteoles: lowermost minute, middle larger and ligulate entire, uppermost very large, deeply bifid like the bract with long lanceolate lobes. Perianth oblong, longly exserted, pluri- or 3-plicate, in the latter case two carinae antical and one postical, $\frac{1}{3}$–$\frac{1}{4}$ lobed, lobes lacinate at the tip.

Plate XIII, figures 14–18.

Hab. On moist rocks.

Distrib. Garhwal.
FAMILY VIII. LOPHOZIACEÆ.  

(EPIGONANTHEÆ SPR.).  

Plants medium or small. Stem irregularly branched, very rarely pinnate, branches almost always lateral. Leaves succubous or transversely inserted, entire or 2-lobed, sometimes 3–5-lobed. Amphigastria generally absent or very small, very rarely large. Inflorescence generally terminal on the main shoots. Male bracts 1–10-androus. Perianth (when present) compressed from the sides, cylindrical, ovate or trigonous with the third angle always antical. Capsule mostly ovate or cylindrical, 4-valved to the base.

**Key to the genera.**

1 {  
   Leaves two- or more-lobed or toothed .. 2  
   Leaves obtuse and entire, neither lobed nor toothed .. 5  
2 {  
   Leaves lobed, not toothed .. 3  
   Leaves not lobed, toothed .. 4  
3 {  
   Leaves almost longitudinally inserted, amphigastria always present .. Lophocolea  
   Leaves obliquely inserted, amphigastria usually absent .. Lophozia  
4 {  
   Amphigastria always absent .. Plagiochila  
   Amphigastria present .. Chiloscyphus  
5 {  
   Amphigastria present, bilobed .. Chiloscyphus  
   Amphigastria absent or small .. Southbya  
6 {  
   Leaves opposite .. Jamesoniella  
   Leaves alternate .. Solenostoma  
7 {  
   Laciniate bracts and bracteoles always present .. Jungermannia  
   Bracteoles usually absent, if present not laciniate .. 8  
8 {  
   Mouth contracted, ciliate ..  
   Mouth not contracted, wide ..  

**XIII. CHILOSCYPHUS Corda.**

Chiloscyphus Corda in Opiz, Beitr. I, p. 651 (1829).

Plants generally green, sometimes brown, laxly cespitose on soil or on bark. Stem irregularly branched, branches lateral.
Rhizoids in tufts from the bases of the amphigastria. Leaves succubous, alternate or opposite, nearly longitudinally inserted, decurrent antically, generally entire though bi- or pluri-dentate in some species. Amphigastria always present, usually bifid and with a tooth on one or both sides. Androecia intercalary on the stem or on long branches, bracts resembling the leaves but saccate with a small incurved lobule at the base of the antical margin. Female inflorescence on very short lateral branches. Bracts in a few pairs, much smaller than the leaves, entire or 2-3-lobed. Perianth campanulate with a wide 3-lobed mouth, the lobes entire or dentate. Capsule longly pedicellate, ovate, wall of several layers of cells, cells of the innermost layer with semi-annular bands. Spores small, brown, smooth or rough. Elaters laxly bispiral.

Key to the species.

1. \{ 
   \{ Amphigastria large, usually entire \} 
   \{ Amphigastria small, bilobed \} 
2. \{ Leaves pluri-dentate \} 
3. \{ Leaves not or slightly imbricate, semi-circular to sub-quadrate \} 
4. \{ Leaves more or less closely imbricate, quadrate to oblong or oval \} 
5. \{ Leaves closely imbricate, quadrate to oblong \} 

C. inflatus
C. argutus
C. polyanthus
C. himalayensis
C. campanulatus

53. Chiloscyphus inflatus St.


Sterile, medium, deep brown, slender, laxly cespitose, mixed with mosses and other liverworts. Stem 2–4 cm. long, simple or sparsely branched. Rhizoids in tufts from the bases of the amphigastria. Leaves secund (all directed upwards), closely imbricate, more or less semi-circular, up to 1.5 mm. x 1–2.5 mm., opposite, inserted by a long straight base, antically decurrent, entire, rounded. Cells circular, median about 30 μ in diameter, some larger, others smaller; trigones acute, prominent, walls rather thick; a few basal cells
elongated, 54 μ x 28 μ. Amphigastria large (smaller than the leaves) fused with the leaves on both sides at the base, appressed, sub- 
orbicular, entire or very shortly bilobed at the apex, lobes small, acute or obtuse, sometimes with a tooth on each side near the 
middle or the lobes and teeth small, obscure, rounded, occasionally 
the amphigastria with several subequal small lobes or coarse teeth.

Plate XIV, figures 1–4.

Hab. On rocks.

Distrib. Chandar Tal, 12,000 ft. (Gamble, 1894); Kidor 
Kanta, 12,000 ft. (Duthie, 1879); Above Jalla 
(Ganges Valley), 11-12,000 ft. (Duthie, 1881) 
(Herb., F.R.I., Dehra Dun); Alwas-Silrundi Road, 
8–10,000 ft.

54. Chiloscyphus argutus Nees.

Chiloscyphus argutus Nees, Syn. Hepat., p. 183 (1844).
Sterile, brownish green, dense depresso-caespitose, mixed with 
other liverworts. Stem 4-5 cm. long, branched. Rhizoids scarce. 
Leaves alternate, plano-distichous or directed upwards a little, 
slightly imbricate, quadrate to rectangular or ovate-quadrate, 
up to 1·75 mm. x 1·5 mm., antical base slightly decurrent, margins 
entire, apex broad with many coarse teeth. Upper cells 15–20 μ 
(mostly 18 μ), basal 40–54 μ x 30–36 μ ; walls and trigones uni-
formly thickened. Amphigastria distant, small, as broad as the 
stem, base broad, hardly decurrent, bifid to about the middle, 
with a rounded sinus, lobes lanceolate, divergent, each usually 
with a tooth on the outer side.

Plate XIV, figures 5–7.

Hab. On rocks or on soil.

Distrib. Churah (Chamba), 4,000 ft.; Western Himalayas.

55. Chiloscyphus himalayensis St.

Monoecious or dioecious, pale green, flaccid, laxly caespitose 
on and among mosses or on moist soil. Stem about 3 cm. long, 
green, delicate, simple or slightly branched. Rhizoids in small
tufts from the bases of the amphigastria. Leaves alternate, closely imbricate, plano-distichous or directed upwards, quadrate to quadrate-oblong or ovate-oblong, up to 1.5 mm. × 1.25 mm. at the base, fixed by a long straight base, antically slightly or not at all decurrent, margins entire, apex rounded, occasionally truncate or with a shallow notch. Upper cells 24–36 µ, basal cells 54–58 µ × 30–45 µ, polygonal; walls slightly thickened, trigones not thickened. Amphigastria small, quadrate to ovate-lanceolate, ¼–½ bifid, lobes divergent from an acute or slightly rounded sinus, lanceolate, acute, often with a tooth on the outer side. Andrœcia terminal or intercalary, 3–9 pairs of bracts similar in shape and size to the leaves, saccate with an incurved lobule at the antical base, bracts mon-androus. Involucral bracts one pair, smaller than the leaves, elliptic-oblong, ¼ bifid, lobes convergent, ovate-lanceolate, acute or acuminate; bracteoles similar, smaller. Perianth ovate-campanulate, mouth wide, bounded by three lobes, lobes broadly triangular, toothed, obtuse. Seta up to 20 mm. long, thin, delicate. Capsule large, deep brown, broadly oval. Spores tetrahedral, smooth, reddish brown, 13 µ. Elaters coloralous, bispiral, about 160 µ long.

Plate XIV, figures 8–14.

Hab. On moist rocks and soil.

Distrib. Mussoorie.

56. *Chiloscyphus polyanthus* (L.) Corda.


*Cheiloscyphus polyanthos* Corda in Opiz, Beitr. I, p. 651 (1829).

Diœcious, medium, in thin flat light or yellow green patches on stones actually under water or on moist soil (in the latter case patches laxly cæspitose). Stem 2 cm. or more long, simple or sparsely branched. Leaves alternate, slightly or not at all imbricate, plano-distichous, semi-circular to subquadrate, up to 1.25 mm. in diam., antical base more or less decurrent, margin entire, apex rounded. Upper cells about 28 µ, basal cells 50–60 µ × 25–36 µ; walls thin, trigones absent. Amphigastria very small, distant, appressed, oblong-lanceolate, apex ¼–½ bilobed, sinus narrow, lobes subulate. Bracts and bracteoles closely appressed
to the perianth. Bracts small, ligulate, entire, obtuse; bracteoles small, ligulate, to about $\frac{1}{2}$ bilobed, lobes narrow, acute. Perianth ovate, mouth large, to about $\frac{1}{2}$ divided into three lobes, lobes entire, rounded. Capsule shortly pedicellate, oval.

Plate XV, figures 1–3.

Hab. On moist rocks or on soil and often actually under running water.

Distrib. Mussoorie; Alwar; Silurundi; Dalhousie-Khajiar Road.

57. Chiloscyphus campanulatus St.


Dicocious, small, pale green, laxly cæspitose. Stem about 2.4 cm. long, delicate, flaccid, sparsely branched. Leaves imbricate, patent-divergent, broadly ovate, up to 1.5 mm. long and 1 mm. broad, entire, rounded. Upper cells mostly 20 $\mu$ (though some larger), basal 60–80 $\mu \times 28–40 \mu$; walls thin, trigones absent. Amphigastria small, apex bilobed, notch v-shaped, lobes narrow, acute, divergent. Andrecia intercalary, bracts 5–6 pairs, similar to the leaves but for the antical lobule, which covers the antheridiun. Involucral bracts in two pairs, ovate-lanceolate, entire, acute; bracteoles two, oval, entire, apex notched, notch rounded, lobes broad, rounded. Perianth on thick short lateral branches, campanulate, mouth broad, to about $\frac{1}{2}$ divided into three lobes, lobes entire or with numerous small teeth. Capsule long, oval. Spores golden yellow, smooth, 12 $\mu$. Elaters concolorous, bispiral, 160 $\mu$.

Plate XV, figures 4–8.

Hab. On moist soil.

Distrib. *Mussoorie* (Gollan, 1895) (Herb., F.R.I., Dehra Dun).

The following species of *Chiloscyphus* has been described by Stephani but has not been seen by us.

58. Chiloscyphus Gollani St.


Dicocious, medium or large, pale, flaccid. Stem up to 5 cm. long, sparsely branched, thin, pale, weak, prostrate, apex long
procumbent. Leaves 2 mm. long, alternate, imbricate, oblique, patent, angle 67°, slightly concave, distichous, broadly ovate, entire, or apex obliquely retuse or unequally obtusely bilobed. Upper cells 36 μ, basal cells 54 μ x 45 μ; trigones nil. Amphigastria small, as broad as the stem, free, oblong, transversely inserted, base with a spine on each side, apex deeply bifid, lobes narrow, lanceolate, spreading. Perianth obcuneate, campanulate, to about the middle trilobed, lobes slightly acute, bilobed or occasionally with a few teeth, teeth strong, acute. Bracts appressed, small, oblong, more or less deeply bifid, lobes acute, entire. Bracteoles appressed, subrotund, trilobed to about the middle, lobes ovate, acute. Androecia in the middle of the stem, bracts about five pairs, slightly smaller than the leaves, antical lobule small, inflated, acute or obtuse.

Hab. Himalayas, Mussoorie (Gollan).

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XIV. LOPHOCOLEA Dum.

Lophocolea Dum., Rec. d'obs., p. 17 (1835).

Plants medium or small, green, delicate and flaccid, laxly caespitose. Stem creeping, irregularly branched. Rhizoids colourless, arising from the bases of the amphigastria. Leaves succubous, nearly longitudinally inserted, antically more or less decurrent, spreading, entire or bifid. Amphigastria usually free, bifid, with a tooth on each side of the base, occasionally plurifid. Androecia longly spicate at the middle or the end of the branches or below the perianth, bracts with an inflated antical lobule, antheridia solitary. Female inflorescence terminal on the main stem or branches. Bracts resembling the leaves, often more dentate or ciliate. Perianth commonly oblong, trigono-prismatic, the keels frequently winged, the wide mouth trilobate with the lobes generally bifid, denticulate or ciliate. Capsule longly pedicellate, ovate, wall of many layers of cells. Spores small, brown, smooth or muricate. Elaters laxly bispiral.
Key to the species.

1 { Plants small, gemmæ abundant ... L. minor
1 { Plants larger, gemmæ not common ... 2
2 { Upper stem leaves usually entire or emar-ginate ... L. heterophylla
2 { Leaves on the stem all alike, bilobed ... 3
3 { Angles of the perianth not winged ... L. bidentata
3 { Angles more or less winged ... L. alata

59. Lophocolea bidentata (L.) Dum.

Lophocolea bidentata Dum., Rec. d’obs., p. 17 (1835).

Monoecious or dioecious. In yellowish green patches. Stem about 1 cm. long, procumbent, simple or sparsely branched. Rhizoids in small tufts from the underside of the stem near the bases of the amphigastria. Leaves slightly or not at all imbricate, obliquely inserted, patent, flat or directed upwards, quadrate-oblong, up to 1·25 mm. × 0·75 mm., antical basal portion longly decurrent, postical not so, margin entire, apex broad, shortly bilobed, sinus broad, generally lunate, lobes cuneate to lanceolate, acute or acuminate, the antical usually smaller, occasionally one lobe obsolete and rarely the apex tridentate. Upper cells 25–28 μ, basal cells 40–50 μ × 25–28 μ; walls thin, trigones minute. Amphigastria small, distant, spreading, divided to below the middle into two linear-lanceolate divergent lobes, usually with an acute lobe or a small process on one or both sides. Androecia terminal on main or short shoots, spicate, bracts 6–9 pairs, smaller than the leaves, closely imbricate, unequally and acutely 2-3-lobed, saccate at the antical base, mon-androus. Involutcral bracts larger than the leaves, oblong, margins entire or with a tooth on either side, shortly bilobed, sinus broad or narrow, lobes triangular to lanceolate, acute, or acuminate. Bracteoles much larger than the amphigastria, oblong, like the leaves but smaller. Perianth oblong, sharply trigonous (not winged), mouth broad, trilobed to about the middle, lobes broadly triangular, margins coarsely dentate-ciliate, each lobe shortly bilobed at the apex.
Plate XVI, figures 1–8.
Hab. On moist soil.
Distrib. Mussoorie.

60. *Lophocolea heterophylla* (Schrad.) Dum.


*Lophocolea heterophylla* Dum., Rec. d'obs., p. 17 (1835).

Monœciuous, in green or brown patches. Stem up to 2 cm. long, sparsely and irregularly branched, the branches often bearing small distant bilobed leaves. Rhizoids in tufts from the bases of the amphigastria. Leaves alternate, slightly or closely imbricate, obliquely inserted, usually directed upwards, lower leaves smaller, upper leaves larger, quadrate to subrectangular, up to 1 mm. long and usually up to 0·75 mm. broad, margins entire, apex in the lower leaves shortly bilobed, in the upper leaves retuse or truncate; sometimes all the leaves bilobed, notch lunate, lobes acute or obtuse. Upper cells about 25 μ, basal cells up to 54 μ × 36 μ (sometimes much smaller); walls thin, trigones thin, prominent. Amphigastria spreading, bifid to below the middle (sometimes nearly to the base), lobes lanceolate, acute, with a tooth on either side near the base. One sub-involucral innovation present. Bracts of the same size as the leaves, shortly bilobed, quadrate-oblong. Bracteoles bifid, margins entire or coarsely toothed. Perianth trigonous, exserted, oblong, to about ½ divided into three lobes, lobes usually more or less coarsely dentate.

Plate XVI, figures 9–14.
Hab. On rocks and bark.
Distrib. Mussoorie.

*Note.*—The species is generally described as monœciuous but we have not seen any antheridia in our specimens.

61. *Lophocolea minor* Nees.


Sterile, delicate, on bark or moist soil, in small dense light green tufts closely applied to the substratum. Stem up to 1 cm.
long, sparsely branched. Rhizoids long, hyaline, in small tufts from the bases of the amphigastria. Leaves alternate, slightly spreading, distant or slightly imbricate, quadrate to subrectangular, up to 0·5 mm. x 0·4 mm., almost longitudinally inserted, antical basal portion slightly decurrent, margins entire, almost always gemmiferous, apex bilobed to $\frac{1}{3} - \frac{1}{4}$, lobes broadly triangular, more or less divergent. Cells about 30 $\mu$; walls thin, trigones small, distinct. Amphigastria small, distant, as broad as the stem, deeply bilobed, lobes narrow, lanceolate, with or without a tooth on the outer side. Gemmæ unicellular, in short simple or branched filaments, the latter forming more or less globose clusters.

Plate XVII, figures 1-2.

Hab. On bark and moist rocks.

Distrib. Mussoorie (fairly common); Lahul; Western Himalaya, locality not noted.

Note.—The plant can easily be recognised by its small size and bilobed leaves which are almost always gemmiferous at the margins of the lobes.

62. Lophocolea alata Mitt. ex Larter.


Diœcious, medium or small, creeping on the surface of soil. Stem about 1 cm. long, irregularly and sparsely branched. Rhizoids in tufts from the bases of the amphigastria. Leaves alternate, closely imbricate, obliquely inserted, erecto-patent, directed upwards, ovate to ovate-oblong, up to 1·25 mm. long and 1·0 mm. broad at the base, antical base decurrent, antical margin recurved, postical straight, apex bilobed, sinus lunate, lobes more or less unequal, tapering from a broad base, acuminate, divergent. Upper cells 25–36 $\mu$, basal cells up to 50 $\mu \times 40 \mu$, many smaller; walls and trigones slightly thickened. Amphigastria small, distant, apex to about $\frac{1}{3}$ bilobed, lobes long, narrow, setaceous with or without a tooth on the outer side. Bracts like the leaves but larger, sinus acute. Bracteoles smaller than the bracts, otherwise similar. Perianth longly exserted, oblong, trigonous, angles more or less
winged, mouth shortly 3-lobed, lobes again irregularly lobed, spinous-dentate or spinous-lacerate. Capsule oblong-oval, longly pedicelled.

Plate XVII, figures 3–6.

Hab. On moist soil.

Distrib. Dalhousie.

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XV. PLAGIOCHILA Dum.


Plants large, rarely small, often robust, on soil, rocks or on bark, laxly caespitose, green or reddish. Rhizome stout, creeping, leafless or with a few small leaves, with numerous rhizoids. Stem firm, reddish or almost black, rarely pale. Branches without rhizoids, ascending or procumbent, dichotomously branched or dendroid, branches arising from the postical angle of the leaves. Leaves almost always large, succubous, alternate, widely spreading, antical margin decurrent, reflexed, nearly straight, postical margin arcuate, rotundate, sometimes semi-circular, reflexed towards the base, margin dentate or spinous-dentate or ciliate, very rarely entire. Amphigastria usually absent. Dioecious. Androecia spicate, linear or fusiform, terminal or intercalary, bracts smaller than the leaves, closely imbricate, saccate at the base, 1–10-androus, usually with only two or three antheridia. Bracts free, 2-3 pairs, similar to the leaves but often broader and more dentate, appressed to the perianth. Perianth laterally compressed in the upper part, inflated in the lower part, mouth truncate or rotundate, variously armed. Capsule shortly pedicellate, oval-globose, 4-valved to about the base, wall many-layered, often very thick and spongy, inner layer with semi-annular bands. Elaters bispiral. Spores small, smooth or rough.

Note.—Plagiochila is one of the few very large genera of the liverworts. Stephani in his monograph has recognised over 800 species of this genus. Most of them are tropical and have very small ranges of distribution. The plants as they grow are so conspicuous that no collector of liverworts can miss them but the
question of determining the species presents a difficult problem for the taxonomist. The various attempts to arrange the species of this genus have been reviewed by Stephani.

The characteristic appearance of the species depends upon how the leaves are inserted on the stem. They may be drooping both in the living and the dry condition or they may be opposite or alternate making angles of various degrees with the stem but not drooping. The first two are small, well-defined groups, but the large majority of the species come under the third group.

The sex organs are rather rare and even if present do not afford suitable basis of classifying the species. One has, therefore, to base the grouping on the vegetative characters alone. Large groups are made according to the attachment of the leaves on the stem (not on the branches), i.e. whether the antical base is decurrent and the degree of it, the postical base is ampliciate or not, decurrent or not and so on. Within these larger groups smaller groups are based on such differential characters as the type of branching present, the shape of the leaves, the number and the peculiarities of their teeth, the size of the leaf cells, and the nature of local thickenings in the cell walls.

Key to the species.

1 \[ \text{Leaves entire or faintly toothed} \]
2 \[ \text{Leaves toothed, teeth long or short} \]
3 \[ \text{Postical base of the leaf covering the stem and more or less crossing it} \]
4 \[ \text{Postical base of the leaf covering a part of the stem and never crossing it} \]
5 \[ \text{Antical base shortly decurrent, postical not decurrent} \]
6 \[ \text{Antical base longly decurrent, postical fairly decurrent} \]
7 \[ \text{Postical base not decurrent} \]
8 \[ \text{Postical base decurrent} \]
9 \[ \text{Teeth small} \]
10 \[ \text{Teeth large, coarse} \]

\[ P. \text{ sp. } A \]
\[ P. \text{ Mittenii} \]
\[ P. \text{ sp. } B \]
\[ P. \text{ similans} \]
\[ P. \text{ ferruginea} \]
Antical base longly decurrent, teeth coarse
and numerous . . . . . . . . . . . . P. accedens

Antical base shortly decurrent, teeth shorter
and less numerous . . . . . . . . . . . . P. mundaliensis

63. Plagiochila mundaliensis St.


Sterile, medium, flaccid, pale green, mixed with mosses, cæspitose. Stem 3-4 cm. long, sparsely branched. Rhizoids few, brown, confined to the base of the stem. Leaves imbricate, patent, oblique, ovate or ovate-triangular, 2.5 mm. long, lower \( \frac{1}{2} \) dilated, base narrow, sinuous, antical decurrent on the stem, postical slightly ampliate, rounded, decurrent on the stem, antical margin almost straight, entire or with 3 or 4 teeth below the apex, teeth small, directed forward; postical margin more or less convex, base entire rest irregularly dentate, teeth 6, sometimes fewer. Upper cells mostly 28 \( \mu \) (some 20–24 \( \mu \)), walls thick, trigones large, subnodulose; basal cells 44–76 \( \mu \times 28–40 \, \mu \), walls thick, trigones large, subnodulose.

Plate XVII, figures 7–12.

Hab. On rocks.

Distrib. Mundali (Jansar) 8,000 ft. (Gamble, 1892) (Herb., F.R.I., Dehra Dun).

64. Plagiochila similana Mitt.


Sterile, small, flaccid, green, densely cæspitose, in pure patches. Stem about 2 cm. long, simple, rarely branched, branches small-leaved. Rhizoids numerous, hyaline, confined to the basal region of the stem. Leaves more or less imbricate, broadly ovate, 2 mm. long, patent-divergent, base narrow, sinuous, antical base shortly decurrent, postical dilated, covering the stem; antical margin straight or narrowly incurved, apical portion toothed, teeth small, postical margin near the base entire, rest with 11 or 12 teeth, teeth small, spreading, a few large. Upper cells 18 \( \mu \), walls thicken-
ed, trigones not conspicuous, basal cells 44 $\mu \times 28 \mu$, rectangular, walls thick, trigones subnodulose.

Plate XVIII, figures 1–6.

Hab. On rocks.
Distrib. *Bhuj Koti* (Jansar), 8,000 ft. (Gamble, 1894) (Herb., F.R.I., Dehra Dun).

65. **Plagiochila Mittenii** St.


Sterile, medium, deep brown, densely caespitose, mixed with mosses and liverworts. Stem about 4 cm. long, sparsely branched, branches either aphyllous or only with small ones. Rhizoids confined to the basal region of the stem or the aphyllous branches. Leaves oblique, patent, imbricate, decurved, symmetrical, ovate, 3 mm. long, base narrow, flat, antical base decurrent on the stem, postical rounded, slightly decurved, antical margin straight or slightly incurved, entire or with 3–4 teeth; postical with almost an entire rotundate base, densely spinose, spines unequal in size, large and small irregularly mixed, strongly spreading. Upper cells 24–28 $\mu$, walls thin, trigones large, acute; basal cells 48–56 $\mu \times 24–28 \mu$, walls and trigones equally thickened. Leaves on the branches small, entire.

Plate XVIII, figures 7–12.

Hab. On rocks.
Distrib. *Kaj Nag*, 12-13,000 ft. (Duthie, 1892) (Herb., F.R.I., Dehra Dun).

66. **Plagiochila ferruginea** St.


Sterile, medium, light brown to reddish brown, mixed with mosses, densely caespitose. Stem brown to dark brown, simple or once or twice forked, with small-leaved flagellæ. Leaves more or less imbricate, patent, asymmetrical, quadrate-ovate, up to 2.5
mm. x 1.5 mm., base narrow, antical base longly decurrent on the stem, postical more or less ampliate, covering the stem but not crossing it, antical margin straight, generally rolled inwards, tridentate below the apex, postical margin more or less convex, irregularly serrate, teeth coarse or fine, sometimes the margin entire. Upper cells 15–22 μ, basal cells 50–70 μ x 25–35 μ; walls slightly thickened, trigones thickened, sometimes thick and nodulose in the upper and middle portion but indistinct at the base.

Plate XIX, figures 1–6.

Hab. — On soil.

Distrib. Mussoorie (Duthie, 1892) (Herb., F.R.I., Dehra Dun); Dalhousie-Khajjar Road.

67. Plagiochila accedens St.


Dioecious, medium, light brown. Stem 3-4 cm. long, sparsely branched, some of the branches flagelliform. Leaves slightly or not at all imbricate, patent, asymmetrical, oblong-ovate, up to 2.50 mm. x 1.75 mm., base narrow, antical base longly and narrowly decurrent on the stem, postical ampliate, covering but not crossing the stem, shortly and narrowly decurrent on the stem, antical margin straight, revolute, lower ½-⅔ entire, upper with 3-4 teeth, postical margin convex with 10-14 teeth. Teeth long and short irregularly mixed, up to 7 cells long, triangular-lanceolate from a broad base which is up to 4 cells broad. Upper cells 18–30 μ (usually 22 μ), basal cells 50–70 μ x 25–30 μ (many much smaller); walls rather thin, trigones large, thickened. Androecia intercalary, bracts about 4 pairs, smaller than the leaves; imbricate, saccate, mon-androus; antheridia globular, long-stalked. Involucral bracts resembling the leaves but larger, coarsely toothed. Perianth not exserted, laterally compressed, mouth wide, subbilipped (with notches at the edges of the compressed perianth) coarsely dentate-laciniate.

Plate XIX, figures 7–12.

Hab. — On soil.

Distrib. Mussoorie (Duthie, 1892) (Herb., F.R.I., Dehra Dun); Garhwal; Dalhousie.
68. *Plagiochila* sp. A.

Dioecious, small, reddish brown, cespitose. Stem sparsely branched, up to 3 cm. long, usually with one or two sub-floral innovations. Leaves patent, imbricate to lax, suborbicular, up to 1.5 mm. long and broad, symmetrical, base narrow, antical base longly and narrowly decurrent on the stem, postical rounded, partly covering the stem, slightly and narrowly decurrent on the stem, margins entire or the upper part faintly and distantly toothed especially in the leaves towards the apex; posterior margin more or less straight, reflexed; teeth 1-celled. Upper cells 18–22 μ, basal cells up to 35–45 μ x 20–28 μ, walls thin, trigones distinct. Bracts similar to the leaves but larger and distinctly toothed, teeth all alike, 1-3-celled. Perianth only slightly exserted, inflated in the lower part, laterally compressed in the upper part, mouth wide, oblique, truncate or shortly bilobed, lobes usually toothed, the teeth in older condition often disintegrated.

Plate XX, figures 1–7.

Hab. On soil.

Distrib. *Chamba-Parmaur* Road.

69. *Plagiochila* sp. B.

Sterile, medium or large, robust, deep brown or greenish brown. Stem dark brown below, brown above, 6–8 cm. long, sparsely branched. Leaves erecto-patent, imbricate, asymmetrical, ovate, up to 2.5 mm. long and up to 2 mm. broad at the base, base narrow, antical basal portion longly decurrent on the stem, postical ampliate, rounded, usually crossing the stem, reflexed, narrowly decurrent on the stem, antical margin rolled inwards, straight or slightly concave, usually entire, sometimes, however, with a few teeth, postical margin rounded, entire at the base, rest with 8–10 spines, spines coarse, long and short irregularly mixed. Upper cells 18–25 μ, walls slightly thickened, trigones distinct; basal cells 34–51 μ x 20–30 μ, walls thick, trigones large, nodulose.

Plate XX, figures 8–13.

Hab. On rocks.

Distrib. *Mussoorie; Kumaon; Simla*; probably also from *Dalhousie-Chamba* Road.
Note.—The teeth of the leaves on the older branches are usually not distinct. They get broken and disintegrated but they are perfectly conspicuous on the well-developed leaves of the younger branches.

The following species of Plagiochila have been described by Stephani but have not been seen by us.

70. **Plagiochila himalayensis** St.


Dicæous, medium, rigid, yellowish green, densely cæspitose. Stem up to 4 cm. long, simple or slightly branched, strong, fleshy and fragile. Leaves 2 mm. long, approximate, decurved-homomalous, strongly concave, slightly decurrent on both sides, postically ampliate, reflexed, slightly covering the stem, quadrate-rotundate, antical margin almost straight, entire, postical semi-circularly curved from the base, entire or upper portion with a few teeth, apex broad, truncate or retuse, angulate or entire. Upper cells 27 μ, trigones large, basal 54 μ x 27 μ, trigones much thickened. Bracts similar to the leaves, upper portion dentate, teeth remote, strong, short, acute, strongly spreading. Perianth half exserted, obovate, slightly compressed, mouth strongly truncate, regularly toothed, teeth small, acute.

Hab. Western Himalaya, Bashar (Gamble); Kashmir, *Tragbal Pass* (Duthie, 9,000 ft.).

71. **Plagiochila Duthiana** St.


Sterile, medium, low, strong, yellowish green, dense depressocæspitose. Stem up to 2 cm. long, thick, green, simple, decurved. Mature leaves 2·5 mm. long, approximate, obliquely spreading, angle 45°, slightly decurrent on both sides, margins highly revolute, subcylindricl, postical ampliate, covering the stem, lower portion of the antical margin almost entire, above armed, rest subcircular, entire. Upper leaves similar, somewhat smaller, above often decurved. Upper cells 18 μ, trigones narrow; basal 54 μ x 27 μ, walls thick.

Hab. Kashmir (Duthie, 9,000 ft.).
72. Plagiochila cavifolia St.


Sterile, small, low, green, dense, depresso-cæspitose. Stem up to 2 cm. long, simple or rarely with a few branches, base with rhizoids, upper procumbent. Leaves 2 mm. long, imbricate, antically and postically-decurved; to about the middle and thence strongly concave, subinflated, subcircular, hardly decurrent, postical ampliate, broadly covering the stem and denticulate at that place, rest entire. Upper cells normally 27 μ, irregular, occasionally much smaller; basal 45 μ x 27 μ; trigones everywhere small, acute.


73. Plagiochila Gollani St.


Sterile, medium, olive green or brown, subflaccid, commonly mixed with mosses or densely cæspitose, terrestrial. Stem up to 7 cm. long, thin, weak, brown, simple or upper portion fascicled with a few branches, branches long spreading. Leaves imbricate, 3 mm. long, obliquely spreading, angle 67°, briefly decurrent on both sides, postical ampliate, broadly covering the stem, recurved, ovate-trigonous, symmetrical, base ampliate, apex ½ as broad, antical margin almost straight, entire or apical half with a few minute teeth, postical at the base semi-circular, slightly arcuate, slightly dentate, teeth below 12, short, broadly triangular, acute. strongly spreading, apex subtruncate with 5 equal teeth, teeth similar, slightly attenuated, sharp. Leaves on the branches as long as those on the stem but strongly spreading, apex half as broad as the base, postical very slightly ampliate, covering the stem, both margins almost entire, postical margin at the apex dentate-spinose. Upper cells 27 μ, trigones small; acute; basal 54 μ x 27 μ, trigones large, acute.

74. Plagiochila grata St.


Sterile, large, slender, rigid, yellowish, becoming brown with age; dense depresso-cæspitose on bark. Stem up to 7 cm. long, with regular long branches, branches 3 cm. long, simple, upper ones slightly smaller. Leaves close, obliquely spreading, canaliculate-concave, ovate-trigonous, 3·5 mm. long, 2·75 mm. broad above the base, asymmetrical, upper margin at the base rotundate and almost straight above, regularly shortly dentate, lower margin slightly arcuate, with a few teeth below the apex, apex obtuse, arcuate. Upper cells 18 μ x 18 μ, trigones nil; basal 36 μ x 27 μ, trigones small.

Hab. Simla (Long).

75. Plagiochila nana St.

Plagiochila nana St., Sp. Hep., Vol. VI, p. 188 (1918).

Sterile, small, rigid, yellowish red, forming cushions on bark. Stem up to 2 cm. long, thick, strong, with a few long branches, branches frequently fasciculate. Leaves imbricate, obliquely spreading, strongly concave, subinvolute, ovate-trigonous, 3·5 mm. long, 2·75 mm. broad at the middle, asymmetrical, inserted by a small base, antical base shortly decurrent, upper margin strongly arcuate, upper portion straight, regularly shortly dentate, lower margin almost straight, in the lower part entire, upper similarly dentate, apex 0·75 mm. broad, emarginate-bifid, lacinæ small, triangulate, minutely denticulate, spreading. Upper cells 18 μ x 18 μ, basal 36 μ x 18 μ; trigones large.

Hab. Simla (Long).

Gola (Atti della R. Accad. delle Sci. di Torino, Vol. XLIX, 1914) has reported Plagiochila asplenioides Dum. from Kashmir, but we have not seen this. The following description is after Stephani (Sp. Hep., Vol. II, p. 319).

76. Plagiochila asplenioides (L.) Dum.


Dicecious, large or very large, robust, green, more or less densely tufted on ground. Stem up to 20 cm. long (usually 4-5 cm.) more or less branched, strong and rigid, lower portion brown, apex decurved, with numerous descending branches. Leaves imbricate or remote, 3 mm. long, obliquely spreading, angle 58°, distichous, margins decurved, concave, subsymmetrical, broadly obovate, postical base slightly ampliate, covering the stem, denticate along the whole margin, teeth approximate, small, usually 2-celled, numerous, upper cells 18 μ, trigones small; basal 36 μ x 18 μ, trigones large. Bracts larger than the leaves, suborbicular, lower portion entire, rest similarly armed. Perianth semi-exserted, compressed, obcuneate, mouth broadly truncate, irregularly denticate, capsule long-pedicelled, oval. Spores brown, 12 μ. Elaters concolorous, bispinal. Andræcia intercalary, short, bracts 6-7 pairs, closely imbricate, above the middle denticulate.

Hab. Kashmir.

* * * * *

XVI. LOPHOZIA Dum.

Lophozia Dum., Rec. d'obs., p. 17 (1835).

Plants small to large, caespitose, generally more or less brown. Stem prostrate or ascending, more rarely erect, simple or slightly branched, frequently with sub-floral innovations. Rhizoids long, hyaline. Leaves alternate, succubous, obliquely inserted, young leaves semi-erect, adult ones more or less spreading, concave, generally 2-lobed, in some 3-many-lobed. Dioecious or monœcious. Andræcia terminal or intercalary, bracts saccate at the base, frequently with an additional antical tooth or lobe. Involucral bracts nearly always larger than the leaves, generally more lobed and frequently dentate. Perianth longly exserted, ovate to cylindrical, nearly always plicate above, contracted at the apex, in a few with a beak. Capsule longly pedicellate, oval, the inner layer of wall with semi-annular thickenings. Spores small, rough. Elaters bispinal. Gemmæ frequent, usually angular.
Key to the species.

1 \{ Lobes toothed to spinous \ldots \ldots L. incisa
    \{ Lobes not toothed, apex rounded or acute \ldots 2

2 \{ Lobes 2 \ldots \ldots L. alpestris
    \{ Lobes 3 \ldots \ldots L. sp.

77. Lophozia alpestris (Schleich.) Evans.


*Lophozia alpestris* Evans, Rhodora, p. 181 (1901).

Sterile, small, in dense tufts, simple or sparsely branched at the base. Stem brownish, 10–15 mm. (sometimes 20 mm.) long. Rhizoids long, hyaline, numerous, from the ventral side of the stem. Leaves imbricate, patent divergent, concave above in the young condition but margins often reflexed in the older condition, transversely inserted by a broad base, encircling half the stem, auriculate and undulate on both sides, suborbicular, up to 2 mm. in diameter, usually shortly 2-lobed, notch triangular, shallow, lobes divergent, apex rounded or obtuse. Upper cells 14–18 \( \mu \), walls and trigones uniformly thickened, basal 45–54 \( \mu \times 14–18 \mu \), walls rather thin, trigones not conspicuous; spherical clusters of dark brown gemmæ on the tips of the lobes of the leaves just below the apex. Gemmæ 2-celled, upper cells usually rounded, lower obovoid. Amphigastria absent.

Plate XXI, figures 1–5.

Hab. On the banks of streams, etc.

Distrib. Zanskar, 14-15,000 ft.; Gurdhar Pass, 14-15,000 ft.

78. Lophozia incisa (Schrad.) Dum.


*Lophozia incisa* Dum., Rec. d’obs., p. 17 (1835).

Diœcious, in compact dark brown depressed patches. Stem dark brown, short and thick, up to 15 mm. long, usually smaller, simple or sparsely branched. Rhizoids long, numerous, extending up to the apex of the stem, brownish. Leaves almost transverse,
quadrate, up to 1.50 mm. × 1.25 mm., half embracing the stem, opposite above and then fused antically, imbricate, lower leaves lax, alternate, subcomplicate, wavy, unequally bilobed, the upper plicate-crispate often forming a bud at the apex of the stem, usually shortly 3-lobed, lobes sometimes obscure, usually spinous, toothed, teeth long, unicellular. Upper cells 25–36 μ, basal up to 50 μ × 25 μ, walls thin, trigones prominent. Amphigastria absent. Gemmae on the margins of the lobes.

Plate XXI, figures 6–9.

Hab. On moist rocks.

Distrib. Alwas-Silrundi Road, 10,000 ft.; Zanskar.

79. Lophozia Sp.

Sterile. In loose brownish tufts. Stem up to 2 cm. long, dark brown, procumbent or ascending, sparsely branched. Rhizoids numerous, dense, colourless, extending up to the apex of the stem. Leaves smaller below, becoming gradually larger above, imbricate, patent, concave, almost transversely inserted, antical base ampliate, half encircling the stem, asymmetrical, broader than long, up to 2.25 mm. broad and up to 1.5 mm. long, conspicuously longitudinally folded in the outer half, margins in the lower part of the leaf a little wavy, usually unequally 3-lobed, lobes (sometimes obscure) rounded or with a short tooth at the apex. Cells rounded, upper and median cells 18–26 μ, basal cells longer up to 43 μ × 18 μ, walls thin, trigones large, nodulose. Amphigastria absent.

Plate XXII, figures 1–3.

Distrib. Chamba-Pangi Road, Silrundi, 10,000 ft.; Gurdhar Pass, 14-15,000 ft.

Mr. Nicholson who examined these specimens thinks that it is a new species.

The following species of Lophozia has been described by Gola but has not been seen by us.

80. Lophozia Piacenzai Gola.

LOPHOZIACEÆ

Dicëcious, small, brown, caespitose, terrestrial. Stem up to 1 cm. long, sparsely branched, branches frequently flagelliferous, with sub floral innovations. Leaves obliquely inserted, arcuate-recurved, subsymmetrical, oblong-rectangulate, postical base slightly ampliate-rotundate, up to $\frac{1}{2}$ lobed, sinus rotundate, obtuse, lobes broadly triangular. Upper cells 25 $\mu$, median 40 $\mu$, basal 50 $\mu \times 22$ $\mu$; trigones large, acute; cuticle smooth or subpapillose. Amphigastria small and always quite distinct, ovate, bifid to about the middle, lobes acute. Involucral bracts and bracteoles about twice as large as the leaves and amphigastria, rest similar, the lobes of the bracteole, however, with 1-2 teeth. Perianth (sterile) 3 mm. long, ovate-campanulate, mouth truncate laciniate, segments gemmiferous. Gemmæ at the tips of the sterile branches, brownish, 2-3-celled.

Hab. Kashmir.

* * * * *

XVII. JAMESONIELLA (Spruce) Schiffn.


Plants medium or large, green, often reddish brown to purple. Stem usually ascending or erect with the apex incurved, often rigid, with sub-involucral innovations. Leaves alternate, succubous, entire, obliquely inserted and almost semi-amplexicaul, erect-connivent, ovate to subrotund. Amphigastria absent or minute. Dioecious. Androecia terminal or intercalary, bracts saccate with an inflated antical lobule. Involucral bracts slightly larger than the leaves, more or less laciniate, bracteoles large, laciniate. Perianth (when fertile) longly exserted, oblong-ovate, deeply phriginal in the upper half, somewhat contracted at the wide mouth, mouth lobed.

81. Jamesoniella elongella (Tayl.) St.


Diœcious, medium, brown or purplish brown, cæspitose. Stem prostrate or procumbent, up to 2.5 cm. long, simple or sparsely branched, sub-floral innovations present. Rhizoids long, numerous. Leaves on the sterile plants and on the basal portion of the fertile plants secund on the antical side, oblique, closely imbricate, erecto-patent, base broad, antical basal portion slightly decurrent, postical non-decurrent, rounded, up to 1 mm. in diameter, entire, apex rounded, truncate or with a shallow notch. Leaves near the apex in the fertile plants longer, squarrose-spreading, saccate on the antical base, ampiate on the postical base. Upper cells 25–29 µ, basal cells 40–48 µ x 25–33 µ; walls thin, trigones large. Andrcæcia terminal or intercalary, spicate, bracts 6–8 pairs. antically saccate, directed towards the apex of the stem and closely appressed. Bracts more or less laciniate, often unequal; bracteoles laciniate. Perianth exserted, ovate, inflated, upper half plicate, mouth shortly lobed, lobes ciliate, capsule longly pedicelled, exserted, ovoid. Spores tetrahedral, dark brown, 12–15 µ, smooth. Elaters concolorous, 160–180 µ, rather closely bispiral. spirals thick, brown.

Plate XXII, figures 4–9.

Hab. On moist rocks.

Distrib. Dalhousie; Kumaon.

* * * * *

XVIII. SOLENOSTOMA Mitt.


Plants small or medium, delicate or robust, cæspitose, green, reddish or brownish purple. Stem prostrate or ascending, seldom erect, simple or slightly branched, often with one, rarely two, sub-floral innovations. Rhizoids numerous, hyaline. Leaves alternate, succubous, obliquely or almost transversely inserted, more or less spreading, rounded, ovate or oblong. Amphigastria usually absent. Andrcæcia terminal or intercalary, spicate or hypogynous; bracts saccate, otherwise like the leaves, 1–3-androus. lnvolucral
bracts in one to several pairs, like the leaves, free or more or less fused with the perianth at the base. Perianth clavate or cylindrical, upper portion with a few folds, mouth narrow and more or less tubular, crenulate. Capsule longly pedicellate, oval or subspherical, wall of two layers of cells, the outer with nodular thickenings, cells of the inner layer with semi-annular thickenings. Spores small, brown. Elaters short, attenuate, bispiral.

**Key to the species.**

<table>
<thead>
<tr>
<th>1</th>
<th>Leaves large, perianth tubular</th>
<th>. . . . . . S. breviflora</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>Leaves not so large, perianth more or less pyriform</td>
<td>. . . . . . 2</td>
</tr>
<tr>
<td>3</td>
<td>Leaves non-decurrent, close-packed</td>
<td>. . . . . . . . S. crenulata</td>
</tr>
<tr>
<td>4</td>
<td>Leaves decurrent, not so close</td>
<td>. . . . . . 3</td>
</tr>
<tr>
<td>5</td>
<td>Leaves semi-amplexicaul, squarrose</td>
<td>. . . . . . . . S. purpurata</td>
</tr>
<tr>
<td>6</td>
<td>Leaves not amplexicaul, patent</td>
<td>. . . . . . . . S. lanceolata</td>
</tr>
</tbody>
</table>

82. *Solenostoma lanceolata* (L.) St.

*Jungermannia lanceolata* L., Sp. pl., 1527.
*Aplozia lanceolata* Dum., Hep. Eur., p. 59 (1874).

Dioecious, cæspitose, in reddish brown patches. Stem prostrate, up to 2 cm. long, simple or sparsely branched, with subfloral innovations. Rhizoids in tufts, long, brownish. Leaves alternate, obliquely inserted, imbricate, patent, recurved, suborbicular or quadrate to oblong-ovate, up to 2 mm. long and 1.75 mm. broad, usually 1.5 mm. × 1.25 mm., antical base decurrent, margin entire, apex rounded or truncate. Upper cells 24–28 μ, basal cells 50–60 μ × 24–28 μ; walls rather thin, trigones large and distinct at the base, small at the apex. Bracts like the leaves, larger. Perianth cylindrical-clavate, exserted, not fused with the bracts, suddenly contracted into a narrow crenate beak.

Plate XXIII, figures 1–3.
Hab. On moist rocks.
Distrib. Alwas-Sitrundi Road.

*Note.*—The plant is said to be monoeious but we have not seen any antheridia in our specimens. It is also said to bear gemmæ on the stem apex and the leaves but we have not seen any.

83. *Solenostoma crenulata* (Sm.) St.

*Jungermannia crenulata* Sm., Eng. Bot., pl. 1463 (1805).

Dioecious, small, in dense and extended patches. Stem prostrate, about 10 mm. long, simple or sparsely branched; subfloral innovations present and often with many small-leaved branches in the same patch. Rhizoids long, hyaline, numerous, extending up to the apex of the stem. Leaves alternate, more or less imbricate, subsecund on the antical side, almost transversely inserted, erecto-patent to patent, concave above, orbicular, up to 0.75 mm. × 0.75 mm. (sometimes slightly broader than long), fixed by a narrow base, antical base slightly decurrent, entire, rounded. Cells 25–36 μ, polygonal or oblong, marginal cells forming a distinct border, walls rather thick, trigones absent or indistinct. Androcæa terminal, bracts small, closely overlapping, up to 8 pairs. Involucral bracts like the leaves but larger and slightly fused with the perianth. Perianth pyriform, ¾-¾ exserted beyond the bracts, upper contracted into a small mouth, 3-4-plicate, mouth denticulate.

Plate XXIII, figures 4-5.

Hab. On moist rocks.
Distrib. Kulu Valley, 8–11,000 ft.

*Note.*—In these specimens the marginal cells are about the same size as the inner cells, being sometimes slightly larger and at others slightly smaller. The outer walls of the marginal cells are in most cases thin, in other cases thick with very thick outer
angles. In this latter case the radial walls are usually quite thick
and the trigones are distinct though small.

In the typical form of this species described by various writers
the marginal cells are said to be larger than the inner cells but in
var. *gracillima* in which the plants are brownish red and with
numerous small-leaved branches the marginal cells are almost the
same size as the inner cells.


Diœcious, in loose tufts of light green or dark brown colour,
mixed with mosses. Stem prostrate or ascending, 1–3 cm. long,
sparsely branched, lower portion leafless, sub-floral innovations
present. Rhizoids hyaline or brownish, in tufts, extending to the
apex of the stem. Leaves alternate, more or less imbricate, sub-
secund antically, erecto-patent to patent, but on smaller basal
branches rather lax and almost horizontal, transversely inserted,
suborbicular to ovate, up to 2 mm. in diameter, often less, antical
base hardly decurrent, postical ampiate, margin entire, apex
rounded, often retuse. Upper cells 22–30 μ, basal cells 70–125 μ ×
30–45 μ; walls thick, trigones only slightly or not at all thickened.
Bracts like the leaves but larger, not fused with the perianth, one
of them folded over the perianth. Bracteole sometimes pre-
sent, small and narrow, fused with the perianth. Perianth cylin-
drical to clavate, not exserted, subplicate in the upper part, often
winged on the postical side, mouth irregularly toothed or crenulate.

Plate XXIII, figures 6–10.

Hab. On rocks.

Distrib. Simla, 6-7,000 ft.

Note.—In the brown specimens cell-walls are thickened and
trigones are present.

This species resembles closely *S. sphærocarpa* (Hook.) St.
[= *Aplozia sphærocarpa* (Hook.) Dum.]


p. 91 (1860).

Dicocious, in loose dark purple tufts. Stem up to 2 cm. long, simple, wiry, lower portion leafless, sub-floral innovations present. Rhizoids few, confined to the base. Leaves alternate, smaller and distant below, slightly overlapping and becoming larger above, obliquely inserted, patent, concave above, suborbicular, a little broader than long, up to 1:50 mm. × 1:25 mm., base cordate, longly decurrent on both sides, very much so on the postical side, margin entire, markedly revolute. Marginal and upper cells 10–15 μ, basal cells 27–47 μ × 15–22 μ (many smaller); walls thin, indistinct. Bracts larger than the leaves otherwise similar, slightly fused with the perianth. Bracteole when present small, adherent to one of the bracts. Perianth ½ exserted, clavate, subplicate near the apex, mouth beaked, shortly lobed-denticulate. Spores 12–15 μ, purplish. Elaters concolorous, bispiral, spirals thick, broad, 80–130 μ.

Plate XXIV, figures 1–4.

Hab. Terrestrial.

Distrib. Silrundii, 10,000 ft.

Note.—The plant agrees very closely with the description given by Mitten though his description as usual is very brief. Stephani's amplified description of this species is, however, a little different. Mitten says that the leaves are orbicular while Stephani says cordiform, i.e. the apex distinctly narrowed from a broad base. In our specimens the leaves are distinctly orbicular. There is a little difference between the size of the cells also as given by Stephani but it is not very marked.

* * * * *

XIX. JUNGERMANNIA L. Ex. parte.


Plants small or large, prostrate or erect, with numerous rhizoids, frequently stoloniferous, rhizoids generally purple, occasionally hyaline. Leaves entire. Amphigastria absent. Androcia long, spicate, bracts saccate at the base, squarrose-recurved above, di-androus. Involucral bracts larger, two to many pairs, coalesced with the perianth or free. Perianth more or less ampliate,
upper half plicate, contracted, mouth lobed or setulose, rarely broadly open. Capsule globose or oval, cells of the inner wall with semi-annular bands. Spores small. Elaters small, attenuate, bispiral, ligulate.

Key to the species.

1 { Leaves plano-distichous \[ J. humilis \]
   \]
     Leaves patent to horizontal \[ 2 \]
     Bracts fused with the perianth \[ J. oblongifolia \]
     Bracts not fused with the perianth \[ J. viridis \]

Note.—This genus is exceedingly like Solenostoma, but differs in the form of the perianth.


Dicëcious, small, in compact patches, mixed with other liverworts. Stem simple or sparsely branched, ascending, up to 15 mm. long. Rhizoids numerous, long, extending up to the apex of the stem, those near the apex hyaline. Leaves subsecund, alternate, imbricate, obliquely inserted, patent-divergent to horizontal, concave above near the base, usually decurved in the apical half, asymmetrical, oblong to oblong-ovate, up to 1·5 mm. × 1·00 mm., base broad, antical decurrent, postical not so, margin entire, apex rounded, sometimes with a slight notch. Upper cells 25–32 μ, basal 43–60 μ × 25–30 μ, walls thin, trigones distinct. Andræcia intercalary, bracts 4–6 pairs, saccate at the antical base otherwise similar to the leaves. Bracts slightly larger than the leaves, otherwise similar. Perianth lanceolate, exserted, lower ⅓ adnate to the bracts, 3-4-pluri-plicate to the base, mouth narrow, bilobed, lobes again lobulate-toothed.

Plate XXIV, figures 5–10.

Hab. On moist soil and rocks.

Distrib. Sibrundi, 10,000 ft.


Plants small, in loose green patches. Stem about 1 cm. long, flaccid, prostrate, simple or sparsely branched. Rhizoids numerous and purple at the base, hyaline above. Leaves lax or slightly imbricate, obliquely inserted, antical base slightly
decurrent, postical not so, patent to almost horizontal, suborbicular to oblong-ovate, up to 1.5 mm. x 1.0 mm., margin entire, apex rounded, decurved. Upper cells 20-32 μ, basal 70-100 μ x 25-35 μ, many smaller; walls thin, trigones absent in the upper part and distinct in the lower part. Androecia intercalary, bracts 4-6 pairs, saccate at the base. Involutural bracts like the leaves but much longer, erect in the lower part, spreading above, enclosing the lower 1/3 of the perianth but not fused with it. Perianth exserted, lanceolate, triplicate, mouth narrow.

Plate XXV, figures 1-4.
Hab. On moist soil.
Distrib. Dehra Dun, 2,000 ft.

Note.—The plant is very similar to *Jungermannia oblongifolia* but it is more lax in habit and is especially distinguished by the free perianth which is merely enclosed by the bracts at the base whereas in the other species it is fused with the bracts in the lower part.


Sterile, small, in dense green patches. Stem up to 2 cm. long, slender, sparsely branched. Rhizoids scanty, long, hyaline. Leaves imbricate, plano-distichous, almost longitudinally inserted by a long base, antical decurrent, postical not so, semi-circular, up to 1.25 mm. x 1.0 mm., margin entire, apex rounded. Upper cells 30-40 μ, basal 60-80 μ x 40-60 μ, walls thin, trigones absent.

Plate XXV, figures 5-7.
Hab. On soil on the sides of drains.
Distrib. *Lahore, Amritsar*.

Note.—This species comes to the lowest altitude and is the only foliose species occurring in the plains.

The following species of *Jungermannia* have been described by Stephani but have not been seen by us.

89. *Jungermannia Duthiana* St.


Monœcious, hypogynous, medium, yellowish green, densely caespitose, on bark. Stem up to 10 mm. long, erect, slightly
branched, sub-floral innovations rare. Leaves remote, strongly concave, ascending, suborbicular. Marginal cells 18 $\mu$, subapical cells 27 $\mu$, median cells 30 $\mu \times 27 \mu$, basal 54 $\mu \times 27 \mu$: trigones small in the upper portion, absent from the basal portion. Perianth large, exerted, clavate, upper half 3-4-plied, mouth small, contracted, dentate. Bracts two, fused with the base of the perianth, strongly concave and slightly spreading. Male bracts two or three pairs, similarly concave and slightly spreading, mon-androus, antheridia globose, pedicel thick. Pedicel of the capsule 12 mm. long and strong, capsule oval. Spores 22 $\mu$, rust-coloured. Elaters concolorous, strongly attenuated, bispiral, spirals ligulate, densely twisted.

Hab. Kashmir (Duthie).

90. **Jungermannia tenerrima** St.


Dioecious, medium, pale green, flaccid, terrestrial, dense depresso-cæspitose. Stem up to 2 cm. long, branched, branches long, stoloniferous, few. Leaves contiguous, more or less spreading, thin, plane, ovate, 2·75 mm. long and 2·5 mm. broad in the middle, apex obtuse, inserted by a broad base, entire. Upper cells 54 $\mu \times 36$ $\mu$, basal 90 $\mu \times 45 \mu$, trigones absent. Amphigastria absent. Bracts appressed, free, $\frac{1}{2}$ shorter than the perianth, ovate, 3·5 mm. $\times$ 2·75 mm., apex crisp, rest entire, bracteoles absent. Androecia not seen. Perianth large, cylindrical, 5 mm. long and 2 mm. broad, apex slightly narrow, truncate, pluriplicate, entire.


* * * * * * * *

XX. **SOUTHBYA** Spruce.


Plants small, cæspitose or among mosses. Stems decumbent, simple or slightly branched with numerous long rhizoids. Leaves opposite, obliquely nearly transversely inserted, succubous, closely imbricate, contiguous or slightly connate at the antical base,
roundish to oval, entire. Amphigastria absent. Involucral bracts erect, highly connate, free margins erose or dentate. Bracteole ovate-lanceolate, fused with the bracts or nil. Perianth shorter than the bracts, concrete with them in the lower part, the mouth wide, lobed or dentate. Capsule oval, globose, 4-valved to the base, valves with semi-annular bands.

This genus even when sterile can be easily distinguished from Solenostoma and Jungermannia by its opposite leaves.

Southbya Gollani St. has been described by Stephani from Mussoorie but has not been seen by us.

91. Southbya Gollani St.


Dicæious, small, delicate and fragile, brown, dense caespitose or mixed with mosses. Stem up to 10 mm. long, prostrate, simple, with sub-floral innovations. Rhizoids from the under-surface. Leaves small, opposite, erecto-connivent, antical base contiguous or slightly connate, rest subrotund, entire, thin. Upper cells 18 μ, basal twice as long, walls thin. Bracts gradually larger, uppermost fused together forming a tube, margins crisp, entire. Bracteoles rudimentary or absent. Perianth? Capsule longly pedicelled, globose, to about the base dehiscing into four valves, valves with semi-annular bands.

Hab. Himalaya, Mussoorie, Nag Tiba, 10,000 ft.
**Suborder Anacrogynæ.**

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the dorsal side. Archegonia in groups.

**Family IX. Calobryaceæ.**

Stems erect, arising from a fleshy rhizome-like basal portion. Leaves arranged radially and more or less regularly in three rows, simple. Rhizoids absent. Female inflorescence on the upper part of the stem, without any involucre. Calyptra large, cylindrical. Capsule cylindrical, the wall of one layer of cells except at the apex, with longitudinal annular thickenings. Elaters bispinal.

Not represented by any species in this area.

**Family X. Codoniaceæ.**

Thallose, foliose or forms intermediate between them. In the foliose forms leaves in two rows, parallel to the stem or obliquely inserted and succulent, simple. Rhizoids always present. Male and female inflorescences scattered on the dorsal side or in groups. Archegonial cluster surrounded by an involucre. Capsule usually with a long seta, globose (oval in Blasia), dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells (four in Blasia, Treubia), well-developed fibrous bands being usually present on either the outer or the inner cells or on both. Elaters adherent to the base or apex of the capsule or partly free, more rarely altogether free, 2–4-spiral.

*Key to the genera.*

1. \{ With leaf-like lobes \ldots \ldots \ldots \ldots \ldots \ldots \ldots 2
   \{ Wholly thallose \ldots \ldots \ldots \ldots \ldots \ldots \ldots 3
2. \{ Nostoc colonies in the thallus \ldots \ldots \ldots \ldots Blasia
   \{ No Nostoc colonies \ldots \ldots \ldots \ldots Fossombronia
<table>
<thead>
<tr>
<th></th>
<th>Dorsal lamellae present</th>
<th>No dorsal lamellae</th>
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<tr>
<td>4</td>
<td>Apical tubers present</td>
<td>No apical tubers</td>
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<tr>
<td>5</td>
<td>Antheridia in pits, no bracts</td>
<td>Antheridia superficial, bracts present</td>
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</tbody>
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**XXI. FOSSOMBRONIA Raddi.**


Stem creeping, simple or dichotomously branched, flattened above and strongly arched below, with long, mostly violet-coloured smooth rhizoids. Leaves green, in two rows, succubous, obliquely inserted and decurrent, generally broader than long, with irregularly sinuate and usually lobed margin, base more than one cell thick, rest 1-layered, cells large, thin-walled. Antheridia orange yellow, accompanied by bracts, on the dorsal surface of the stem near the insertion of the leaves. Archegonia singly on the dorsal surface of the stem at the bases of the leaves. Each on fertilisation becoming enclosed in a perianth. Perianth with a wide lobed mouth and narrow base, often longitudinally plicate, frequently incised to the base. Calyptra pyriform, thick at the base. Capsule shortly pedicellate, globose, dehiscing irregularly or imperfectly by four-valves. Wall of two layers of cells, the inner layer with frequently incomplete bands. Spores large, rounded, tetrahedral. Elaters short, bi- or tri-spiral.

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**92. Fossombronia himalayensis** Kashyap.


Monoeious or dioecious. Plants cæspitose among grass or moss or singly on moist rocks, small and compact in former places but open and longer in latter places, two or three times branched, branches up to 6 mm. long. Rhizoids usually violet, sometimes hyaline. Leaves oblong, wavy, ascending, overlapping to about
\frac{1}{2} \text{ of the length, outer margin irregularly and indistinctly toothed. Perianth with wavy margin, sometimes split to the base along one side. Seta up to 5 mm. long, often very short; capsule usually exserted. Cells of the outer layer of the capsule wall with thin walls, those of the inner layer with U-shaped bands on the inner and radial walls near the apex but only simple bands on radial walls at other places. Dehiscence by separation of the apical portion. Spores brown with furcate high lamellae, sometimes forming a few reticulations, 40–50 \mu m in diameter. Elaters brown, laxly bi- or tri-spiral, 100–140 \mu m long.}

Plate XXVI, figures 11–15.

Hab. Moist rocks or among grass and moss.
Distrib. Common. Outer Himalayas, Ravi valley; Simla, etc.; Kumaon, Mussoorie, etc. 5,000–7,000 ft.; Lahore, rare; Jawala-mukhi (Devi Dyal); South India, Nilgiris (Rangachariar); Bombay, Panchgani (Blatter).

Note.—Towards the end of the season the apex of the plants ceases to form the leaves, bends downwards and becomes thickened. These apical tubers are thus borne on cylindrical stalks and remain buried in the ground during winter. They grow out into new plants next spring.

* * * * *

XXII. SEWARDIELLA Kashyap.


 Dioecious. Plants thallose, simple or forked, occurring in thick patches on rocks or singly among grass and moss in shady places. Thallus winged, wings attenuated, directed upwards. Dorsal surface concave. Midrib thick, projecting ventrally, flat above and rounded below. Ventral surface usually with minute red scales in two rows. Wings many-layered at the base, gradually becoming thin and 1-layered throughout the greater portion, ascending, margin wavy. Male and female plants similar. Antheridia in a cluster on the dorsal side of the midrib mingled with a few bracts. Archegonia in a cluster on the dorsal side. Perianth
bell-shaped, margin lacerated into numerous processes, often split at one or more places up to the base, many-layered at the base, 1-layered above. Calyptra thin, 1-layered. Sporogonia one or more in each perianth; foot small; capsule included or slightly exserted. Capsule wall 1–3-layered; inner layer with thick bands. Spores reticulate-lamellate. Elaters bi- or tri-spiral; no fixed elater-like cells anywhere in the capsule.

93. Sewardiella tuberifera Kashyap.


Dioecious. Thallus up to 10 mm. long and 12 mm. broad, often once forked, arising from a thick base and ending in a wingless stalked tuber at the apex, the apical wingless portion often forked, midrib mycorrhizal, thick, projecting ventrally, rounded below. Ventral surface usually with minute red scales in two rows. Wings often unequal, many-layered at the base, gradually becoming thin, one-layered throughout the greater portion, ascending, margin wavy; upper surface of the thallus concave. Antheridia on the midrib, each antheridium globular, on a short stalk; bracts few, scattered between the antheridia. Perianth bell-shaped, margin lacerated into numerous narrow processes; calyptra thin, 1-layered. Sporogonia 1–3, sometimes more, in each perianth; foot small, seta up to 1.25 mm. long, capsule 1–1.3 mm. in diameter, included or slightly exserted. Capsule wall 2-3-layered; the cells of the outer layer usually thin-walled, sometimes with thick bands on the radial walls; cells of the inner layer with U-shaped bands on inner and radial walls or only simple bands on the radial walls. Spores reticulate-lamellate, less than four reticulations in the diameter, 40 μ. Elaters bi- or tri-spiral, 300–400 μ; no fixed elaters at the base or elsewhere.

Plate XXVI, figures 6–10.

Hab. In large patches on moist rocks, occasionally singly among moss or grass.

Distrib. Common at 5,000 to 7,000 ft., Mussoorie, Simla, etc.

*Note.*—Towards the end of the season the plant forms apical tubers like *Fossombronia himalayensis*. The thick tubers are
borne on cylindrical stalks, are covered by small red scales and remain buried in the soil during winter. When the tubers germinate next year the scales are carried on the under-surface of the plants but are naturally restricted mostly to the posterior part of the plant. The tuber-bearing portion often forks and sometimes the whole plant is forked, each branch bearing a tuber at the apex.

The plant is closely allied to *Fossumbronia himalayensis* not only as regards tuber-forming habit but in the position of the sex organs, the perianth and the structure of the sporogonium. As a matter of fact, the only difference between the two genera is that, whereas, in *Fossumbronia* the wing is divided intolobes (leaves), in *Sewardiella* it is entire. *Sewardiella* may be said to be a condensed *Fossumbronia*. The plant may well be put in the genus *Fossumbronia* if the same procedure is followed in the other *Anacro-gynous Jungermanniales*, and the difference between an entire and a lobed wing (leafy stem) is not considered to amount to a generic difference.

The plant can be easily recognised by its midrib raised up in the middle and bent down both anteriorly and posteriorly, and ascending wings. From the apical tuber, which lies buried underground, the plant on germination begins to grow upwards, then grows horizontally for a short distance and ultimately bends down to form a new tuber. The midrib in this way forms a characteristic bend with the concavity downwards. Several such bends may be met with in the same plant behind one another indicating several years' growth, but the wing, naturally, disappears in the older plants.

In the young condition the plant is exceedingly like the tuberous prothallus of *Gymnogramme leptophylla*, a fern, which is sometimes met with in the localities where this plant grows.

The perianth arises in the form of several bracts, which do not grow simultaneously. Gradually the bracts fuse and all of them are then carried upwards by basal growth. Sometimes fusion cannot take place at one or two places, the bracts being at a distance from each other. In such cases the perianth shows one or two splits extending to the base. As the bracts do not arise in a regular ring but some towards the outside and others towards the centre nearer the archegonia we find that in the ripe perianth
these may be fused to both the inner and the outer surface of the perianth. Sometimes the number of these bracts is so great that the perianth has the appearance of a double flower.

The morphology of the involucre and the perianth in the Codoniaceae requires further investigation. As pointed out above, in the genus Sewardiella in the young condition, the archegonia are surrounded by a number of bracts, and these later on, by basal zonal growth, are carried upwards and a more or less bell-shaped structure is produced which has got these bracts on the margin and often on the inner and outer surface also. The whole structure may as well be called an involucre.

* * * * *

XXIII. PETALOPHYLLUM Gottsche.


Plants small and slender with a short basal cylindrical stalk-like portion and a fan-like expansion, simple or furcate, with parallel erect lamellæ on the dorsal surface. Antheridia scattered on the dorsal surface, spherical, with a pedicel, accompanied by scales. Archegonia in groups on the dorsal surface, surrounded by scales and enclosed at maturity by the tubular perianth. Calyptra free, large. Capsule rather shortly pedicellate, spherical, dehiscing irregularly. Wall of three or four layers of cells, the inner with incomplete annular bands. Spores reticulate-lamellate. Elaters long, more or less attenuate, 2-3-spiral.

94. Petalophyllum indicum Kashyap.


 Dioecious. Plants simple or furcate, growing singly or in patches of three or four, up to 12 mm. long and 7 mm. broad. Basal portion cylindrical and wingless. Wing many-layered at the base, gradually becoming one-layered, wavy along the margin. Lamellæ one-cell thick and 15–24 cells high, running outwards and forwards from the midrib, not always parallel. Antheridia in groups behind the apex, protected by scattered scales. Arche-
gonia in groups of 4-7 on the midrib, protected by a bell-shaped perianth with a lacerated margin, often with two or three splits along the whole length. Sporogonia 1-4, usually one, in each perianth. Seta usually 10-20 mm. long, sometimes very short, occasionally up to 25 mm. Capsule 2 mm. in diameter, spherical, dark brown. Capsule wall usually 3-layered; cells of the outer layer thin-walled, sometimes with thick radial walls; those of the inner layers with thick annular or sometimes semi-annular bands. Spores dark brown, about 40 µ in diameter, spherical, with a membranous wavy margin, reticulate-lamellate, 3-4 reticulations in the diameter, reticulations pentagonal or hexagonal, 8-10 µ, marginal wing 14-17 µ. Elaters trispiral, lightly coloured, spirals very distinct, brown and lax, 280-400 µ long, 8-10 µ broad, simple or occasionally branched, attenuated towards both ends. A few elaters are short and about 16 µ broad.

Plate XXVI, figures 1-5.
Hab. Moist places.
Distrib. Lahore, Ravi bank; Bank of the Beas.

Note.—At the end of the season the apex becomes thickened forming a tuber and becomes buried underground. The dorsal vertical lamellæ easily distinguish this plant from other liverworts.

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XXIV. BLASIA L.


Thallus several times dichotomously branched, with a broad midrib passing into 1-layered lobes (leaves). Under-leaves in one row on each side of the midrib. Leaf-auricles containing *Nostoc* colonies present at the base of the lobes usually in pairs. Male plants smaller, antheridia oval, with a short pedicel, immersed singly in small chambers. Archegonia in a cluster, at first naked, the fertilised one becoming enclosed by a fusiform thick involucre with a constricted mamillate apex. Calyptra free, thin and membranous. Capsule rather longly pedicellate, oval, with a collar at the base. Dehiscence by 4, rarely 5-6 valves. Capsules wall of 3-4 layers
of cells, those of the outer layer with thick radial walls, those of the inner layers smaller and tender, without bands and soon becoming disorganised. Elaters bispiral, spirals often splitting. A few rudimentary elaters fixed at the base of the capsule. Gemmæ of two kinds.

95. **Blasia pusilla** L.


 Dioecious. Plants rather fleshy, dichotomously branched, lobed, lobes (leaves) rather shallow, not extending to the midrib, very leaf-like at the apex. Thallus up to 30 mm. long and up to 5 mm. broad. Midrib broad, projecting ventrally, gradually passing into the wings, about 10 cells thick in the middle. Upper and lower epidermal cells small, middle ones large. Under-leaves in two rows, one on each side of the midrib, distant, small, hyaline, ovate to subrotund, irregularly toothed, peltate. *Nostoc* auricles usually two at the base of each lobe. *Nostoc* colonies rounded or oval, seen from the dorsal side through the thallus, appearing as if embedded in the thallus. Star-shaped gemmæ generally present behind the apex, easily detached and scattered. Flask-shaped gemmæ receptacles rare. Male plants smaller, antheridia few, oval. Pedicel of the capsule 2 cm. long. Spores 33–43 μ, rounded, yellowish brown, granular. Elaters paler in colour.

Plate XXVII, figures 1–4.

Hab. Moist rocks.

Distrib. Kulu (6,000 ft.), Nagar; Kumaon; Garhwal, Gangotri Road.

Note.—The sterile plants resemble *Anthoceros* superficially on account of the *Nostoc* colonies. They can be easily distinguished by the star-shaped gemmæ which are almost always present on the dorsal surface just behind the apex.

The plant is intermediate between the thallose and the foliose forms. The lobes in the posterior part are quite shallow, but at the apex they are very leaf-like. They are regarded as lobes or leaves variously by different writers. In addition to these lobes the plant has other appendages on both the ventral and dorsal surfaces. On the ventral surface are the under-leaves and *Nostoc* auricles. On
the dorsal surface are found two kinds of gemmæ. Just behind the apex naked star-shaped gemmæ are met with in almost all plants. These scale-like gemmæ are loosely attached singly to the dorsal surface behind the apex and are fixed at the base, unlike the amphigastria which they resemble in shape but which are peltate. The gemmæ begin to grow while still attached to the plant and are usually detached in the form of a tuft. They are easily detached and are seen scattered on the dorsal surface. Other gemmæ are met with in flask-like cavities on the dorsal side. Sometimes archegonia occur in these receptacles along with the gemmæ.

We have so far come across no ripe sporogonia and the description of the sporogonium is after Macvicar and Stephani.

* * * * *

XXV. PELLIA Raddi.

Pellia Raddi, Mem. Soc. Ital. Mod. 18, p. 49 (1820).

Thallus thin, prostrate, dichotomously branched, with a broad midrib, slightly projecting below, gradually passing into the wings; wing many-layered towards the midrib, becoming 1-layered towards the margins. Internal cells wider than the epidermal cells. Scales absent; club-shaped mucilage hairs present at the apex. Antheridia globular, shortly stalked, immersed singly in the cavities on the dorsal side of the midrib in two to several rows. Archegonia on the dorsal surface of the thallus in a pit surrounded by a complete or incomplete (open in front) tubular involucre, capsule with a long seta, globular, wall two or more cells thick, dehiscing by four valves up to the base. Spores large, germinating within the capsule. Elaters 2- or 3-spiral, many fixed to the base of the capsule.

Note.—All the three species of the genus are said to occur in the Himalayas. Unfortunately fertile plants with ripe sporogonia are rarely met with. P. calycina as described here is exceedingly common throughout the Western and the Kumaon Himalayas from 5,000–8,000 feet. Pellia epiphylla is exceedingly common in Sikkim and the Eastern Himalayas generally, being very abundant round about Darjeeling on the road to Tiger Hill,
What looks like *P. epiphylla* has been met with occasionally in the Western Himalayas, but we have not come across specimens, which could be certainly referred to *P. Neesiana*.

Stephani does not mention the presence or absence of fibrous bands as a distinguishing feature of the species. All the specimens described here under *Pellia calycina* are without such fibres, though the involucre in these forms is more like that described by others for *P. Neesiana*.

**Key to the species (after Macvicar).**

\[
\begin{align*}
1 \quad & \text{Thallus without fibrous bands on the cells as seen in cross section of the thallus} \quad \Rightarrow P. \text{ calycina} \\
2 \quad & \text{Thallus with brown bands, calyptra exserted, inner wall of the capsule with bands} \quad \Rightarrow P. \text{ epiphylla} \\
4 \quad & \text{Monoeious; involucre hood-like posteriorly, wanting in front} \quad \Rightarrow P. \text{ Neesiana}
\end{align*}
\]


Dioecious. Plants green, growing among moss and grass, or in dense patches of overlapping individuals under flowing water, dichotomously or more or less pinnately divided, lobes quadrate to oblong-linear, about 5 mm. broad, often with a dark streak along the mid-dorsal line, margin undulate, apex slightly notched. Midrib conspicuous, slightly projecting ventrally, gradually passing into the many-celled lamina, which becomes one-layered towards the margin, one-celled portion from a few to 15 cells broad, greatest thickness in the middle about 10 cells, no thickened bands on the cells. Antheridia conspicuous, in two or three rows on the dorsal side of the midrib. Archegonia in a cluster. Involucre tubular, directed forwards, posterior wall long, anterior short, mouth shortly irregularly dentate. Calyptra included. Seta long, pellucid. Outer layer of the capsule wall with nodular thickenings at the angles,
innermost layer without thickening bands. Spores 56–77 μ in diameter. Elaters vermiciform, 10–12 μ broad, 3-4-spiral. Elater-bearers very long and slender, bispiral.

Plate XXVII, figures 5-6.

Hab. On moist soil among moss and grass, or actually under flowing water.

Distrib. Exceedingly common in the Kumaon and the Western Himalayas, becoming less frequent to the west up to Kashmir, 5,000–8,000 ft., Mussoorie; Kulu; Simla; Dalhousie; Pangi; Murree; Jummu, Patni Pass; Verinag; Kaghan Valley (N.A. Qizilbash); Poonch (R. R. Stewart); etc.

The description of spores and elaters given above is after Macvicar: Student’s Handbook of British Hepatics, p. 75 (1926).

Note.—The plant forms large patches of overlapping individuals under flowing water, usually accompanied by Dumortiera hirsuta and often by Conocephalum conicum. It can easily be recognised from the former by its smaller size and lighter colour and from the latter by the absence of reticulations, pores and scales. It varies greatly in length, breadth and thickness of the lobes. In very moist and shady places the lobes are long, narrow and thin; in other places they are broader and thicker, with a conspicuous dark mid-dorsal streak. During the growing season the plants form a very characteristic tuft of small lobes at the apex owing to the rapid and repeated dichotomy.

97. Pellia epiphylla (L.) Lindb.

Pellia epiphylla Lindb., Hep. in Hib., p. 534 (1874).

Monœcious, in flat dark green patches. Thallus narrow at the base, oblong or obcordate, up to 4 cm. long and about 1 cm. broad, entire or slightly undulate, midrib in section about 12 cells thick, cells with thickening bands. Involucre reduced to a pouch open in front, lobed at the free margin. Antheridia on the dorsal side along the middle in two or three rows behind the archegonial cluster. Calyptra exserted, tubular. Pedicel of the capsule
hyaline, long. Capsule globose, wall of two or three layers of cells, cells of the inner layer with semi-annular thickening bands and those of the outer layer with nodulose thickenings. Spores 80–100 μ in diameter, oblong-oval, muriculate. Elaters very long and thin, 8 μ broad, bispiral, elater-bearers thick, 3-4-spiral.

Plate XXVII, figures 7-8.

Hab. On moist rocks, etc.

Distrib. Common in Sikkim Himalayas, near about Darjeeling; occasionally Western Himalayas.

*Note.*—The description of the capsule, spores and elaters is after Macvicar: Student’s Handbook of British Hepatics, p. 72 (1926).

**98. Pellia Neesiana** (Gottsche) Limpr.

*Pellia epiphylla* forma *Neesiana* Gottsche in Hedwigia, p. 69 (1867).


Diœcious. In less extended patches than *P. epiphylla*, nearly always tinged with dark red, especially on the midrib, translucent towards the margin. Thallus rather narrower, more undulate and of more equal width, less expanded and usually less lobed at the apex; in section about 12 cells thick in the middle with interlacing thickened bands. Involucre forming a short complete cylinder, or occasionally split on the antical side, irregularly crenate-lobulate at the mouth. Calyptra more or less exserted, seldom included, cylindrical with expanded apex, roughened with 2-celled scattered hairs. Capsule, spores and elaters as in *P. epiphylla*. Male plants generally growing with the female.

Plate XXVII, figures 9-10.

The above description is after Macvicar: Student’s Handbook of British Hepatics, p. 73 (1926).

* * * * *

**XXVI. CALYCULARIA** Mitt.


Diœcious. Plants large or medium, gregarious, prostrate, light or deep green. Thallus dichotomous or innovating from the
apex, rarely so; from the ventral surface, wings ascending, canaliculate; midrib rather broad, gradually passing into the wings. Wings gradually attenuated from a thick base and one cell thick towards the margins. Amphigastria always present, aggregated towards the apex of the lobes, lanceolate or subulate. Androecia on the dorsal side of the midrib, bracts more or less aggregated, each with one antheridium, erect, hood-like, apex lacerated. Arche- gonia aggregated towards the apex on the dorsal side. Bracts long, lanceolate, strongly laciniate or distantly spinous, united at the base into a ring. Perianth large, broad at the base, infundibuliform, campanulate or inflated-cylindrical, often with longitudinal folds; opening broad, spinous or lacerated. Calyptra large, base more or less thick. Capsule on a short pedicel, broadly oval, wall many-layered, cells of the external layer small, brown and equally thickened, cells of the inner layers delicate. Dehiscence by 4–7 valves. Spores small, papillate or echinate. Elaters short, fusiform, bispiral.

**Key to the species.**

<table>
<thead>
<tr>
<th>Plants long, in tufts</th>
<th>..</th>
<th>C. crispula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants short, compact and solitary</td>
<td>..</td>
<td>C. compacta</td>
</tr>
</tbody>
</table>


 Dioecious. Plants large, strong, growing in tufts with mosses, pale green, simple or branched, ventral shoots present, up to 20 mm. long and 4 mm. broad, lobes broadly ligulate, margins crisped. Midrib conspicuous from above, 15 cells thick in the middle, broad, projecting ventrally and gradually passing into the wings, wings about half the width of the frond, flat. Amphigastria linear or linear-lanceolate, ending in a few-celled filaments, with one- or more-celled filamentous projections ending in rounded mucilage cells arising from the margin. Male plants smaller, androecia dorsal and often covering the whole of the midrib, in several rows. Antheridia short stalked, globular, in the axils of laciniated scales which are often more or less confluent. Archeegonia in
a cluster on the dorsal side; each cluster surrounded by a number of involucral scales both at the back and on the sides but not in front, the involucral ring in front being completed by the upturned amphigastria. Perianth large, infundibuliform, lower portion entire, thick, upper lacerated, thin. Calyptra delicate. Capsule with a thick short seta, subglobose, spores 45–65 μ, purple brown, long echinate, bristles long, cylindrical, apex truncate. Elaters up to 350 μ, bispiral, or shorter (about 240 μ) and thicker, some elaters branched.

Plate XXVIII, figures 1–6.

Hab. Mixed with mosses.

Distrib. Garhwal, Mussoorie, Gaurikund; Kumaon, Gangoli-hat; Dalhousie-Khajiar Road, about 7,000 ft.; Darjeeling very common on the road from Ghoom to Tiger Hill. The Mussoorie specimens were found by Mr. P. N. Mehra on the trunk of a tree.

Note.—In the young condition the archegonia are surrounded by scales on three sides, i.e. posteriorly and laterally, being protected in front by the upturned amphigastria. In many cases the posterior bracts are in several rows and extending for a considerable distance behind the receptacle.

The perianth arises in the form of several bracts which do not grow simultaneously. Gradually these bracts fuse and all of them are carried upwards by basal growth. Moreover, in many cases there are no bracts outside the perianth which make one think that the involucre is absent. The proper thing would be to say that the fusion has effected all the bracts so that no bracts are left free. Thus there is no hard and fast line between the involucre and the so-called perianth, and the perianth is the result of the fusion of all or most of the involucral bracts which are carried up by basal growth.

The following few cases are of special interest in this respect:—

1. In one case there were two bracts attached to the lateral surface of the mature perianth, one in front of it and two or three bracts absolutely , free just behind the perianth.

2. In another mature perianth two sporogonia of different
ages were seen. Inside this perianth there were four free bracts quite separate from the perianth and one of them was quite large and actually separated the two sporogonia.

3. In another case behind a mature perianth were six scattered bracts and inside the perianth were found three bracts two of which arose from the base of the perianth and were not attached to it and the third one arose from the inner surface of the perianth and was attached to it. (Compare with the development of the perianth in Sewardiella.)


Dioecious. Plants small, dark green, occurring singly among moss and grass, slightly branched, with ventral shoots, 12 mm. long and up to 6 mm. broad. Rhizoids from the ventral surface of the midrib, numerous, simple, yellowish. Midrib conspicuous as seen from above, projecting below, up to 16 cells thick; wings thin, crisped, occasionally crenate, ascending, one cell thick throughout their greater portion. Amphigastria long linear, bent towards the dorsal side at the apex or merely filamentous, of a few cells each (6–10 cells). Bracts on the male plants many, laciniate, with long, linear or filamentous processes. Antheridia aggregated along the midrib throughout the length of the plant, globular, shortly stalked, accompanied by bracts. Bracts on female plants more or less ovate, laciniate or occasionally simply acuminate. Perianth erect, 1-2 mm. long, thick at the base, narrow below, broad above, thin, plicate, mouth shortly lobed, lobes irregularly spinous, denticulate. Rest not seen.

Plate XXVIII, figures 7–9.

Hab. On moist earth among moss and grass, mixed with Aneura indica.

Distrib. Lahul, Kyelang, 11,000 ft.

Note.—A small, delicate and very compact plant with very closely crisped margins. Older parts of the midrib mycorrhizal. Possibly a compact form of C. crispula adapted to the dry climate of Lahul. In the present species the plants occur singly and not in tufts as in C. crispula. The plant grows up from a
cylindrical basal portion, then becomes horizontal, and at the end of the season bends down again.

FAMILY XI. BLYTTIACEÆ.

Thallus with a distinct and usually sharply defined midrib, male and female inflorescence on the dorsal surface of the thallus, not on special branches, the archegonia in groups. Involucre double or single. Capsule generally cylindrical, usually dehiscing incompletely by 2–4 valves, the inner wall without semi-annular thickenings.

Not represented by any species in this area.

FAMILY XII. ANEURACEÆ.

Thallus fleshy or membranous, in Metzgeria with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells, of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end with one broad spiral band, or fixed, short and obtuse with an indistinct spiral band and persistent as erect tufts at the apex of the valves.

Key to the genera.

Thallus gradually thinning towards the margins . . Aneura
Sharply defined midrib and one-layered wings . . Metzgeria

XXVII. ANEURA Dum.


Thallus fleshy, often pinnately branched, with usually a broad midrib. Epidermal cells usually smaller than the inner cells. Sex organs on short lateral branches. Male branches with
a more or less circular outline, distinct, margin more or less papillate; antheridia usually biseriate. Female branches very short, margin laciniate, enclosing 2–8 biseriate archegonia. Perianth absent. Calyptra large, cylindrical or clavate, fleshy, always with papillae at the apex. Capsule longly pedicellate, oblong-cylindric, opening by four valves to the base, wall of two layers of cells, cells with semi-annular bands. Spores small. Elaters short, attenuate, monospiral. Fixed elaters persistent as erect tufts on the apex of the valve.

Note.—The capsule has a columella-like structure projecting from the apex into the cavity of the capsule and bearing a number of fixed-elaters. On dehiscence this structure also divides into four pieces along with the four valves and the fixed-elaters remain attached to them sticking outwards.

Gemmae are not uncommon in some species. They are usually 2-celled and are formed endogenously in the cells of the uppermost layer of the thallus, becoming free by the rupture of the cell wall.

Key to the species.

Thallus lobes broad, usually fleshy, plants occurring singly or in patches ... ... A. indica.

Thallus lobes long and very narrow, plants densely overlapping ... ... A. Levieri

101. Aneura indica St. (Ms.).


Dicocious. Thallus simple or irregularly pinnately branched or forming rosettes, loosely attached to the humus or closely attached to the soil. Lobes up to 3 cm. long and 5 mm. broad, thick or thin, margin undulate, slightly raised or firmly fixed to the soil. No distinct midrib, thallus gradually thinning towards the margins; greatest thickness in the middle 8–13 cells. Cells of dorsal epidermis flat, convex or strongly papilliform. Male plants smaller, irregularly branched, branches rather long and narrow, thick, fleshy, margin turned upwards. Antheridia on small branches with a circular outline, restricted to the central part of the
dorsal surface. Archegonia with filamentous or small flat green scales. Sporogonium (from the South Indian specimens): seta 6 mm. long; capsule shortly cylindrical, 2.5 mm. long; both layers of the capsule wall with thick brown annular bands. Spores lamellate, with a broad margin, 20–30 μ. Elaters monospiral, 190 μ long.

Plate XXIX, figures 1–6.

Hab. Moist rocks, among grass and moss in the hills or on moist earth in the plains.

Distrib. Common. Western Himalayas, Dalhousie, Sahasar Dhara (3,000 ft.), Mussoorie, etc.; Lahul, Kyelang (11,000 ft.). Occasionally occurs in the Punjab plains also, Lahore, Sialkot. South India (Rangachariar); Palni Hills, 7,000 ft. (Mrs. Robinson).

Note.—This plant is extremely variable. In moist shady places in the hills the plants remain thin and light green, only loosely attached to the soil; while in exposed places (in the plains) the plants are thick, fleshy, deep green and firmly fixed to the soil. Dorsal epidermal cells of the plants from moist places are flat and of those from exposed places are convex to distinctly papillate. The dorsal epidermal cells of the male plants are always papillate. As a consequence the length of the upper epidermal cells is very variable.

Specimens of Aneura from the Punjab plain and Mussoorie were sent to Stephani in the beginning of 1914 for determination. He named them Aneura indica and A. mussuriensis respectively. A study of the specimens, however, from a large number of places in India, both from the plains and the hills, shows that the plant is very variable and the specimens referred to above belong to one and the same species. The name A. indica has, therefore, been given to this species. Some forms of the plant resemble A. pinguis (L.) Dum. very much.

102. Aneura Levieri Schff.

Plants brownish, densely overlapping in thick patches, very much branched in an irregularly pinnate manner, up to 10 mm. long. Lobes linear or linear-oblong, ultimate branches quadrate or obovate-oblong, or in very moist places linear. No distinct midrib. Main shoot up to 8 cells thick, biconvex in cross-section; cells all alike or epidermal cells rather small. Rest not seen.

Plate XXIX, figure 7.

Hab. Moist rocks.

Distrib. Chamba-Chuari Road, 6,000 ft.; Pangi, in running water, near Shaichu, 8,000 ft.; Alwas-Silrundi Road, 8,000–10,000 ft.; Palni Hills, South India, 7,000 ft. (Mrs. Robinson.)

Note.—The Pangi specimens are much longer, up to 40 mm., but the older parts are dead. They are also thinner and the ultimate lobes are oblong or linear-oblong.

There is a specimen of a species of Aneura labelled Aneura pinguis Dum. collected from Boshar in June, 1864, at the herbarium of the Forest Research Institute, Dehra Dun. Stephani (Sp. Hep., Vol. I, pp. 272-273) has also reported this species from the Himalayas which is according to him very widely distributed in the whole world. The following description is given after him.

103. Aneura pinguis (L.) Dum.

Aneura pinguis (L.) Dum., Comment., p. 115 (1822).

 Dioecious, broadly linear or ligulate, thick, green or yellowish green, in large patches. Thallus up to 2 cm. long, furcate, fixed by numerous rhizoids, lobes divergent, simple, canaliculate, 3 mm. broad, midrib broad, 8 cells thick, strongly produced on the lower side, abruptly passing into the wings, wings obtuse, entire, ascending, crisped, inner cells of the thallus much larger than the epidermal cells. Male branches pseudo-lateral from the thallus, oblong, sometimes with rhizoids, short, often 2- or 3-lobed, lobes ovate, wings thin, spreading, 3 cells broad, four pairs of antheridia, occasionally in three rows. Female branches pseudo-lateral from the main shoot, shortly and thinly laciniate at the apex, covered
by a margin of the thallus. Calyptra cylindrical, at maturity 8 mm. long, smooth, mamillae small, highly papillate. Spores reddish, minutely papillate, 18 μ. Elaters up to 200 μ, reddish, laxly spiraled, narrowly attenuated at the apex.

Hab. Himalaya (Duthie).

XXVIII. METZGERIA Raddi.

Metzgeria Raddi in Att. Soc. Scient. Mod. 18, p. 34 (1818).

Thallus membranous, usually dichotomously or sometimes pinnately branched, with ventral innovations arising from the sides of the midrib. Midrib slender, sharply defined from the wings, wing of one layer of cells. Sex organs on greatly reduced ventral branches. Antheridia few, shortly pedicellate, globose. Female branch curved into an obcordate involucre furnished with hairs. Perianth absent. Calyptra thick, fleshy, clavate, hairy. Capsule shortly pedicellate, oblong-oval, 4-valved, wall of two layers of cells, the outer with nodular thickenings, the inner with indistinct annular bands. Spores small, spherical, smooth or minutely papillate. Elaters long, attenuate, monospiral, the spiral band broad, reddish brown. Fixed elaters partly persistent as erect tufts on the apex of the valves. Gemmæ discoid to linear.

Note.—The genus is at once recognised by the distinct midrib and 1-layered wing.

Key to the species.

Plants with straight bristles all over the surface and the margins . . . . . . M. pubescens
Plants with long slender hairs only on the under-surface of the midrib and along the margins . . . . . . M. himalayensis

104. Metzgeria pubescens Raddi.

Metzgeria pubescens Raddi in Att. Soc. Scient. Mod. 18, p. 46 (1818).

Dioecious. Plants forming rather large patches on rocks, or thin layers on mosses, etc. yellowish green. Thallus up to 50 mm. long and 2 mm. broad, irregularly pinnate or more or less
distinctly dichotomous, margin undulate, wing sometimes interrupted; thickly beset on both surfaces and margins with straight bristles. Ventral innovations very common. Midrib subterete, highly and almost equally arched on both surfaces. Cells of the wing 5-6-angled, not elongate, 32–40 μ in diameter, walls thin, angles hardly thickened. Male branch with hairs only on the postical surface. Female branch with hairs on both surfaces.

Plate XXX, figures 1–3.

Hab. Moist shady rocks.

Distrib. Common, 7,000–10,000 ft. Dalhousie-Chamba Road; Chamba-Pangi Road; Kulu, Bhaboo Pass; Kumaon, Mussoorie, near Gangotri; Kashmir, Burzil Valley, 10-11,000 ft. (Duthie); Tehri-Garhwal, Chansil range, 10-12,000 ft. (Duthie), Boshar, (Herb., F.R.I., Dehra Dun), etc.

Note.—The plant can be very easily recognised by the densely arranged bristles on both surfaces of the thallus (midrib as well as the wings) and along the margins. The plant varies greatly in size and mode of branching. Some plants are long and robust extending up to 50 mm. in length, and up to 2 mm. in breadth of lobes, and are always pinnate. Others are much smaller, delicate, not exceeding 1 mm. in breadth and they are more or less distinctly dichotomous. Intermediate forms are also met with.


Monoecious. Plants deep green, dichotomous, up to 15 mm. or more long. Lobes up to 4 mm. long and up to 1 mm. broad. Midrib biconvex, lamina plane or undulate, occasionally interrupted. Long hairs present on the under-surface of the midrib and along the margins, the rest naked. Midrib 4–6 cells thick and 3–4 cells broad through the centre. Epidermal cells of the midrib 2/2. Lamina in older parts up to 14 cells on each side; cells 32 μ × 30 μ. Male branches without hairs. Female branches with numerous hairs.
Plate XXX, figures 4–6.

Hab. Moist places.
Distrib. Fairly common from 5,000–9,000 ft. Dalhousie; Kulu, Bhaboo Pass; Mussoorie; Kaj Nag, 12-13,000 ft. (Duthie), Chandar Tal, 12,000 ft. (Gamble) (Herb., F.R.I., Dehra Dun), etc.

Note.—The number of hairs on the thallus in this species varies very greatly. Sometimes there is a regular fringe all along the margin and many hairs may be met with on the ventral side of the midrib. In other cases only a few hairs are met with here and there on the margin and none may occur on the midrib. The hairs may be straight, long and slender, or hamate.

There is a specimen in the herbarium of the Forest Research Institute, Dehra Dun, labelled *M. furcata* (L.) Lindb. from Boshar, but it is not so far reported from India. The following description is after Stephani (Sp. Hep., Vol. I, p. 289, 1899).


*Jungermannia furcata* L., Sp. Pl., p. 1136 (1753).
*Metzgeria furcata* (L.) Lindb. Monogr. Metzg., p. 35 (1877).

Dioecious, small, pale, on bark, dense depresso-caespitose. Thallus furcate, subplane, apex rounded. Midrib thin, antical two cells broad, postical four cells broad, cells small and narrowly rectangular, ventral surface with long hairs. Wings scarcely decurved, more or less densely hairy, hairs long, distributed up to the margins; hairs on the margin absent. Cells of the wing 36 μ × 27 μ, those near the midrib longer, trigones small. Female branches obcordate, plano-convex, longly and sparsely hairy. Calyptra clavate-pyriform, more or less hairy.

Hab. Himalaya (Boshar).

107. Metzgeria conjugata Lindb.

Metzgeria conjugata Lindb. Monogr. Metzg., p. 29 (1877).

Monœcious, medium, dense-caespitose. Thallus repeatedly furcate, convex, apex obtuse. Midrib ventrally produced, bounded by 6 cells, 2 antical and 4 postical, postical small with long hairs. Wing strongly decurved, naked, margins with more or less numerous hairs, hairs short, straight, in pairs, divergent. Cells of the wing $65\mu \times 40\mu$, trigones absent. Female branch with long hairs on the dorsal surface of the margin; calyptra with numerous bristle-like hairs.

Hab. Kashmir.
SPHÆROCARPALES.


FAMILY XIII. RIELLACEÆ.

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.

* * * * *

XXIX. RIELLA Mont.


Plants thallose, small or medium, delicate, light green, erect or ascending, with thin-walled rhizoids at the base, under water, occasionally on moist soil when water has flown away. Midrib in section elliptical, central cells elongated, cortical cells parenchymatous. Branching furcate. Wing arising from the dorsal side of the midrib, 1-layered, delicate, narrow at the base, well-developed above, falcate-rotund at the apex; margin entire or slightly lobed or incised, plane or slightly undulate. Leaves on the dorsal side, on both sides at the base of the wing, rudimentary or well-developed. Antheridia on the margin of the wing, immersed, in rows, shortly pedicellate, ovoid, each surrounded by an envelope, papillae inconspicuous. Archegonia from the dorsal side of the midrib, each surrounded by an involucre; involucre large, 1-layered, ovoid, in the upper portion more or less inflated, opening small. Calyptra strong, 2-layered. Capsule spherical, wall 1-layered, pedicel short, foot thick. Spores large, tetrahedral, minutely reticulate-lamellate. Sterile cells a little smaller than the spores, hyaline, without any spiral bands.
Note.—The dorsal wing distinguishes this genus from all other liverworts, and the plants of this genus are always aquatic. The sterile cells are disorganised when the spores are ripe.

108. Riella indica St. (Ms.)


Plants submerged, erect or ascending, firmly fixed to the mud by the rhizoids, often in dense patches, light green, simple or once or twice forked, up to 10 mm. long. Often many branches are given off from the base and plants have a tufted habit. Wing well-developed in early stages, up to 2 mm. broad, in the fertile portion small and interrupted. Lateral leaves (bracts) long and narrow, linear, conspicuous. Involucres up to six on each plant, densely situated, cylindrical, pointed, up to 2 mm. long, cells papilliform. Spores reticulate on the convex side, 7-8 reticulations in the diameter, the angles projecting as spines, merely spinous on the flat sides, 60–70 μ.

Plate XXXI.

Hab. In shallow water in a water channel of the Shalamar Garden, Lahore; occasionally on mud.

Note.—The plants were first found in the months of February and March of 1913 and 1914. This is the only species of the genus so far found in India.

Family XIV. SPHÆROCARPACEÆ.

Thallus without a distinct midrib, of one layer of cells towards the margin, entire or lobed, involucres of sex organs closely grouped, pear-shaped or conical. Spores usually permanently united in tetrads.

Not represented by any species in this area.
SYNOPSIS.

JUNGERMANNIALES.

Family I, Lejeuneaceæ.
Genus I, Frullania.
  1, F. squarrosa.
  2, F. retusa.
  3, F. muscicola.
  4, F. gracillima.
  5, F. pyriflora.
  6, F. Grevilleana.
  7, F. Gollani.
  8, F. himalayensis.
  9, F. Duthiana.

Genus II, Lejeunea.
  10, L. (Ptychanthus) Perrottetii.
  11, L. (Ptychanthus) chinensis.
  12, L. sp. A.
  13, L. sp. B.
  14, L. sp. C.
  15, L. sp. D.
  16, L. (Physocolea) sp. E.
  17, Ptychanthus striatus.

Family II, Madothecaceæ.
Genus III, Madotheca.
  18, M. appendiculata.
  19, M. campylophylla.
  20, M. Gollani.
  21, M. plumosa.
  22, M. denticulata.
  23, M. acutiphylla.
  24, M. variabilis.
  25, M. platyphylla.
  26, M. decurrens.
  27, M. Gambleana.
28, M. macroloba.
29, M. gracillima.
30, M. obtusifolia.
31, M. angusta.
32, M. hastata.
33, M. ovalis.
34, M. trigonifolia.
35, M. virens.
36, M. densiramea.
37, M. densifolia.
38, M. Borellii.

Family III, Pleuroziaceae.
Not represented by any species.

Family IV, Radulaceae.
Genus IV, Radula.
39, R. complanata.
40, R. grandifolia.
41, R. Douleana.
42, R. Lindbergii.

Family V, Scapaniaceae.
Genus V, Diplophyllum.
43, D. orientale.
Genus VI, Scapania.
44, S. verrucosa.
45, S. purpurea.
46, S. parva.

Family VI, Ptilidiaceae.
Genus VII, Anthelia.
47, A. julacea.
Genus VIII, Blepharostoma.
48, B. trichophyllum.

Family VII, Cephaloziaceae.
Genus IX, Lepidozia.
49, L. reptans.
Genus X, Mastigobryum.
50, M. triangulare.
Genus XI, Calypogeia.

51, C. renistipula.

Genus XII, Cephalozia.

52, C. Gollani.

Family VIII, Lophoziaceae.

Genus XIII, Chiloscyphus.

53, C. inflatus.
54, C. argutus.
55, C. himalayensis.
56, C. polyanthus.
57, C. campanulatus.
58, C. Gollani.

Genus XIV, Lophocolea.

59, L. bidentata.
60, L. heterophylla.
61, L. minor.
62, L. alata.

Genus XV, Plagiochila.

63, P. mundaliensis.
64, P. simlna.
65, P. Mittenii.
66, P. ferruginea.
67, P. accedens.
68, P. sp. A.
69, P. sp. B.
70, P. himalayensis.
71, P. Duthiana.
72, P. cavifolia.
73, P. Gollani.
74, P. grata.
75, P. nana.
76, P. asplenioideae.

Genus XVI, Lophozia.

77, L. alpestris.
78, L. incisa.
79, L. sp.
80, L. piacenzai.
Genus XVII, Jamesoniella.
81, J. elongella.

Genus XVIII, Solenostoma.
82, S. lanceolata.
83, S. crenulata.
84, S. breviflora.
85, S. purpurata.

Genus XIX, Jungermannia.
86, J. oblongifolia.
87, J. viridis.
88, J. humilis.
89, J. Duthiana.
90, J. tenerrima.

Genus XX, Southbya.
91, S. Gollani.

Family IX, Calobryaceae.
Not represented by any species.

Family X, Codoniaceae.
Genus XXI, Fossombronia.
92, F. himalayensis.

Genus XXII, Sewardiella.
93, S. tuberifera.

Genus XXIII, Petalophyllum.
94, P. indicum.

Genus XXIV, Blasia.
95, B. pusilla.

Genus XXV, Pellia.
96, P. calycina.
97, P. epiphylla.
98, P. Neesiana.

Genus XXVI, Calycularia.
99, C. crispula.
100, C. compacta.

Family XI, Blyttiacæ.
Not represented by any species.

Family XII, Aneuraceae.
Genus XXVII, Aneura.
101, A. indica.
102, A. Levieri.
103, A. pinguis.

Genus XXVIII, Metzgeria.
104, M. pubescens.
105, M. himalayensis.
106, M. furcata.
107, M. conjugata.

Sphaerocarpales
Family XIII, Riellaceae.
Genus XXIX, Riella.
108, R. indica.

Family XIV, Sphaerocarpaceae.
Not represented by any species.
APPENDIX I.

CLIMATIC DETAILS OF SOME IMPORTANT PLACES.

LAHORE.

Height above sea level .... 700'.
Average annual rainfall .... 19.58".

In summer the temperature goes up to 115° F. or sometimes even more. In winter, during the nights the temperature on the grass falls below 32° F. and for a couple of months there is hoar frost of 5° to 10°. The rain falls mostly in July and August, but a small amount falls in winter also. The summer is very hot and dry, being quite hostile to the growth of tiny and delicate plants like Liverworts.

SIMLA.

Height above sea level .... 6,000' to 8,000'.
Average annual rainfall .... 63".

The mean maximum temperature in winter (December to February) ranges between 49.4° F. and 44.5° F. and the mean minimum temperature between 30.1° F. and 34.5° F. The mean maximum temperature in summer (in July, the hottest month) is 74.4° F. and the mean minimum is 61.0° F.

Snow falls in winter which is the resting season. The rain chiefly falls from July to September.

MUSSOORIE.

Height above sea level .... 6,000' to 8,000'.
Average annual rainfall .... 109.69".

The climate is very much like that of Simla. As the station has got a moist and humid climate the Hepatic flora is very rich.

DALHOUSIE.

Height above sea level .... 6,000' to 8,000'.
Average annual rainfall .... 83.88".
Being further north-west to the above-mentioned stations the climate is not as suitable for Liverworts as that of the two stations given above. The vegetation, therefore, is a little less luxuriant.

KULU.

Height above sea level. . . . . . . (Nagar) . . . . . . . 5,780'.
Height above sea level. . . . . . . (Sultanpur) . . . . . . . 4,000'.
Average annual rainfall. . . . . . (Nagar) . . . . . . . 49·4".
Average annual rainfall. . . . . . (Sultanpur) . . . . . . . 39·74".

Snow falls in winter at Nagar and the winter is severe in the higher lying tracts of Kulu, and in sheltered places snow lies well till April. The mean temperature from June to August at Sultanpur is about 75° F. Mean minimum from January to February 41° F. (Kulu Gazetteer).

CHAMBA.

Height above sea level . . . . . . 3,027'.
Average annual rainfall . . . . . . 47·6".
Mean maximum temperature . . . . . 77·7° F.
Mean minimum temperature . . . . . 56·5° F.

In the Ravi Valley, as elsewhere, the climatic conditions vary with the altitude. In the lower portion of the Valley from the capital downwards they are of a semi-tropical character. The heat is great and rainy season well marked, while the winter is mild and the snowfall light. In the capital the maximum temperature recorded is 108·3° F. and the minimum 30·3° F. From the capital upwards the conditions are more severe, and vary from temperate to semi-arctic. Arctic conditions prevail along the high ranges for several months in winter. In the Brahmaur Wizarat the summer is mild, but winter is severe (Chamba Gazetteer).

KYELANG.

Height above sea level . . . . . . 10,000'.
Average annual rainfall including winter (melted) snow . . . . . . . . . . . . . 23".
Average annual rainfall not including winter snowfall . . . . . . . . . . . . . 6".
The climate of Lahul is most bracing. The air is crisp and keen especially in the Valley of the Chandra; that of the Bhaga Valley at Kyelang has not quite the same vigorous quality. The maximum temperatures at Kyelang range from 33·3° F. in February to 73·6° F. in August, the minimum from 13·4° F. in February to 50·2° F. in July. Lahul is set in a basin, the edge of which consists of enormous mountain ranges. The barriers keep off the monsoon currents, causing the rain to spend itself on their south and west faces. In consequence the summer rainfall in Lahul is scanty, affecting on the average no more than three days in each month. The total rainfall during the whole season from June to September is about 6”. On the other hand nearly three times as much precipitation occurs during the period of December to May, and is then associated mainly with storms of high elevation which traverse Northern India from west to east and pass over the mountains which obstruct the monsoon in summer (Kulu Gazetteer).

In the Chandra Bhaga Valley the climate is temperate in summer and semi-arctic in winter. As the lowest altitude in the Pangi Valley is 7,000 feet, no great heat is felt. The summer is exceedingly mild and pleasant, while owing to the scanty rainfall the degree of humidity is always low. The winter, however, is very severe. Snow commences to fall in October but does not lie permanently till December, after which the whole valley is under snow till March or April (Chamba Gazetteer).

**LEH (LADAK).**

- Height above sea level . . . 11,000′.
- Average annual rainfall . . . 3”.

Winter is very severe. Cold and dry winds are prevalent in the whole of Ladak. Trees are met with only in low-lying sheltered places. In Rupshú the altitude of the plateau is from 13,000 feet to 16,000 feet at different places, and the climate is extremely rigorous. There are absolutely no trees there.
APPENDIX II.

LIVERWORTS OF CERTAIN LOCALITIES.

1. Panjab plain (Lahore, etc.).

1. *Anthoceros himalayensis*, Lahore.
5. *Cyathodium tuberosum*, rare, Jullundur.
15. *Riccia sanguinea*, very common along rivers everywhere.
17. *Fossombronia himalayensis*, rare, Lahore.

The number of species becomes larger and individuals of each species more numerous as we go to the foot of the hills. The two species of *Plagiochasma, Grimaldla indica*, *Fimbriaria pathankotensis, Riccia pathankotensis* and *Riccia himalayensis* become particularly common. *Ricciocarpus natans* and *Riccia fluitans* are met with at Peshawar.

2. Pangí and Lahuí (Chandra Bhaga Valley) 8,000 ft. to 10,000 ft.

2. *Preissia quadrata*, very common.
15. *Madotheca Gambleana*.
17. *Madotheca gracillima*.
18. *Chiloscyphus inflatus* from Chandra Dal by Gamble.

The following have been met with in the Chandra Valley above 13,000.
19. *Sauchia spongiosa*, Dokpo Gongma, about 15,000 feet, and just below the top of the Manh pass.

3. **Spiti.**
2. *Preissia quadrata*.
3. *Reboulia hemispherica*.
4. *Riccia robusta*.

Specimens were collected only between the Manh pass (going from the Chandra Valley) and Losar.

4. **Transhimalayan region (Ladak, etc.).**
1. *Marchantia polymorpha*, beyond the Baralacha pass near Kinlung, about 15,000 feet; Kargil, Leh, etc.
2. *Preissia quadrata*, beyond the Baralacha pass near Kinlung, about 15,000 feet.
3. *Sauchia spongiosa*, beyond the Baralacha pass near Kinlung, a little below 15,000 feet.

5. *Madotheca ovalis* (Stephani, Sp. Hep.).

6. *Anthelia julacea*, Zanskar, about 12,000 to 13,000 feet.

7. *Blepharostoma trichophyllum*, Zanskar, about 12,000 to 13,000 feet.

8. *Lophozia alpestris*, Zanskar, about 12,000 to 13,000 feet.

9. *Lophozia incisa*, Zanskar, about 12,000 to 13,000 feet.

Only the upper part of the Zanskar Valley above Tangse has, however, been visited. More species may be expected in the lower parts. In the body of the book the name Rupshu has been used for the country beyond the Baralacha pass for geographical and climatic reasons but politically the part immediately beyond the pass is included in British Lahul whose boundary extends to a little beyond the Lingti plain.

5. **Kashmir Valley.**

The list is not quite complete, specially as there is a great range of altitude.

1. *Anthoceros sp.*

2. *Marchantia polymorpha.*


5. *Preissia quadrata.*


8. *Plagiochaasma appendiculatum.*

9. *Fimbriaria reticulata.*

10. *Fimbriaria sp.*


15. *Frullania pyriflora.*


17. *Madotheca obtusifolia.*

19. Scapania parva.
20. Plagiochila Mittenii.
22. Plagiochila Duthiana.
23. Plagiochila cavifolia.
25. Fimbriaria Calciatii.
26. Metzgeria pubescens.
27. Lophozia Piacenzai.
28. Lophozia alpestris.
29. Plagiochila asplenioides.
30. Lepidozia reptans.
31. Radula Lindembergiana.
32. Madotheca Borellii.

Species Nos. 18–24 are reported by Stephani (Species Hepaticarum, Vols. I–VI).
Species Nos. 25–32 are reported by Golla (Atti Della R. Accademia Delle Scienze Di Torino, Vol. XLIX, 1914).

APPENDIX III.

BIBLIOGRAPHY.

This short list includes either such papers as deal exclusively with Indian Liverworts or works of a more general nature in which reference is made to Indian Liverworts. A very full bibliography of systematic works is given at the end of Stephani’s Species Hepaticarum.


APPENDIX


XIII The genus *Notothylas* in India. Lahore Philosophical Society, Vol. IV, 1925. (Jointly with Mr. N. L. Dutt.)

XV Liverworts of the Western Himalayas and the Panjab Plain, Part I. Lahore, (1929).

XVI Supplement to the above (No. XV), 1932.


II Hepaticae in Engler und Prantl.


III Hepaticarum Species Novae X. Hedwigia, Band XLIV, pp. 74–75, (1905).


ALPHABETICAL INDEX TO GENERA, SPECIES, AND SYNONYMS.

(Synonyms are in Italics.)

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PLATE I.

FRULLANIA SQUARROSA. 1—5.
1. A shoot, from below.
2. A shoot, from above.
3. A leaf. Note the appendage.
4. Upper cells.
5. Basal cells.

FRULLANIA RETUSA. 6—9.
6. A shoot, from below.
7. Another shoot, from below.
8. Upper cells.

FRULLANIA MUSCICOLA. 10—12.
10. A shoot, from below.
11. Upper cells.

FRULLANIA GRACILLIMA. 13—15.
13. A shoot, from below.
14. Upper cells.
15. Basal cells.
PLATE II.

FRULLANIA PYRIPLOSA. 1—3.
1-2. Two shoots, from below.

FRULLANIA GREVILLEANA. 4—7.
4. A shoot, from below.
5. A leaf.
6. Upper cells.
7. Basal cells.

LEJEUNEA (PTYCHANThUS) PERROTTETII. 8—12.
8. A shoot, from below.
11. Upper cells.

LEJEUNEA (PTYCHANThUS) CHINENSIS. 13—15.
13. A shoot, from below.
14. Upper cells.
15. Basal cells.
Plate II.

FRULLANIA PYRIFLORA. 1—3.

1-2. Two shoots, from below.

FRULLANIA GREVILLEANA. 4—7.

4. A shoot, from below.
5. A leaf.
6. Upper cells.
7. Basal cells.

LEJEUNEA (PTYCHANTHUS) PERROTTETII. 8—12.

8. A shoot, from below.
11. Upper cells.

LEJEUNEA (PTYCHANTHUS) CHINENSIS. 13—15.

13. A shoot, from below.
14. Upper cells.
15. Basal cells.
PLATE III.

LEJEUNEA SP. A. 1—7.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Basal cells.
5. Involucre.
6. A perianth.
7. A part of an elater.

LEJEUNEA SP. B. 8—11.

8. A shoot, from below.
10. Upper cells.
PLATE XXIV.

SOLENOSTOMA PURPURATA. 1—4.

1. A plant.
2. Upper cells.
4. Basal cells.

JUNGERMANNIA OBLONGIFOLIA. 5—10.

5. A fertile plant.
6. A sterile shoot.
7. A leaf.
8. Upper cells.
PLATE VI.

MADOTHECA GOLLANI. 1—5.

1. A shoot, from below.
2. A leaf and lobule, from below.
3. A leaf attached to the stem, from above
4. Upper cells.
5. Basal cells.

MADOTHECA PLUMOSA. 6—10.

6. A shoot, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
PLATE VII.

MADOTHECA DENTICULATA. 1—4.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Basal cells.

MADOTHECA ACUTiphyLLA. 5—9.

5. A shoot, from below.
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Median cells.
Plate VIII.

MADOTHECA VARIABILIS. 1—5.

1. A shoot, from below.
2. Another shoot, from below.
3. A leaf attached to the stem, from above.
4. Upper cells.
5. Basal cells.

MADOTHECA PLATYPHYLLA. 6—10.

6. A shoot, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
10. Involucre and perianth.
PLATE IX.

MADOTHECA DECURRENS. 1—4.
1. A shoot, from below.
2. Two leaves attached to the stem, from above.
3. Upper cells.
4. Basal cells.

MADOTHECA GAMBLEANA. 5—9.
5. A shoot, from below (only one lobule shown).
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Basal cells.

MADOTHECA MACROLOBA. 10—13.
10. A shoot, from below.
11. A leaf attached to the stem, from above.
12. Upper cells.
PLATE X.

MADOTHECA GRACILLIMA. 1—5.

1. Two shoots, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
5. Basal cells.

MADOTHECA OBTUSIFOLIA. 6—10.

6. A shoot, from below.
6 (a). Two leaves with lobules, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
PLATE XI.

RADULA COMPLANATA. 1—4.

1. A sterile shoot, from below.
1 (a). A fertile shoot, from below.
2. A leaf attached to the stem, from above.
3. Marginal gemmae.

DIPLOPHYLLUM ORIENTALE. 5—9.

5. A fertile shoot, from above.
6. Dorsal lobe, from above.
7. Ventral lobe, from below.
8. Upper cells with one tooth.
SCAPANIA VERRUCOSA. 1—7.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
5. Basal cells.
6. T.S. leaf.
7. T.S. leaf (through the keel).

SCAPANIA PURPUREA. 8—13.

8. A shoot, from below.
9. A shoot, from above.
10. A leaf, from above.
11. Upper cells.
PLATE XIII.

ANTHELIA JULACEA. 1—2.

1. A sterile shoot.
   1 (a). A perianth with involucre.
2. Leaf cells.

BLEPHAROSTOMA TRICHOPHYLLUM. 3—4.

3. A sterile shoot.
   3 (a). A shoot with perianth.
4. Leaf cells.

MASTIGOBRYUM TRIANGULARE. 5—9.

5. A shoot, from below.
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Median cells.

CALYPOGEIA RENISTIPULA. 10—13.

10. A shoot, from below.
11. Upper cells.
12. Median cells.

CEPHALOZIA GOLLANI. 14—18.

14. A sterile shoot, from below.
15. A female plant, side view.
16. Upper cells.
17. Basal cells.
18. Bracts and bracteole.
PLATE XIV.

CHILOSCYPHUS INFLATUS. 1—4.
1. A shoot, from above.
2. A shoot, from below.
3. Upper cells.
4. Basal cells.

CHILOSCYPHUS ARGUTUS. 5—7.
5. A shoot, from below.
6. Upper cells.
7. Basal cells.

CHILOSCYPHUS HIMALAYENSIS. 8—14.
8. A male shoot.
9. A plant with antheridia and a female shoot.
10. A sterile shoot, from below.
11. 4 Amphigastria.
12. Spores and an elater.
13. Upper cells.
**Plate XV.**

**CHILOSCYPHUS POLYANTHUS.** 1—3.

1. A shoot, from above.
1 (a). An amphigastrium.
2. Upper cells.

**CHILOSCYPHUS CAMPANULATUS.** 4—8.

4. A shoot, from below.
5. A male shoot, from above.
6. A female shoot.
7. Upper cells.
8. Basal cells.
PLATE XVI.

LOPHOCOLEA BIDENTATA. 1—8.

1. Female shoot, from above.
2. Sterile shoot, from below.
3. Two male bracts.
4. Upper cells.
5. Basal cells.
6. A bract.
7. Two bracteoles.
8. The perianth flattened out.

LOPHOCOLEA HETEROPHYLLA. 9—14

9. Two shoots.
10. An amphigastrium.
11. Two bracteoles.
12. Upper cells.
PLATE XVII.

LOPHOCOLEA MINOR. 1—2.
1. A plant, from above.
2. Leaf cells.

LOPHOCOLEA ALATA. 3—6.
3. A plant, from above.
4. Involucre and perianth.
5. Upper cells.

PLAGIOCHILA MUNDALIENSIS. 7—12.
7. A shoot, from above.
8. A leaf attached to the stem, from below.
9. Two leaves.
10. A tooth.
11. Upper cells.
PLATE XVIII.

PLAGIOCHILA SIMLANA. 1—6.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Two teeth.
5. Upper cells.

PLAGIOCHILA MITTENII. 7—12.

7. A shoot, from above.
8. A leaf attached to the stem, from below.
10. A tooth.
11. Upper cells.
PLATE XIX.

PLAGIOCHILA FERRUGINEA. 1—6.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Three teeth.
5. Upper cells.

PLAGIOCHILA ACCEDENS. 7—12.

7. A shoot, from above.
8. A leaf attached to the stem, from below.
10. Two teeth.
11. Upper cells.
PLATE XX.

PLAGIOCHILA SP. A. 1—7.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Upper cells.
5. Median cells.
7. An involucral bract.

PLAGIOCHILA SP. B. 8—13.

8. A plant, from above.
9. A leaf attached to the stem, from below.
10. A leaf.
11. A tooth.
12. Upper cells.
PLATE XXI.

LOPHOZIA ALPESTRIS. 1—5.

1. A shoot, from above.
2. A leaf attached to the stem.
3. Upper cells.
5. Basal cells.

LOPHOZIA INCISA. 6—9.

6. A shoot, from above.
7. Three leaves.
8. Two teeth.
PLATE XXII.

LOPHOZIA SP. 1—3.

1. A shoot, from above.
2. A leaf.

JAMESONIELLA ELONGELLA. 4—9.

4. A fertile shoot, from above.
5. A fertile shoot, side view.
6. Upper cells.
7. Basal cells.
8. A bract and bracteole.
PLATE XXIII.

SOLENOSTOMA LANCEOLATA. 1—3.

1. A fertile shoot, from above.
2. Upper cells.

SOLENOSTOMA CRENULATA. 4—5.

4. A fertile shoot.
5. Median cells.

SOLENOSTOMA BREVIFLORA. 6—10.

6. A shoot, from above.
7. A leaf.
8. Upper cells.
PLATE XXIV.

SOLENOSTOMA PURPURATA. 1—4.

1. A plant.
2. Upper cells.
4. Basal cells.

JUNGERMANNIA OBLONGIFOLIA. 5—10.

5. A fertile plant.
6. A sterile shoot.
7. A leaf.
8. Upper cells.
PLATE XXV.

JUNGERMANNIA VIRIDIS. 1—4.
1. A sterile shoot, from above.
2. A fertile shoot, from above.
3. Upper cells.
4. Basal cells.

JUNGERMANNIA HUMILIS. 5—7.
5. A sterile shoot, from above.
6. Upper cells.
7. Basal cells.
PLATE XXVI.

PETALOPHYLLUM INDICUM. 1—5.
1. A male plant.
2. A female plant.
3. Perianth with sporogonium.
4. An elater.
5. Two spores.

SEWARDIELLA TUBERIFERA. 6—10.
6. A forked male plant, from above (left) and from below (right). Note the tubers in the latter.
7. Two female plants. In the specimens to the left the wings have been removed on one side to show the sporogonium. Note the bends in the stem indicating the growth of several years.
8. A perianth cut open.
10. An elater.

FOSSOMBRONIA HIMALAYENSIS. 11—15.
11. A male plant.
12. Two female plants. In the specimen to the right note the characteristic bend in the stem and the apical tuber.
13. A spore.
15. Portion of the capsule wall.
I. A plant with flask-shaped gemmae receptacles.
2. An amphigastrium.
3. Two stellate gemmae.
4. A gemma from the flask-like receptacle.

PELLIA CALYCINA. 5—6.
5. A fertile plant.

PELLIA EPiphylla. 7—8.
7. A plant.
8. T.S. Thallus.

10. Inner wall of the capsule.
PLATE XXVIII.

CALYCULARIA CRISPULA. 1—6.
1. A male plant.
2. A female plant.
3. Another male plant.
3 (a). A male bract.
4. T.S. Thallus.
5. A portion of the above more magnified.
6. Three amphigastria.

CALYCULARIA COMPACTA. 7—9.
7. A male plant.
8. } Two female plants.
PLATE XXIX.

ANEURA INDICA. 1—6.

1. A sterile plant.
2. A male plant.
3. A female plant.
4. T.S. Thallus, from Simla specimens.
4 (a). Portion of the above, more highly magnified to show epidermis.
5. T.S. Thallus, from Chamba Valley specimens.
5 (a). Portion of the above, more highly magnified to show epidermis.
6. T.S. Thallus, from Sialkok specimens.
6 (a). Portion from a similar section more highly magnified to show epidermis.

ANEURA LEVIERI. 7.

7. A plant.
PLATE XXX.

METZGERIA PUBESCENS. 1—3.

1. Four plants showing habit.
2. Two T.S. Thallus.
3. Part of the wing, surface view.

METZGERIA HIMALAYENSIS. 4—6.

4. A plant.
5. T.S. Thallus.
6. Part of the wing, surface view with marginal hairs.
PLATE XXXI.

RIELLA INDICA. 1.

1. Four plants showing habit.