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MOSSES

OF SOUTH AUSTRALIA

by

D. G. CATCHESIDE

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OF SOUTH AUSTRALIA

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INTRODUCTION

HISTORY

The first enumeration of the mosses of South Australia was in a paper by Carl Müller and Hampe (1853) based on F. von Mueller's collections. Previous to von Mueller's botanical explorations, most Australian mosses had been recorded either from Tasmania, collected mainly by J. D. Hooker, or from Western Australia, collected by J. Drummond and L. Preiss. In a total of 84 for Australia as a whole, in von Mueller's collections, 27 were recorded for South Australia, no fewer than ten being described as new. However, no more than three of the "new" species have proved to be unlike previously described species; these are *Barbula subtorquata, Bryum erythrocarpoides* and *Fissidens pungens.* Moreover, four of the names listed have turned out to be only two species, so the real total then was 25. These casualties need some explanation. In the early days of botanical exploration by Australians in the absence of competent bryologists outside of Europe, it was customary to send collections for identification and description to experts in Europe. These included E. Hampe, Carl Müller, W. Mitten and, later, F. V. Brotherus; then in this century H. N. Dixon (England) and E. B. Bartram (U.S.A.) wrote on the Australian moss flora. The earlier workers in particular commonly assumed that nearly every exotic moss from a newly explored region would be a new species and treated very many in this way on the most slender evidence. In consequence several names were applied to the same species and modern workers have the difficult task of assessing their plants in the absence of careful descriptions and, too often, the absence of type specimens. This is particularly true of C. Müller's species, for his collection in Berlin was apparently destroyed in World War II.

F. von Mueller (1864) published "Drawings of Australian Mosses", a collection of twenty plates, including four based on South Australian specimens. One was a new record for the State, bringing the total to 26, and was erroneously described as a new species, *Dawsonia appressa (= D. longiseta).* Tate (1881) listed all the mosses known for the State, based on the collections of von Mueller, identified by Hampe; this list, taking account of synonyms, brought the total to 33. In 1882, Tate added five further records, bringing the total to 38. Mitten's (1883) list for Australia contained no species new to South Australia. However, von Mueller (1887) added one and Watts and Whitelegge's (1902, 1905) enumeration added twelve (several collected by O. Tepper), the total early in the Twentieth Century being 51. This accounting eliminates synonyms and omits four other names, one of which (*Tortula baileyi* Broth.) proves to be a mixture, two (*Fissidens serrato-marginatus* and *Leucoloma limbatum,* named by C. Müller) which cannot be traced and are presently disregarded, while *Mesochaete undulata,* a rain-forest species, must be mislocated. Up to 1950, some five species were added, principally by J. H. Willis, who stimulated others to collect for him.

In the next decade, no fewer than 52 species were added, some by Willis (7 species) but most by me, when I was resident in Adelaide and could explore the flora at favourable seasons. In the 1960s, some 21 species were added, especially through the efforts of L. D. Williams (15 species) one of whose discoveries proves to constitute a new genus, *Phascopsis*. In the 1970s, no fewer than 50 species were found in the State for the first time, bringing the total to 179. A significant contribution in this last decade has been the fine work of Dr. Ilma G. Stone on the minute ephemeral mosses, growing on soil and rarely noticed except by experts. The total may be increased when the status of a few species, particularly in the genera *Bryum* and *Bartramia,* is better understood. But it seems unlikely that the rate of new discoveries can continue at such a pace.

The total may well be increased in the future, expecially by further exploration in the wetter areas of the South-East and in special habitats. Some species in adjacent arid areas of other States should occur also in South Australia. These include all five of those which occur in the southern part of the Northern Territory, two of the four peculiar to Western Australia and perhaps two of the nine common to Victoria and Western Australia so far not known in our State. However, everything considered, it seems unlikely that the State's moss flora could exceed 200, if it even reached that figure.

An interesting feature of the moss flora is the presence of adventive species, introduced unwittingly usually by man, probably with nursery stock or with ballast. They are usually associated with artificial or disturbed environments and some may be able to spread rather easily. Unfortunately it is difficult to be sure that species are not really native due to the poor knowledge of the flora in the past. Even presence in remote areas is not evidence for being indigenous, However, several species are good candidates for being considered as fairly recent introductions, e.g. *Amblystegium serpens, Brachythecium rutabulum, Eurhynchium praelongum, E. pumilum, Aloina ambigua, A.rigida.* It is of interest that some species, native to Australia, have been introduced to Britain and have been successful colonists. *Campylopus introflexus, Orthodontium lineare* and *Tortula stanfordensis* are notable, though the last is a rare plant in Australia only recently detected here and perhaps not native, but not yet known in South Australia.

LIFE HISTORY AND STRUCTURE

The mosses (Class Musci) comprise the larger of the two non-vascular groups of land plants. The other group is the hepatics or liverworts (Class Hepaticae). In both there is an alternation of generations between a haploid leafy or thallose plant (the *gametophyte)* that bears the sexual reproductive organs and a diploid structure (the *sporophyte*), borne on the gametophyte, that produces spores. In contrast to ferns and their allies, the gametophyte is relatively conspicuous and often perennial, while the sporophyte is relatively inconspicuous and of short duration. The mosses and hepatics do not have roots, but mosses often have *stomata* on parts of the sporophyte.

It is convenient in expounding the life history of a moss to begin with the spore and to describe what happens in the common *Funaria hygrometrica,* unless otherwise mentioned. Its spore is small (about 13 to 16 μm in diameter) with a brownish outer wall *(exospore)* enclosing one cell. On a suitable substrate, such as moist earth, the spore germinates by swelling, rupturing of the exospore and protrusion of a slender thread. This becomes green with chloroplasts, elongates rapidly, dividing into many cells and branching to form the *protonema.* Every branch is a single row of elongated cells, separated by transverse cross walls. At this stage there is a strong resemblance to some filamentous algae. It may be noted in passing that the protonema is a flat plate of cells in a few mosses, e.g. *Sphagnum.* In time some branches, particularly those that penetrate into the substrate, change abruptly into *rhizoids.* These consist of elongated cells, separated by oblique cross walls, and lack chloroplasts; their walls are brown. In a short time small knots of cells appear at various places on the protonema and these enlarge and produce small leaves arranged spirally around a short central stem. The young plants *(gametophores)* grow rapidly larger, producing successively larger leaves until the mature form is reached.

The stem grows under the control of an apical cell from which daughter cells are cut off in regular sequence. The apical cell is roughly an inverted tetrahedron with a free rounded face and three sides adjacent to surrounding tissue. It undergoes division so that cells are cut off in succession by walls roughly parallel to the three sides. There is a slight asymmetry leading to an apparent rotation of the apical cell and a spiral arrangement of products. Each of the cells cut off from the apical cell divides, after enlargement, to cut off an inner from an outer cell. The inner cells by further growth and division form most of the tissues of the stem. The outer cells give rise to leaves, buds and the outside part of the stem. Each outer cell, after growth, first divides into an upper and a lower cell, the upper cell producing a leaf while the lower cell contributes to the outside of the stem between leaves and to lateral buds if any are formed. Thus the shoot is derived segmentally from the apical cell, one leaf from each segment and any bud from below the leaf, not from its *axil.*

The growth of the leaf itself is also under the control of an apical cell, roughly three-sided in surface view, the free side being rounded. Daughter cells are cut off alternately from the two sides adjacent to other tissue and which are at an angle to one another. The regulation of growth patterns by *apical cells* is characteristic of mosses and is shown by all organs, including the sex organs *(gametangia)* and the sporophyte.

An interesting feature of mosses in general is that the cells are so little differentiated that almost any one can regenerate protonema under suitable conditions and so serve to propagate the plant vegetatively. Many mosses indeed produce specialised organs (p.17) for vegetative reproduction and these can better survive adverse conditions. Small groups of cells borne on rhizoids form roughly globular or irregularly shaped tubers (also called *brood bodies* or *brood tubers* in translation from the German Brutknollen). These tubers

germinate to form *protonemata* on which form the knots of cells that differentiate into leafy gametophores.

The leaves of mosses are generally only one cell thick except at the *costa* (midrib or nerve) and sometimes around the margin. However, the costa is very wide in some genera, e.g. *Campylopus* and *Polytrichum*. The leaves first formed on the young gametophore are not differentiated and it is only in the older ones that the costa starts to appear. The oldest leaves of *Funaria hygrometrica* have a well-developed costa which runs into the point of the leaf.

The stem of the moss has no vascular bundles, so characteristic of ferns, conifers and flowering plants, nor does it have roots. The only attachment to the substrate, and presumably also a means of drawing nutrients therefrom, is provided by the filamentous rhizoids. The stem is differentiated into a central strand of narrow elongated cells and there is an outer zone of cells with thick walls providing rigidity. However, there is considerable variation, in part correlated with the size of the particular species.

The sexual organs are of two kinds, the female *archegonia* and the male *antheridia* and they may be borne on the same plant (*monoecious*) or on different plants (*dioecious*). In monoecious species, the antheridia may be in the same cluster as the archegonia or separate, the relationship being characteristic for the species. In *Funaria hygrometrica* the archegonia and antheridia are in receptacles at the ends of separate branches. The antheridia are borne in a cluster (the *gonium*) at the end of a tall shoot (to about 1 cm) and are surrounded by perigonial leaves scarcely different from the most mature foliage leaves. The archegonia are borne on a short branch, initially very small, arising some distance below the gonium; they are surrounded by *perichaetial* leaves. The antheridia are ellipsoid to clavate, with a short stalk, and consist of a wall of one layer of cells surrounding the cells which form *spermatozoids*. The antheridia are intermixed with *paraphyses*, multicellular hairs with large heads. The archegonia are flask shaped with a long neck; each has an egg in the enlarged base (the *venter*). Fertilisation is accomplished by spermatozoids swimming through a film of water to the neck of the archegonium and thence down to the egg. Following fertilisation the fertilised egg (zygote) develops into the sporophyte, differentiated into a foot, embedded in the gametophyte, a stalk (*seta*) and a *capsule* which is more or less highly differentiated. Until the seta elongates, development proceeds inside the enlarging venter of the archegonium. Later, as the seta elongates, the enlarged venter splits and the young capsule carries the apical part aloft as a cap (*calyptra*). The lower part remains around the foot and base of the seta as a small cup, the *vaginula*. Only one archegonium in a cluster proceeds as a rule to develop a sporophyte, even though several may be fertilised.

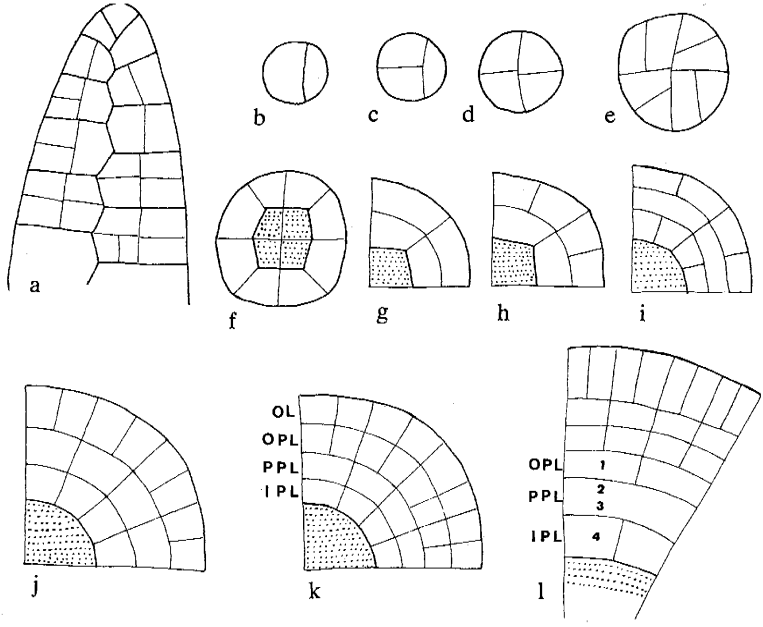

Fig. 1. Development of the capsule, with special reference to the peristome layers in the Bryopsida, Arthrodonteae; OPL=outer peristome layer; PPL=primary peristome layer; IPL=inner peristome layer. Endothecium shaded.

A brief account of the early embryogeny is useful to understand the relationships of the structures of the mature capsule. The sporophyte grows from a two-sided apical cell from which segments are cut off alternately from either side (fig. 1a). Initially these are semicircular wedges (fig. 1b) but as divisions continue, the walls separating the older segments are bent down to a horizontal position, so that they are in more or less vertical columns. Further cell divisions occur as follows, as seen in transverse sections. From the two cells seen near the apex, each divides (fig. 1c) radially into two to form a quadrant (fig. 1d) and then eight cells in a ring (fig 1e). From four of these, tangential walls cut off an inner zone of four cells from the outer ring of eight (fig. 1f). The outer ring forms the *amphithecium*, ultimately six cell layers thick (fig. 1l), and is the source of everything from epidermis to peristome in the region of the operculum and of epidermis to outer spore sac in the region of the urn. The inner zone forms the *endothecium* and is the source of the inner parts of the capsule, including the *archesporium*, which forms the spores, and the *columella*.

The basic quadrant structure is the reason why the number of parts in the *peristome* is always four or a multiple of four.

The developing capsule swells considerably and shows a differentiation into several parts, especially a basal neck *(apophysis)* which has stomata, a central region in which the tissue forming the spores is located and an apical part that forms the lid *(operculum)*. Until the capsule is of full size it is green and capable of photosynthesis, supplementing the supply of carbohydrate provided by the leafy gametophyte. By this time also the capsule is bent over, partly by asymmetrical growth and partly by a curve at the top of the seta. The calyptra sits askew on the top of the capsule, covering most of it by its inflated basal part.

A longitudinal section through the middle of a maturing capsule shows an outer layer *(exothecium)* consisting of cells with thickened walls. Inside are a few layers of *parenchyma* consisting of cells with thin walls, and with chloroplasts, and then a layer of *aerenchyma* with filaments of cells *(trabeculae)* threading the large space and supporting the sporogenous archesporium and associated tissues. Generally, where trabeculae are present, sixteen may be seen in a transverse section of the capsule. The archesporium is barrel shaped, surrounded on the outer side with three layers of small cells (outer spore sac) connected to the aerenchyma and on the inner side enclosing a mass of tissue that forms the columella and a connection to the inner tissue of the apophysis. The cells of the archesporium are in one layer and mature into spore mother cells, each of which undergoes *meiosis* to form four haploid cells which enlarge and differentiate into spores. The spores acquire a specialised, protective outer wall *(exospore)* which is ornamented and sculptured with thickening. The tissues within the exothecium gradually wither as the spores grow and occupy the space so freed.

The operculum is at first continuous with the capsule but eventually detaches by splitting at a ring of elastic and hygroscopic cells *(annulus)* in one or two rows between the rim of the operculum and the mouth of the capsule. The cells of the annulus are usually rounded above and have very thick walls and small cavities. The annulus may be persistent on the mouth of the urn, the part of the capsule containing the spores, or be detached, as in *Funaria*.

Part of the tissue of the operculum is differentiated to form the *peristome,* commonly present as a fringe at the mouth of the capsule and regulating dispersal of the spores. Some mosses have no peristome, presumably usually lost by evolutionary reduction, and others have no differentiated or separable operculum either. The peristome consists of a ring of teeth, four to sixty four in number, always a multiple of four and standard for each species and genus. The structure of the peristome is used as a major criterion in classification. In most mosses the peristome is derived from the cell walls between particular layers of cells differentiated within the operculum. In a few mosses the peristome is derived from groups of whole cells; among South Australian species only *Polytrichum* and *Dawsonia* are of this kind.

In *Funaria hygrometrica* the cells of the outside layer *(epidermis)* of the operculum become thickened at maturity, rather like the exothecial cells of the urn, though they are narrower. At maturity the operculum separates off to disclose a peristome which acts to close the mouth of the capsule and to control the shedding of the spores. The peristome consists of two circles each of sixteen lanceolate teeth slightly twisted to the right, the teeth (or *processes*) of the inner circle (*endostome*) standing immediately behind corresponding teeth of the outer circle (*exostome*). The outer face of each exostome tooth (fig. 127d) shows a zigzag line up the middle and horizontal lines coming off to the side from each sharp angle of the zigzag. Between these lines ornamental thickening is deposited, mainly as vertical striae topped with minute *papillae,* to form the plates of the peristome. The inner face of each exostome tooth (fig. 127e) shows a series of horizontal bars (trabeculae) and the face is homogeneously thickened between the trabeculae. The endostome teeth also show vertical and horizontal lines on the inside face, with vertical papillate striae on the intervening plates. Thus the inside of the endostome tooth resembles the outside of the exostome tooth. The peristome as a whole is supported on a circular ledge of thickened cells projecting inwards from just below the mouth of the capsule.

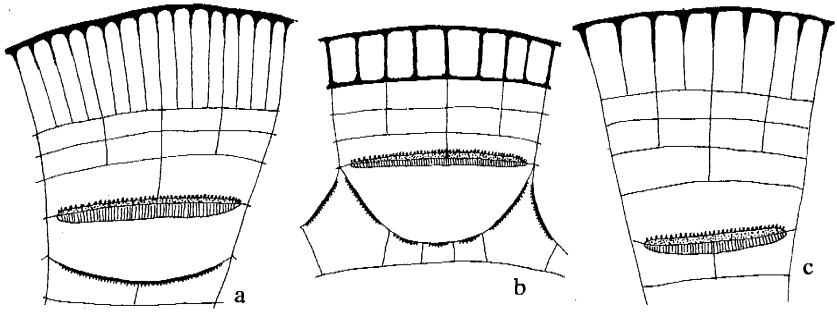

Fig. 2. Sources of the peristome in (a) *Funaria*, (b) *Bryum* and (c) *Dicranoloma*. The cells disposed on a one sixteenth sector of the capsule are diagrammed.

How is the peristome formed? The layers of cells which contribute to it have long been known, but the disposition of the ornamented thickening was differently and incorrectly described in all accounts of *Funaria* until Proskauer (1958) reexamined the matter. Transverse sections (fig. 2a) in the region of the operculum of a developing capsule near maturity, but before death and shrivelling of any cells, show a series of concentric circles of cells of which the outer six, formed from the amphithecium, concern us. The outermost, having

up to 256 cells in a circle (but fewer as the apex of the operculum is approached) forms the thickened epidermis and the annulus. Inside, the successive circles show 64, 64, 32, 16 and 32 cells (see also fig. 1l). The fourth, fifth and sixth are those concerned in the formation of the peristome, and may be referred to as the outer peristomial layer (OPL), the primary peristomial layer (PPL) and the inner peristomial layer (IPL), following the usage introduced by Blomquist and Robertson (1941). It will be noticed that there are sixteen similar segments (fig. 2a), slightly inclined to the left when viewed as from the apex of the operculum. This, with a right-handed twist of the columns of cells from base to apex, leads to the twisted peristome of *Funaria hygrometrica*. Thickening material is deposited in a pattern on some of the tangential walls of the peristomial layers and the relevant ones may be numbered 1 (inner OPL), 2 (outer PPL), 3 (inner PPL) and 4 (outer IPL) as in fig. 1l. Longitudinal striae, coalescent at the base and capped with small papillae, are laid down on 1 and 4. Homogeneous thickening is laid down on 2 and extends considerably on the horizontal anticlinal walls of PPL to form the trabeculae.

In most other mosses having double peristomes formed in this way (the Diplolepideae) the teeth are not twisted and the endostome teeth alternate with the exostome teeth. Often there are more than 32 cells in the IPL and between the endostome teeth (processes) there may be one to three slender *cilia* standing behind the exostome teeth; these are formed from some of the excess cells in the IPL. The exact means of development whereby the processes of the endostome come to alternate with the exostome teeth needs some explanation. The following is summarised from the account of development in *Aulacomnium heterostichum*, an American species, by Blomquist and Robertson (1941); mostly the description concerns the peristomial cells as seen in transverse section. When the IPL and PPL are first cut off, both consist of a ring of sixteen cells at any particular level (fig. 1k). The PPL cells do not increase in number but they do increase considerably in size, bulging convexly on the inside so that ultimately each is roughly semicircular in section. The IPL cells divide repeatedly anticlinally until there are four or five to each PPL cell. Moreover there is one IPL cell between each two PPL cells and it assumes a five-sided wedge shape, becoming much larger than the other IPL cells (fig. 2b). When thickening is deposited on the walls of the IPL cells it is distributed on the two walls of each of the wedge cells except close to the boundary between two PPL cells. The wedge cells form the processes, each between two exostome teeth, each with a gap up the middle except near the apex and each with a keel. The other IPL cells between each pair of wedge cells form the cilia, the precise number of which depends upon the original number of IPL cells.

Among these mosses there are two distinct types of ornamentation of the outside plates of the exostome. Most of the pleurocarpous ones have horizontal striae on the lower plates (hypnoid peristome). None of the acrocarpous species have horizontal striae, but are usually very finely papillose on the lower plates (bryoid peristome) or have vertical or oblique striae. Double peristomes of these types are called diplolepideous and are found in the vast majority of

mosses. However, in related species, even in the same genus, either the endostome or the exostome or both may be missing.

Another type of peristome is the single one, haplolepideous, found in families which include such genera as *Fissidens, Dicranoloma* (fig. 2c), *Campylopus, Barbula* and *Ceratodon* (Evans and Hooker, 1913). In *Dicranoloma* the sixteen split teeth of the peristome are formed from the tangential walls between an outer ring of 16 cells (the PPL) and an inner ring of 32 cells (the IPL). Each tooth has a series of horizontal bars (trabeculae) on the outside, from thickening deposited on the inner parts of the horizontal anticlinal walls of the PPL. Between is a single vertical series of transversely rectangular plates ornamented with vertical striations below and papillae above. On the inner side of each tooth there is a zigzag line up the middle and a series of horizontal marks from each angle; these are the remains of the anticlinal walls of the two columns of cells of the IPL. The plates between are thinner than those on the outside of the tooth, but are similarly ornamented. The teeth may be divided part way, or all the way, down or else perforated. In essence the haplolepideous peristome tooth looks like the exostome tooth of the diplolepideous peristome, but reversed. Developmentally it corresponds to the endostome of the diplolepideous peristome in that it is formed on the same primary wall, but it is differently thickened.

These basic types of peristome are subject to detailed variations, which are useful in classification. Besides reductions involving poor development or loss, there are various ways in which the teeth are split or perforated or even joined in pairs or, in the case of the endostome, more or less joined in a network. Only a limited range of the variants is represented in the South Australian flora and described in the main text.

It is convenient at this stage to summarise the ontogeny and homology of the single and double types of peristome in the Arthrodonteae, since the features are fundamental to classification. Viewed in transverse section the peristome of these mosses is derived from a ring of sixteen cells, the primary peristomial layer (PPL) of Blomquist and Robertson (1941). The adjoining layers are the outer peristomial layer (OPL), a ring of 32 cells, and the inner peristomial layer (IPL), a ring of cells varying from 16 to about 72 according to the species. The number of layers outside OPL differs from species to species, but is usually two or three. Tracing the embryogeny downwards, the IPL and the outer spore sac are derived from the same layer of amphithecial cells, while the PPL and the aerenchyma come from the next outer layer (Kreulen 1972).

The deposition of thickening on the walls of the cells which form the peristome is controlled by the position assumed by the nucleus and most of the cytoplasm in each cell. Thickening is deposited on the cell wall closest to the nucleus, hence occurs on only one tangential wall of any of the peristomial cells. In the diplolepideous peristome thickening is on both sides of the walls separating OPL and PPL and on the inner side only of the walls separating IPL from PPL. In the haplolepideous peristome thickening is on both sides of the walls between PPL and IPL. The number of cells in the three layers and the

disposition of thickening can be represented by a formula with the numbers of cells in OPL, PPL and IPL in that order, a colon (:) representing no thickening on a wall face and a vertical bar (|) thickening on a wall face.

Examples are:

Haplolepideae	*Ceratodon purpureus* 32::16||24
Diplolepideae	*Funaria hygrometrica* 32||16:|32
	Hypnum cupressiforme 32||16:|40
	Brachythecium rutabulum 32||16:|52

Moss peristomes are strongly hygroscopic, responding by active movements to changes in the moisture in their tissues. The ornamentation on the two sides of each tooth is different in such a way that, on the absorption of moisture, the outer side elongates more than the inner, so closing the teeth together over the mouth of the capsule. On drying the reverse happens and the teeth move outwards to open up the capsule. The movements are usually fairly slow and can be observed under a dissecting microscope or with a good lens, moistening the peristome by breathing on to it.

The peristome plays a part in the distribution of the spores, the hygroscopic property having a role in this function. The general effect is to liberate the spores in small quantities when the air is dry, so that air currents distribute them, and to sift them so that they are separated. In mosses with a pendent capsule, like *Funaria hygrometrica*, the inner peristome is the sieve, while the outer responds to moisture to close the apertures in wet weather, conversely opening when dry. In mosses with an erect capsule, release of spores in dry air occurs by shaking of the capsule at the top of an elastic rather stiff seta; in moist conditions the peristome closes in and the seta also becomes flaccid. When a moist peristome closes, some of the spores may adhere to it; as the system dries the peristome teeth may lift out a few spores which are later shaken or blown off. This occurs especially in species with a single peristome, usually only the exostome.

Such is an outline of the life history and structure of a common moss as a guide to later taxonomic application. More information will be found in special texts, e.g., Parihar (1965) and Watson (1971). However, there is probably no moss for which a really full knowledge of structure, life history and general biology is available; especially is this so for Australian species. No data are available on phenology, such as time of development of sex organs, time of fertilisation, stages of development of sporophyte and so on. Likewise the morphology of stages in development to maturity, longevity, perennation, vegetative reproduction are known only in crude outline. Observations bearing on these problems could readily be gathered by an amateur naturalist without the need for elaborate equipment, beyond a microscope and simple tools.

VEGETATIVE REPRODUCTION

Many mosses are perennial while others are annual and virtually ephemeral. The perennial species in particular exhibit a range of methods of vegetative reproduction. Some indeed may have no other means over a large part of their natural range, fruiting being rare or unknown. For example, the dioecious moss *Tortula papillosa,* which reproduces freely by means of globular gemmae formed on the costa, fruits commonly in Australia but not at all in Europe or North America. Whether only one sex occurs in the areas of sterile distribution is unknown. The related *Tortula pagorum,* also dioecious and producing abundant *propagula* like minute leaves, is only female in North America and male in Europe; both sexes occur in Australia and fruits occur occasionally.

Cushions and mats of perennial mosses are often quite old and probably constitute clones formed by growth and branching followed by death and decay of older parts. Successive annual increments of growth can be readily seen in some mosses, e.g. *Polytrichum juniperinum.* Commonly, any piece detached from a plant is capable of regenerating and in some species, as in *Campylopus clavatus* and *Eccremidium pulchellum,* there are deciduous shoot tips.

In many mosses, there are specialised organs of vegetative reproduction, even in species which fruit quite commonly. One sort is a modified branch of bud-like form, such as the *bulbils* borne in leaf axils of *Bryum pachytheca.* Another is a *tuber,* often borne on rhizoids, as in *Bryum capillare* and *Leptobryum pyriforme.* A distinct class are *gemmae,* of specialised structure, borne on leaves or shoots. Sometimes these are globular, as in *Tortula papillosa,* or spindle-shaped or clavate with a few cells in a row, as in *Zygodon* species. *Bryum albo-limbatum* forms long filamentous gemmae in the axils of leaves. The minute leaves of *Tortula pagorum* were referred to above.

Very little is known about how gemmae, tubers or other fragments are dispersed; presumably water washing and wind must play a part. Nor is much known about the longevity of these fragments in the face of adverse conditions. A little has been gleaned from the success or otherwise experienced in attempting to grow plants from the gemmae or tubers of dried specimens. Whitehouse (1966) records germination of a tuber of *Bryum bornholmense* after 12 years and 2 months in a herbarium. To a considerable extent the question of survival of these special organs is closely connected with the ability of mosses to live under adverse conditions.

PERENNATION AND SURVIVAL

Mosses, like other plants, are dependent upon moisture for growth. They are also dependent for sexual reproduction on a film of moisture in which the sperm can swim to the archegonia. Consequently both growth and sexual reproduction can occur only in the rainy season in climates which have marked dry seasons. For the same reason, mosses are commoner, more lush and in greater variety of species in moist sheltered situations, such as gorges. Lacking roots that may penetrate deeply to underground water and lacking bulky perennating

structures like seeds, bulbs or corms, it may be wondered how mosses can manage to persist in climates that are intermittently dry to very dry, often hot and where prolonged droughts occur.

Some species of mosses are aquatic or semiaquatic (the distinction is arbitrary) and can survive only in streams or pools or swamps or in the vicinity of waterfalls or other humid environments. In these environments desiccation is rare and of short duration. Such habitats are scarce in South Australia, so it is not surprising that only seven aquatic species (*Drepanocladus aduncus, D.fluitans, Fissidens crassipes, F.fontanus, F.rigidulus, Leptodictyum riparium, Sphagnum molliculum*) and about twelve semiaquatic species (*Acrocladium chlamydophyllum, Barbula ehrenbergii, Bryum subcurvicollum, Cratoneuropsis relaxa, Cryphaea dilatata, Distichophyllum microcarpum, D.pulchellum, Eriopus apiculatus, Grimmia apocarpa, Pterygophyllum dentatum, Rhacopilum convolutaceum*) are known in the flora and most are uncommon. A fairly large number of other species is almost restricted to moist and sheltered habitats.

A significant number of species are ephemeral, appearing after rains, growing rapidly and fruiting in a short space of time. Probably these survive by the agency of spores and it is characteristic that they fruit abundantly. Most of them are small to minute in size. In the South Australian flora, more than 50 species, in more than 22 genera, are probably in this category of being primarily or exclusively dependent on spores for survival. Lack of knowledge of the biology of some of the species makes it uncertain whether in some of them the gametophytes are perennial or have perennating organs. Large genera comprised in the ephemeral category are *Fissidens* (5 species), *Funaria* (9 species), *Pottia* (7 species) and *Acaulon* (8 species). The other genera in this category have usually one, occasionally two or three, species. Some of the ephemeral mosses have exceptionally large spores (e.g. *Acaulon* spp., *Eccremidium* spp.) which might be expected to favour survival. Nevertheless many others have spores of sizes comparable with the range in perennial mosses. Moreover, there are two small mosses which may behave in part as emphemerals and have very large spores, yet can perennate. These are *Gigaspermum repens*, which is widespread in arid areas, and *Archidium stellatum*. It appears that even some of the species dependent primarily on spores for survival are able to regenerate from vegetative material, apparently even after a prolonged state of desiccation. Moreover, in the same habitats, subject to prolonged aridity and with seasonal moist periods, there are species which are unknown in fruit. The most remarkable is *Tortula oleaginosa*, which has an enormously thickened costa in the leaf, the leaves being caducous and the only known means of propagation and perennation.

Many other species, the majority of the South Australian flora, inhabit places where they are subject to prolonged or intermittent desiccation and nevertheless survive well in a vegetative state. In some of these the fruiting stages are quite unknown anywhere, e.g. *Anomodon tasmanicum* and *Leptodontium paradoxum*, while in others fruits are rare to very rare, e.g., *Eccremidium pulchellum, Ischyrodon lepturus* and *Tortula pagorum*. Some of these species are

dioecious and the lack or rarity of fruit is due to male and female clones not being in close enough proximity. Particularly arid habitats, often exposed to extreme insolation as well, are rock surfaces and tree trunks. Nevertheless, *Grimmia laevigata* is quite common on firm rock surfaces in areas of low and uncertain rainfall and is subject to high surface temperatures on the rocks. Like others in such habitats, it may benefit from dew.

These facts suggest that mosses (and some hepatics), or at least some species, possess remarkable powers of persisting in a state of suspended animation while desiccated and subjected to more or less intense heating (and alternate chilling). Even ephemeral species are subject to intermittent drying and under these conditions the leaves shrivel and curl or crisp in characteristic attitudes, no doubt protective of the young and meristematic tissues. On moistening, the leaves rapidly recover their normal form. It is assumed that on doing so the normal activities of metabolism, such as assimilation, are resumed. Experiments suggest that assimilation is at first at a lower rate.

Selected species have been examined in the Northern Hemisphere to measure some of these properties; analogies to Australian species may be perceived. Thus Dilks and Proctor (1974) collected shoots of a number of species in Devonshire, England and stored them in desiccators at controlled humidities. All were first kept for a few days in a misting unit before being dried to known degrees. At intervals, samples were taken, their moisture restored and measurements made of assimilation and respiration and of ability to grow. The species showed great diversity in their capacity to survive. Some did better at low humidities of storage, others at high humidities. Some were extremely resistant to desiccation, others survived for only a few days. The latter was especially the case for species, such as *Hookeria lucens* and *Plagiochila spinulosa*, characteristic of humid habitats. In our flora, *Pterygophyllum dentatum* and others of the semi-aquatic species listed previously, would probably be of this kind.

Capacity to survive is illustrated by the following data for the two species which survived better in conditions of low humidity. In *Rhacomitrium lanuginosum*, a moss which grows on rocks, 50 per cent of shoot tips died in 100 to 110 days of storage at 76 per cent relative humidity, 20 per cent died in 250 days when stored at 54 per cent relative humidity and none were dead after 239 days storage at 32 per cent humidity. *Grimmia pulvinata* and *G.laevigata* are probable analogues. In *Tortula ruraliformis*, a moss which grows in sand dunes, none survived 80 days at 76 per cent relative humidity or 110 days at 54 per cent relative humidity and only 10 per cent survived nearly 300 days at 32 per cent relative humidity. In this species, much of the regeneration after prolonged times of dormancy came from the base of the stem. Our *Tortula princeps* is a prominent member of the moss flora of sand dunes and sandy mallee, as well as of rocks, and is probably similar in properties to *T.ruraliformis*.

The net assimilation rate is at first lower and that attained 24 hours after revival is progressively less with increasing periods of desiccation, as though the photosynthetic apparatus is increasingly damaged. If the values of assimilation

are plotted on a probability scale against the logarithm of the days of desiccation, straight lines declining from higher to lower values of assimilation with increasing desiccation are found. These graphs yield P_{50} values, which are the number of days of desiccation required to reduce assimilation to half that of fresh material. The range ascertained is 4 days for *Plagiochila spinulosa* at 32 per cent relative humidity to 150 days for *Rhacomitrium lanuginosum* at 54 per cent relative humidity.

These experiments clearly illustrate the capacity of many species to survive very adverse conditions. However, it is not easy to extrapolate to natural conditions with intermittent dryness and insolation. Moreover, other factors are at work. The capacity to survive changes cyclically with the season, as Dilks and Proctor (1976) have demonstrated. There is a general tendency for most bryophytes tested from Devonshire to be most sensitive during the autumn and early winter, their tolerance of desiccation increasing progressively through the spring to a maximum in the early summer. There are exceptions; thus *Andreaea rothii,* a species of granitic rocks, subject to intermittent desiccation and insolation, is invariant with respect to season and is highly resistant to desiccation at all times. Our *Grimmia laevigata* is perhaps its analogue. Summer collections, even of relatively sensitive species, survive well. For example, the hepatic *Plagiochila spinulosa* collected in May (early summer) for desiccation showed 100 per cent survival in samples tested 70 and 110 days later. The means by which vitality is preserved in the virtually dormant tissue is scarcely known. It is presumably analogous to the means by which fungal conidia and spores survive in a dried state.

Some indication is afforded by the observation that mosses and hepatics are divisible into those that are rich in starch and those in which there is none or very little (Rancken 1914; Marchal 1906 and others). Mesophilous and hygrophilous species are rich in starch, whereas lithophytic and epiphytic ones (e.g. *Andreaeaceae, Grimmiaceae, Orthotrichaceae*) are free from starch. The latter are those especially tolerant of drying. *Tortula ruraliformis* (Willis 1964) has no detectable starch, but large amounts of sugars and glycosides, totalling some 106·4 mg per gram of residual dry weight; the principal sugar is sucrose, about 80 mg per gram of dry weight.

In summary, species of mosses show great diversity in their ability to survive adverse conditions of dryness. They do so in two ways, either by avoiding or by tolerating desiccation. Ephemerals survive as spores in the soil, grow rapidly and quickly pass through to maturity when conditions are favourable. Hence they are prominent only in the late winter and spring and in habitats where they are not smothered by herbs. Therefore, ephemerals are commoner where there are open habitats of silty soil, especially in depressions into which there is some drainage of water to maintain moisture over a longer period. The margins of rivers, lakes and billabongs come into this category. Perennials survive by their ability to remain alive while desiccated and to recover rapidly when conditions are favourable. Some have special organs, including perennating tubers, which are virtually drought-avoidance mechanisms. There is a wide range of performance among perennials and consequently habitats are increasingly rich

in perennial species as they are increasingly humid and less subject to occasional drying. Hence the richest habitats are those in gorges or gullies, especially with an aspect away from the sun, the southerly aspect in this hemisphere.

A factor in the ability of mosses to survive desiccation is the way in which the plant shrinks and the leaves curl or crisp in characteristic ways. In some, the leaves inroll and twist around the stem in a tight spiral, leaving projecting points; in others the leaves inroll and twist spirally on themselves or else inroll downwards from their apices to form a tight coil. The total effect is to reduce the volume greatly and the packing tends to protect the more delicate photosynthetic cells. The outside of the pack consists mostly of the abaxial sides of the costae. These protective devices clearly operate in those that have photosynthetic plates *(Polytrichum, Dawsonia, Pterygoneurum)* or filaments *(Aloina, Crossidium)* on the adaxial side of the leaves. These are covered over when the leaf dries. Mosses growing on soil or rock tend to become covered with grains of sand or dust. Dried, curled up leaves and shoots uncurl vigorously on wetting and throw off the particles of dirt quite violently so that the shoots do not become buried permanently. The curling and uncurling is chiefly a mechanical property of the cell walls for it is shown by specimens that have been dried in the herbarium for a long time. Watson (1914) has reviewed exhaustively the various devices that enable mosses and hepatics to live under less moist conditions than if the devices were absent.

It is worth drawing attention to features of mosses that may encourage access to and distribution of moisture especially from meagre sources such as condensation as dew from the atmosphere. The presence of finely pointed leaves, partly from shape or inrolling and partly from the possession of hair points or awns, provides foci for condensation. The presence of fine channels, such as the narrowly revolute or involute margins of leaves, or inrolled, channelled or grooved leaves and the presence of papillae, may help to conduct the water into the interior of the plant, which is often a member of a close tuft.

GENERAL ECOLOGY

Mosses and, indeed, hepatics and lichens not only have habitat preferences dictated by their need for particular conditions, or by their tolerances, but also they act as pioneers in many environments. Burnt areas show a sequence in which *Funaria hygrometrica* is followed by *Ceratodon purpureus* and then by *Polytrichum juniperinum* together with *Campylopus clavatus* and *C.introflexus* accompanied by various lichens, especially *Cladonia* species. The first two phases occur quickly and are passed through in about two seasons, but the third phase lasts for a long time and may be permanent. Bare soil is colonised by various mosses, dependent upon the particular kind of soil. Unfortunately, no close studies of these environments have been made, so no general statements are possible. In a few special cases the association of a few species with unusual soils may be noted. The most remarkable is the presence on saline muds of *Funaria salsicola* and *Pottia drummondii,* together with the hepatics *Carrpos sphaerocarpus* and *Riella halophila.* Quite a large number of the South

Australian mosses are calcicolous, abundant on alkaline soils and absent from acid soils. Many of these, such as *Gymnostomum calcareum* are indicators of alkalinity.

Soil relatively free of other vegetation becomes colonised by a wide variety of mosses, as well as thallose hepatics and crustose lichens, and these serve to fix the soil crust and prevent or diminish destruction by wind and other agencies. Mosses play an important part in helping to stabilise sand dunes, *Tortula princeps* being prominent in this role, accompanied by *Barbula torquata, B.crinita, B.calycina, Tortella cirrhata* and some species of *Bryum*. These are all species able to tolerate being dry for long periods and, after being buried, able to sprout through a cover of sand when well wetted. Moore and Scott (1979) have described the ecology of mosses on sand dunes in Victoria. On rocks, stones, bricks and concrete there is a succession of mosses, the first being *Tortula muralis* followed by *Grimmia pulvinata*. In favourable habitats, with enough moisture, others follow according to whether the substrate is acid or alkaline. These small plants are foci for the collection of soil in which seeds of higher plants can germinate.

In common with lichens, mosses and hepatics are good indicators of atmospheric and soil pollution. Very few species are able to survive in cities, especially in the vicinity of industries emitting sigificant amounts of sulphur dioxide and fluorides into the atmosphere. Hydrocarbons and lead are other deleterious ingredients of the urban environment. Nevertheless, a few species are tolerant of these conditions, notably *Bryum argenteum, Tortula muralis* and *Ceratodon purpureus*. The crevices of bricks, which provide relatively moist microhabitats, are commonly occupied by these or other species. In the City of Adelaide the crevices of the paving bricks in the Rundle Mall are occupied by a species of *Bryum* which survives a great deal of trampling. It is characteristic that the richness in number of species and in vigour of growth falls off with increasing atmospheric pollution. Moreover the habit of the species in increasingly polluted areas is more closely matted, exposing less area directly to the air. Feathery species are excluded.

Special tolerance of salt has already been mentioned. Another sort of environmental pollution, inimical to plants, is the presence of various metals, like copper, lead, cadmium and zinc, in relatively high concentrations, as in the tailings around mines. Few species, if any, can grow in the presence of very high levels of these toxic metals (Rao et al., 1977). However, tolerant strains of species can arise, as is known for higher plants, especially grasses, and for fungi, such as yeast. These tolerant strains apparently take up the metal ions, to much the same extent as do intolerant strains or even more. They deposit the metals in their cell walls, perhaps by attachment to polyuronic acids or similar compounds, so excluding the metals from poisoning the living parts of the cells. In other cases, metals are excreted from the moss as metal sulphates, washed away by rain but forming a powdery crust in dry periods. Many mosses concentrate various metal ions to levels well above that in the environment, at least comparing the contents in the ash of the moss and the substrate. Some of

the metal ions toxic in high concentrations are essential trace elements, e.g., copper and zinc; others are not essential, especially lead, cadmium, nickel and titanium.

A significant number of mosses are known to tolerate or even prefer the presence of rather high levels of some of these metals, to the extent that they are regarded as indicators of orebodies (Brooks 1971). Some mosses (and hepatics) are known as indicators of copper enrichment in the substrate. These include species of *Mielichhoferia, Pohlia nutans, Grimmia atrata* and species of *Merceya.* Recently, two new species of *Ditrichum* have been recorded from mine wastes in Britain, one of them, *D.plumbicola,* from lead mine waste in Northumberland. No systematic study of these soils has been made in Australia.

CULTIVATION OF MOSSES

Much more can be discovered by growing bryophytes and observing them at all seasons than by the most intensive field study. Cultivation is useful to the solution of problems in taxonomy, ecology, development and physiology. Mosses may be grown on natural media, such as soil, rock, wood or bark or on artificial media. Pure culture, in the absence of contamination with bacteria, fungi and algae is possible only on artificial media, but this is necessary only for particular kinds of experimental work. Cultures may be started by transplanting whole tufts, as unmixed as possible, or single shoots from natural habitats, or from spores, gemmae or small fragments. In general, it is difficult to start with spores or small fragments unless the medium, e.g., soil, is previously sterilised by autoclaving or steaming.

Richards (1947) describes his experiences with methods which mimic horticultural practices. It is useful to imitate natural conditions as closely as possible, but many species can be grown in pots on soil, sand, clay, rocks, rotten wood or peat in pans or flower pots standing in a dish containing a little water, one to two cm deep, or in shallow glazed pans or glass vessels. For most species the vessel should be covered permanently with a sheet of glass unless the environment, such as a shaded greenhouse, is humid. Direct sunlight is deleterious to most species and diffuse, but not weak, light is best. Of course, a few species tolerate very low light intensities, but many species become spindly and etiolated in poor light. The moisture both of atmosphere and soil needs regulation. Some species abhor water-logging and excessive moisture may encourage algae which will smother the plants. Ordinary tap water, especially town supplies such as that in Adelaide, must be avoided in favour of distilled water or its equivalent rain water. The salts in solution and, especially, the chlorine and fluorine are very harmful. Attention needs to be paid to whether the species has a preference for an acid or an alkaline medium and it is useful to have a neutral soil or clay which can be adjusted in either direction by additions. *Sphagnum* peat will make it acid, chalk or lime will make it alkaline. When the plants are growing, attention must be paid to weeding so that the desired species are not swamped by weedy species, such as *Funaria hygrometrica* or *Leptobryum pyriforme* or some hepatics like *Lunularia cruciata.* Like higher plants, perennial

mosses pass through a yearly cycle of development and many may die down or halt their growth at particular seasons, especially in the summer. Rest and protection, especially from insolation, is indicated.

These methods are less successful when applied to small terrestrial bryophytes, for these usually become overgrown by blue-green or other algae within a few months. Such bryophytes have been grown on agar media under sterile conditions by Robbins (1918) and others. Agar media are, however, unsuitable for prolonged culture because they dry out comparatively quickly. Moreover, fungal contaminants are liable to grow more quickly on agar or other organic media than on inorganic substrates like sand. Voth (1941) and Geldreich (1948) used glass cloth moistened with dilute nutrient solution (see below). Voth's cultures became contaminated with algae and he made attempts (Voth 1945) to use algastatic agents, but these proved to be more or less harmful to bryophytes.

Schelpe (1953) successfully used sand moistened with dilute nutrient solution. The gametophytes were grown on rather flat domes of sand in Petri dishes, the domes allowing drainage; with small mosses the dishes allowed enough clearance for the plants to grow. Larger species could be grown in deeper dishes. Calcicolous mosses may be grown on untreated calcareous sand, but calcifuge species need sand treated by washing and acid treatment to remove organic materials, metal salts and so on. After washing thoroughly with water, treatment with dilute hydrochloric acid and further washing, finally with distilled water, the sand is sterilised by autoclaving while moist and dried in an oven. Dry sand is mounded into Petri dishes and wetted with sterile culture solution, sufficient to moisten the surface and allow a little to drain out around the edges.

Fries (1942) and Schelpe (1953) obtained cultures free of algae and, as Fries claimed, usually free of bacteria by cutting off etiolated shoots grown in a low light intensity, the process repeated as necessary until successful. Schelpe washed cuttings from natural sources by shaking them violently in several changes of water before planting in sand cultures. Others (Whitehouse 1961, 1966) sterilised the surface of fragments, especially shoot cuttings and tubers, by dipping them for a few seconds in a dilute solution (1·5 per cent) of sodium hypochlorite before rinsing and planting out on agar medium. Spores may be germinated on agar medium by squeezing out from ripe capsules that have been surface sterilised in this way. After a little growth on agar, the cultures may be transplanted to soil or sand.

A number of different culture media have been used and the following have proved suitable. For sand cultures, the agar is omitted.

Modified Knop's agar		*Beijerinck agar*	
KCl	60 mg	KH_2PO_4	50 mg
$Ca(NO_3)_24H_2O$	100 mg	NH_4NO_3	12 mg
KH_2PO_4	60 mg	$Mg\,SO_4$	12 mg
$Na\,No_3$	36 mg	$Ca\,Cl_2$	2 mg
ferric tartrate	6 mg	Bo,Cu,Fe,Mn,Mo,Zn salts	traces
agar	2 g	agar	10 g
distilled water	100 ml	distilled water	1 L

The media are generally autoclaved in small volumes in test tubes and the autoclaving should be for as short a time as possible.

For some purposes, much more sophisticated and exacting methods are needed. This is particularly the case with genetical experiments with mosses, where very precise controls are needed. Wettstein (1925) was a pioneer in genetical studies with mosses. One of the species he used is *Physcomitrella patens* which completes its life cycle *in vitro* in the relatively short period of 7-8 weeks under defined conditions. Engel (1968) grew it on Hutner's (1953) minimal medium, consisting solely of inorganic compounds apart from the washed agar, at half strength with the pH adjusted to 6·0 before autoclaving. The medium was supplemented with organic compounds in order to obtain auxotrophic mutants. Cultures were grown at controlled temperatures under continuous light from cool white fluorescent lamps. Spores germinate and gametophores grow at 25-30°C and 200-300 foot candles, while the induction of sexual maturity and the completion of the life cycle requires 15-19°C and 150-200 foot candles. This species proves to be a useful one for genetical experiments directed, for example, towards problems concerned with growth and differentiation. The methods involved require, as indicated above, advanced laboratory methods and equipment.

COLLECTION AND HERBARIUM METHODS

Essential equipment for field collections includes a good pocket lens (x10), a sharp pocket knife, some small tins, envelopes and tissues in which to wrap specimens, and a bag to hold the collections. It is not a good idea to put specimens indiscriminately into plastic bags for this is a certain way to lose small and interesting plants. Samples should be gathered in such a way that different ones are kept separate and tufts and mats, especially of terrestrial species, are kept intact as far as possible. Collections may be made into small tins or small envelopes or packets (e.g. of cellophane), small and delicate specimens being wrapped in tissue. The samples taken should be small and not likely to endanger the species. Note should be made of localities and of habitats. It is useful in this respect to use running numbers, written on the packet and with data entered in a pocket note book against the numbers. On returning from the field, collections should be sorted and cleaned of excessive soil. Unless material is to be grown, it should be dried as quickly as possible at room temperature. Specimens left moist in containers quickly etiolate and go mouldy. Pressing, as for vascular plants, is

inadvisable as it alters the appearance too much. However, it is often convenient to spread specimens in folders of newspaper to dry, but not under any pressure.

For the herbarium, specimens are best stored in packets folded from a sheet of good paper, with the data (name, locality, habitat, date, collector and number) written on the top flap. These packets, of a uniform size, are readily stored, like filing cards, in boxes. Small specimens should be enclosed in an inner folded packet or cellophane envelope, within the outer packet, a cross reference being written on each. The size of the packet is a matter for individual preference. I use 12·5 × 7·5 cm packets, folded from half a foolscap sheet, for most; this is an economical size to store and suitable for most species. However, much larger or longer packets are needed for some specimens and require separate storage.

MICROSCOPICAL TECHNIQUES

Although most mosses can be identified with the aid of a good lens (×10 or ×20), a compound microscope capable of high magnification is essential for critical study. Also, a dissecting microscope is essential for preparing specimens for examination. A binocular dissecting microscope is best, but a lens mounted on a wooden holder over a stage of white card will suffice.

Mosses, even after having been long dry, usually quickly resume their natural form and appearance, to the naked eye and microscopically, on wetting. This is speeded by using warm water and it may be necessary to heat a specimen in water to drive out air from the tissues. To examine leaves, strip some off downwards, towards the base of the stem, with the aid of a pair of finely pointed (watchmaker's) forceps. It may be advisable to do this for single leaves under a dissecting microscope, especially where the leaves have decurrent bases or basal auricles. Transverse sections of leaves and stems may be needed. If serial sections are required to trace changes in structure, embedding in paraffin wax and sectioning with a microtome will be necessary, requiring a suitably equipped laboratory. For details of methods see, for example, the relevant botanical sections in Bolles Lee (1950).

However, free-hand sections will be suitable for most ordinary purposes. Sections may be cut by holding the wetted specimen between pieces of pith (e.g. from fennel) or of carrot. With practice (and a steady hand) good sections may be obtained in this way. A more reliable method of embedding and free-hand sectioning was introduced by Taylor (1957) and has been widely adopted (Foster 1977). The supporting media are polyethylene glycols, water soluble waxes marketed as Carbowax in America. BDH Chemicals' Polyethylene Glycol 20M, also marketed as Gurr's Carbowax 20M, is suitable. Two preparations, A and B, are used; A is a 20 per cent solution plus a little disinfectant (e.g., thymol); B is the pure material, a little melted as a small drop on a slide. Stems are placed in B and, after the drop is solid, the preparation is trimmed at one end with a razor blade to the point where sectioning is to start. Then the thinnest possible wafers are cut off, the drop being trimmed at intervals as necessary. The blade is steadied by resting the far corner on the slide and cuts are made by drawing the blade towards one, watching under the low power of the dissecting microscope.

The cut sections are transferred to a small drop of water on a slide. Leaves which crisp or curl are first soaked in preparation A until the solution has thickened, when they can be transferred to B without shrinking; then proceed as before.

Peristomes are examined after excision from the capsule in the following way. Soak the capsule thoroughly in water and prise off the operculum, with a needle, if it is still attached. Under the dissecting microscope, cut the capsule across below and parallel to the mouth, using a sharp small scalpel or forceps. Then cut the resulting ring vertically into two parts and mount one to display the outside and the other the inside of the peristome. Since the peristome is hygroscopic and different species behave differently, some trial is needed to find a medium in which the teeth will lie flat; dilute glycerol solution or lactic acid solution is usually suitable.

The examination of the surface features of spores, peristomes and leaves by scanning electron microscopy requires special laboratory facilities and will not be described here.

Leaves, sections, peristomes, spores and other dissections may be mounted temporarily in water, dilute glycerol or Amann's lactophenol on 3 × 1 inch and covered with no. 1 or no. 0 cover slips. The leaves of some mosses, e.g. *Funariaceae,* tend to shrivel in glycerol. This may be overcome by soaking them in lactic acid and rinsing in water before mounting. Water mounts evaporate quickly, but the other mounts keep satisfactorily for several days or longer if protected from dust. Preparations may be made permanent either by mounting in glycerine jelly or glycerol or lactophenol and sealing or in gum chloral. Sealing may be done with nail varnish or various other materials, or by the double cover slip method of Diehl (1929). In the latter, a mount is made in glycerine jelly between a large and a small cover slip. When the mount has set, and keeping the larger slip below, a drop of fluid Canada balsam is placed in the centre of the smaller coverslip and a slide is gently lowered until the balsam covers the exposed flanks of the larger coverslip. When the slide is inverted, the objects are then under one coverslip and surrounded by a protected balsam seal. This method can be adapted to liquid mounts (glycerol, lactophenol), but the junction of the two coverslips must first be sealed, e.g. with nail varnish.

Faure's gum chloral (Bolles Lee, section 431), which has been widely used for insects, etc., has been found effective for mosses (Bolles Lee, section 1423). Variants were adopted by Sayre (1941) and Bowers (1964), who used it also for making cytological preparations permanent. The formula I use consists of 100 ml distilled water, 40 g gum arabic, 20 ml glycerol and 50 g chloral hydrate. The gum arabic is first dissolved in the cold water, this taking up to two days. Then the glycerol and chloral hydrate are added, heating gently in a water bath until the chloral hydrate dissolves. Finally, while hot, filter the mixture through a course filter paper (Whatman No. 31), or several layers of muslin. Specimens may be mounted in a drop of this preparation (diluted a little if necessary) from glycerol or lactophenol or a small drop may be added to the side of the cover slip of an aqueous mount and allowed to diffuse in.

All of these mounting media, especially gum chloral, tend to clear material and make them more transparent than is desirable, so that features like papillae are hard to see. This is overcome by staining lightly beforehand with any one of cotton blue, toluidine blue, aqueous haematoxylin or chlorazol black E.

Measurements are most readily made by means of a micrometer in the eye-piece, the micrometer being previously calibrated against a graticule engraved on a slide. Drawings are made by matching a square graticule placed under drawing paper with a square graticule (16 divisions to 1 mm) in the eye piece of the microscope. However, a camera lucida or other special drawing apparatus may be used if available.

CYTOLOGY

The determination of chromosome numbers and the study of meiosis have become important tools in taxonomy. Mosses are difficult subjects because of the small size of their chromosomes. Anyone intending to enter this study is advised to become skilled with flowering plant material first of all. Methods are detailed by Darlington and La Cour (1976). Nevertheless a substantial number of Australian species have been counted (Ramsay 1967, 1974) and some intriguing problems brought to light. The methods are adaptations of those applicable to vascular plants (Lewis 1957). The most suitable material consists of partly grown capsules, but if these are not available etiolated shoots are an alternative, though harder to use.

Meiosis is found in young capsules of full size but still green and translucent. The operculum of the capsule is removed and the columella and surrounding archesporium may be squeezed out. The best results follow fixation and then staining because thereby oil droplets in the spore mother cells are removed, the cells are hardened and the contents can be extruded intact and flattened without damage. However, satisfactory results are achieved by squashing fresh material in acetic orcein and making preparations. The chief fixatives used are acetic alcohol (1 part by volume of acetic acid to 3 parts of pure ethanol, freshly mixed) and Carnoy's fluid (1 part of acetic acid, 3 parts of chloroform and 6 parts of ethanol, freshly mixed). Ferric chloride is added to each fixative, sufficiently to give a pale straw colour, to act as a premordant for staining. Staining is conducted with iron acetocarmine or with acetic orcein. The former is the better stain for fixed material, the latter for fresh material. Shoots need to be hydrolysed by heating in dilute hydrochloric acid to soften the tissues and allow the cells to be separated and later flattened after staining.

In some species of mosses there is a variety of chromosome numbers often without any distinct correlation with morphological or ecological differences. For example, in *Tortula muralis* Newton (1968) and others have found haploid (gametophytic) numbers over the range 24, 26, 27, about 40, 48, 50, 52, 55, 60, 66. The higher numbers tended to be found in the larger plants, but there was no absolute or even strong correlation. It was not possible to separate populations with certainty on morphological criteria. The Australian populations examined have 48 chromosomes. In other species different numbers related as haploid and

diploid *(Funaria hygrometrica, Grimmia pulvinata)* have been found. In *Bryum billardieri,* Australian populations with n=10, 11, 20 and 21 are known, in *Barbula calycina* n=13, 30 and 52 in plants of different size are recorded, and in *Thuidium furfurosum* n=11 and 22 occur.

KEY TO SOUTH AUSTRALIAN MOSSES

A prime purpose of this book is to enable the student of mosses to identify each of the species to be found in the State and the adjacent arid zone. As a first step, the following key should be consulted and, to begin with, followed precisely, step by step. With experience and knowledge, short cuts can be taken, often directly to individual genera. The key consists of a general part which first splits the known species into twenty groups (A to T) each of whose principal characters are given at the head of the individual group key. It must be noted that, in general, species cut off in an earlier group may not appear in a later one, though having its character. Thus some species of *Fissidens* have a border of narrow cells to the leaf, but do not appear in group D because they are already taken out in group A through the distichous (two ranked) arrangement of their leaves. This applies fairly generally to mosses with particularly distinctive features separating them off in the early groups.

Most mosses can be identified with a high degree of probability whether or not fruit is present, but in some cases fruit is essential for certainty. Nevertheless, fruit is unknown in some species and rather rare in many others. Therefore the general section of the key, from couplet 7 onwards, attempts to deal separately with the problem of discovering identity in the presence and absence of fruit. Note also that fruit must generally be close enough to ripeness to exhibit essential characters.

A great many characters are derived from the leaves and their arrangement on the stem and it is necessary to explain how the different parts of the leaf are commonly distinguished. The side towards the stem will be referred to as adaxial, rather than ventral or front, while the side away from the stem is abaxial, rather than dorsal or back. In some complicated leaves, like those of *Fissidens*, more distinctions are necessary (see text account). The characters of the cells of a leaf often differ from one part to another. The region nearest to the stem will be referred to as basal or lower, the region furthest from the stem apical or upper and the intervening region as middle or mid leaf; lower and upper cover wider areas than basal and apical. Not infrequently the lower cells may be rather sharply distinct from the middle and upper and the connotation in description therefore obvious. The cells at the basal angles (alar cells) may be different from those nearer to the costa and sometimes are so swollen as to form an auricle. The cells at the margin or near the costa (juxtacostal) may be distinct from others. Further usages will be explained as they occur and also in the glossary.

It should be emphasized that the key is an artifical aid to discovering the name of a moss. It is not an expression of the classification relating genera into families and these into orders. This will be dealt with after the general artificial key. It should also be noted that the key is not infallible. In using it follow a choice at each couplet, bearing in mind that sometimes the choice to be made is somewhat subjective. After reaching a tentative identification refer to the detailed description in the text and to the illustrations which are intended to aid

interpretation of the descriptions. Failure to identify a specimen by means of the key may mean merely an error in choice at some stage or it may mean a species not included in the key and so hitherto not known for the State. Names of species or genera not known for the State, but likely to occur, are given in brackets.

Type localities are cited, as far as can be discovered, usually by quotation from the original description, using the original spelling.

GENERAL KEY

1. Leaves, at least on barren stems, distichous or strongly complanate ..... A
   Leaves in three or more rows on stem, not complanate 2
2. Leaves, at least the upper, with hyaline points or with the costa excurrent in an awn, often hyaline ..... B
   Leaves without hyaline points or awns 3
3. Leaves with longitudinal lamellae, either numerous or two to three and inconspicuous, on adaxial face of costa C
   Leaves without lamellae on costa 4
4. Leaves whitish when dry, composed of two kinds of cells, one large, hyaline and empty (leucocysts), the other narrow and green (chlorocysts) evenly distributed 5
   Hyaline cells, if present, restricted in distribution to costa, border, apex or basal angle 6
5. Leaf one cell thick, with the leucocysts thickened internally with spiral fibrils and surrounded by, usually six, narrow chlorocysts; branches in fascicles ..... *Sphagnum molliculum*
   Leaf two or more cells thick, with the chlorocysts embedded between adaxial and abaxial layers of leucocysts, which lack fibrils; branches single ..... *(Leucobryum candidum)*
6. Leaves bordered with narrow cells or border thickened ..... D
   Leaves not bordered 7
7. Plant with fruit 8
   Plant without fruit 17
8. Capsule immersed or just emergent 9
   Capsule exserted on a distinct seta 10
9. Operculum not separating (cleistocarpous) and usually not differentiated; plants very small, terrestrial ..... E
   Operculum separating (stegocarpous); plants large, on trees or rocks, or small and terrestrial ..... F
10. Peristome absent or rudimentary or capsule cleistocarpous ..... G
    Peristome present 11
11. Seta borne at end of stem or of a relatively long leafy branch (acrocarpous) 14
    Seta surrounded at its base only by perichaetial leaves and borne at side of stem or on a short branch (pleurocarpous) 12

12. Leaves either with no costa or a short double one; upper leaf cells elongate L
    Leaves with a single costa to at least mid leaf 13
13. Upper cells of leaf short, not twice as long as wide ..... S
    Upper cells of leaf usually at least thrice as long as wide ..... T
14. Capsule striate, regularly furrowed when dry ..... H
    Capsule smooth or only lightly, and irregularly, sulcate when dry 15
15. Capsule erect or suberect 16
    Capsuel inclined or cernuous or on an arcuate seta ..... K
16. Peristome teeth 16, entire or slightly and irregularly cloven I
    Peristome teeth 16 and deeply divided at least to half way (though the segments may be cross connected) or 32 ..... J
17. Leaves with no costa or with a short double one 18
    Leaves with a single costa, at least to mid leaf 19
18 Cells short, quadrate to rectangular above, papillose ..... *Hedwigia*
    Cells elongate, more or less rhomboidal, at least thrice as long as wide L
19. Plants with gemmae or filaments on the leaves or in their axils or on the stem ..... M
    Plants without such appendanges 20
20. Costa very broad, about one third or more of base of leaf, or greatly swollen in upper part of leaf ..... N
    Costa less than one third of width at base of leaf 21
21. Upper cells of leaf wide, 20 μm or more in least diameter ..... O
    Upper cells of leaf small or narrow, rarely more than 15 μm wide 22
22. Leaves obtuse and entire, or bluntly apiculate ..... P
    Leaves acute or, if obtuse, serrate at margin 23
23. Acrocarpous (see 11); stem usually erect or ascending, simple or dichotomously branched, never pinnate; leaf cells usually quadrate, rounded or hexagonal, rarely hexagonal rhomboid; costa often reaching apex of leaf or excurrent 24
    Pleurocarpous (see 11); stem usually prostrate or creeping, sometimes pendulous or erect, often long and with divergent lateral branches, sometimes pinnate; leaf cells most usually rhomboid or linear, sometimes oval and rounded, not quadrate; costa scarcely ever excurrent 13
24. Leaves with an excurrent costa or with a long fine subula into which the costa runs ..... Q
    Leaves not subulate, costa not excurrent ..... R

A. LEAVES DISTICHOUS OR BRANCHES STRONGLY COMPLANATE

1. Leaves distichous, at least on sterile shoots 2
   Leaves complanate, in more than two rows but in the same plane 3
2. Leaves with an adaxial sheathing lamina basally and a dorsal and apical wing ..... *Fissidens*
   Leaves without a sheathing lamina ..... *(Mittenia plumula)*

3. Leaves with a border of narrow cells 4
   Leaves without a differentiated border 6
4. Leaves with a short forked costa ..... *Eriopus apiculatus*
   Leaves with a single costa to at least mid leaf 5
5. Plants with a cluster of branches topping an erect stem; leaves in ranks, the ventral smaller and rounder than the lateral leaves
   Hypopterygium rotulatum
   Plants prostrate, little branched, leaves not obviously in ranks, nor differentiated in size and shape ..... *Distichophyllum pulchellum*
6. Dorsal leaves smaller than the lateral leaves, all with a strong longly excurrent costa ..... *Rhacopilum convolutaceum*
   Leaves not obviously differentiated in size, costa not excurrent 7
7. Costa broad, green, forked at tip; apex of leaf pointed, margin toothed
   Pterygophyllum dentatum
   Costa narrow, coloured; apex of leaf rounded, margin entire or crenulate
   Distichophyllum microcarpum

B. LEAVES WITH HYALINE POINTS OR WITH THE COSTA EXCURRENT AS AN AWN, USUALLY HYALINE

1. Leaves with longitudinal lamellae or filaments on the adaxial side of the costa 2
   Leaves without lamella or filaments 5
2. Leaves with lamellae 3
   Leaves with filaments 4
3. Plants robust, with numerous lamellae; awn reddish brown
   Polytrichum juniperinum
   Plants very small, lamellae only two or three; awn hyaline
   Pterygoneurum ovatum
4. Margin of leaf widely involute ..... *Aloina sullivaniana*
   Margin of leaf narrowly revolute ..... *Crossidium geheebii*
5. Leaves without a costa or costa short and double ..... *Hedwigia ciliata*
   Leaves with a distinct costa to at least midway 6
6. Costa at least one third of width of leaf near base ..... *Campylopus*
   Costa much less than one third of width of base of leaf 7
7. Cells at base of leaf enlarged and coloured reddish brown
   Dicnemoloma pallidum
   Cells at base of leaf not highly coloured nor much enlarged 8
8. (Three alternatives). Lamina hyaline at apex; costa apparently vanishing at apex ..... *Grimmia*
   Lamina hyaline for upper part, often half, of leaf; costa ceasing well below the apex ..... *Bryum argenteum*
   Lamina not hyaline above; costa excurrent as an awn 9
9. Shoot strongly complanate; leaves dimorphous *Rhacopilum convolutaceum*
   Shoot not complanate; leaves not dimorphous 10
10. Cells rhomboid, at least above, with pointed ends ..... *Bryum*
    Cells more or less quadrate above; peristome long and twisted ..... *Tortula*

C. LEAVES WITH LONGITUDINAL LAMELLAE ON ADAXIAL SIDE

1. Shoots short, bulbiform, plants small; lamellae two or three, rather inconspicuous 2
   Shoots robust, elongated; lamellae numerous; leaves large with sheating base 3
2. Capsule globose, immersed in leaves; no operculum ..... *Acaulon* (subgen. *Alaticosta*)
   Capsule shortly cylindrical, emergent on a short seta; operculum conical, rostrate ..... *Pterygoneurum*
3. Leaf margin entire, widely involute; costa excurrent in a brownish hair; peristome teeth short, thick, connected by an epiphragm ..... *Polytrichum juniperinum*
   Leaf margin dentate, narrowly involute; apex rather blunt; peristome consisting of numerous linear hairs forming a whitish tuft which is slightly twisted ..... *Dawsonia longiseta*

D. LEAVES WITH A BORDER OF NARROW CELLS, SOMETIMES HYALINE

1. Shoots with leaves complanate ..... Return to A4
   Shoots with the leaves radially symmetrical or falcate and turned to one side 2
2. Leaves lanceolate subulate, often falcate; cells with thick, porose walls; alar cells strongly differentiated ..... *Dicranoloma*
   Leaves ovate to ovate lanceolate; cells with thin walls; no differentiated alar cells 3
3. Cells papillose, rather small and isodiametric except at base and border; leaves with globular gemmae on adaxial surface .. *Calyptopogon mnioides*
   Cells smooth, hexagonal or rhomboid, elongated, larger 4
4. Cells lax, wide, often truncately hexagonal; capsule erect ..... *Funaria*
   Cells hexagonal or rhomboid, pointed at ends; capsule inclined or nodding ..... *Bryum*

E. CAPSULE IMMERSED OR EMERGENT, CLEISTOCARPOUS: PLANTS SMALL TO MINUTE

1. Plant growing from a persistent green protonema; leaves coarsely and spinously toothed; without a costa ..... *Ephemerum cristatum*
   Protonema not persistent; leaves not coarsely toothed; costa present or not 2
2. Leaves lanceolate subulate to linear, usually 10 × 1 3
   Leaves ovate, ovate lanceolate, oblong, spathulate or obovate, rarely more than 5 × 1, usually 2-3 × 1 4
3. Seta distinct, capsule emergent, obovoid, with a green apophysis; spores 35-45 μm diameter, ornamented with long, flattened spines; operculum large, campanulate ..... *Bruchia brevipes*

Seta none or short, capsule globose or ellipsoid; without a distinct apophysis; spores 20-25 μm diameter, papillose; operculum small, cucullate ..... *Pleuridium nervosum*

4. Seta distinct, about as long as capsule 5
   Seta short or apparently none 6
5. Capsule ellipsoid; leaves with a strong costa; leaf cells with crescentic or annular papillae ..... *Tetrapterum cylindricum*
   Capsule globular; costa weak, scarcely reaching mid leaf; leaf cells smooth ..... *Physcomitrella readeri*
6. Leaves oblong, obtuse entire (but perichaetial leaves attenuated); costa ceasing below apex; upper leaf cells subquadrate, papillose; capsule enclosed in a large inflated calyptra, not separated from vaginula *Bryobartramia novae-valesiae*
   Leaves pointed, costa usually percurrent or excurrent; calyptra not inflated, separating from vaginula 7
7. Capsule globose, not apiculate; spores relatively few, very large, usually more than 100 μm diameter; cells of leaves smooth ..... *Archidium*
   Capsule apiculate or not; spores numerous, smaller, 20-30 μm diameter; leaf cells smooth or papillose 8
8. Leaves very concave, with reflexed or straight, short or long tips; upper leaf cells wide and lax; two or three inner perichaetial leaves very wide and concave; capsule globose, not or only minutely apiculate ..... *Acaulon*
   Leaves spreading, carinate but not concave; upper leaf cells small, incrassate, papillose; capsule ellipsoid, apiculate 9
9. Leaves oblong lanceolate, carinate with an excurrent costa; apex of capsule not differentiated ..... *Phascum tasmanicum*
   Leaves oblong to oblong elliptical; apex of capsule with several rows of smaller cells at base of apiculum ..... *Phascopsis rubicunda*

F. CAPSULE IMMERSED OR EMERGENT, STEGOCARPOUS, OPERCULUM SEPARATING

1. Small (1-3 mm) terrestrial mosses, ephemeral or with annual growth 2
   Large mosses, usually more than 1 cm., perennial, on rocks or trees 5
2. Leaves without a costa 3
   Leaves with a costa 4
3. (three alternatives)
   Plants green; leaves ovate to ovate lanceolate with a denticulate point; calyptra inflated, large, campanulate, shortly beaked, with eight longitudinal ribs from eight pleats when young, lobed at base; spores large, to 75 μm, surface reticulate ..... *Goniomitrium enerve*
   Plants grey; lower leaves nearly orbicular, apiculate; upper leaves ovate acuminate, whitish, entire; calyptra mitriform, very small, smooth; spores very large, to 130 μm, coarsely verrucose ... *Gigaspermum repens*
   Plants green, lax; leaves, especially the upper, long and narrow, ovate lanceolate to acuminate; sometimes with a weak costa; capsule emergent; calyptra small, mitriform; spores very large, surface colliculate *(Eccremidium whiteleggei)*

4. Capsule emergent on an arcuate or straight seta; calyptra small, mitriform; spores large, colliculate ..... *Eccremidium*
   Capsule immersed, covered with a large, campanulate, pleated calyptra; spores large, reticulate ..... *Goniomitrium acuminatum*
5. Leaves without a costa; leaf cells narrowly linear at base, shorter and oval or quadrate above, small and incrassate ..... *Hedwigia*
   Leaves with a costa 6
6. Acrocarpous, with fruit terminal; stems short, branched irregularly; upper leaf cells short and isodiametic, below longer and wider, often with sinuous walls. On rocks ..... *Grimmia apocarpa*
   Pleurocarpous, with fruit on a short lateral branch; stems creeping, with erect or pendulous secondary stems which are branched subpinnately; leaf cells oval or rounded above, longer below, those at the basal margin forming a patch of subquadrate or rhombic cells ..... *Cryphaea dilatata*

G. CAPSULE EXSERTED; NO PERISTOME OR CAPSULE CLEISTOCARPOUS

1. Capsule with eight longitudinal grooves when dry 2
   Capsule smooth or irregularly sulcate when dry 3
2. Leaves linear lanceolate, usually somewhat falcate; leaf cells covered with very numerous minute papillae; fruit lateral .. *Amphidium cyathicarpum*
   Leaves oblong lanceolate; leaf cells smooth or with a few (2-5) papillae; fruit terminal on a long seta ..... *Zygodon*
3. Leaf cells elongate, hexagonal, very lax and thinly walled 4
   Cells more or less quadrate in upper part of leaf or elongate but small and narrow 5
4. Calyptra small, mitriform, erect, finally 4-5 lobed at base; operculum apiculate or rostellate, the cells in straight lines from centre to margin *Physcomitrium pyriforme*
   Calyptra large, inflated at base, finally oblique, cucullate, otherwise entire at base; operculum plano convex, the cells usually in spiral lines from centre to margin ..... *Funaria*
5. Leaves ovate, oblong or obovate 6
   Leaves (at least the upper) lanceolate, linear or subulate 10
6. Leaves obtuse, costa ceasing below apex 7
   Leaves acute, costa percurrent or excurrent 8
7. Leaves large, cells opaque with large multifid papillae; calyptra long, cylindrical, covering capsule completely ..... *Encalypta vulgaris*
   Leaves smaller, cells with several simple papillae; calyptra cucullate, covering about half of capsule ..... *Gymnostomum calcareum*
8. Capsule cleistocarpous on a very short seta; leaves widest below, contracted at a waist where papillose cells commence ..... *Tetrapterum cylindricum*
   Capsule stegocarpous on a relatively longer seta; leaves not contracted abruptly above a wide base 9
9. Leaves with two or three longitudinal lamellae on the costa . *Pterygoneurum*
   Leaves without lamellae ..... *Pottia*

10. Capsule globose; operculum convex; leaves smooth or sparely papillose . 11
    Capsule ovate oblong to elliptical; operculum rostrate; upper leaf cells densely papillose ..... *Weissia brachycarpa*
11. Capsule on a long (5-10 mm) seta, arising from a pale or glaucous green, irregularly branched, thin, more or less prostrate gametophyte *Bartramidula pusilla*
    Capsule on a short (about 1 mm), rather thick straight or arcuate seta arising from a short, erect gametophyte, becoming overtopped with innovations, julaceous in some. ..... *Eccremidium*

H. CAPSULE MORE OR LESS STRIATE, FURROWED WHEN DRY: PERISTOMATE; ACROCARPOUS

1. Capsule on an arcuate seta 2
   Seta straight, the capsule erect or oblique 5
2. Leaves ovate with very lax cells with thin walls ..... *Funaria*
   Leaves lanceolate or subulate, cells small with thick walls 3
3. Costa wide, at least a third of leaf width at base ..... *Campylopus*
   Costa narrow 4
4. Capsule subglobose; leaves papillose, plicate at least at base *Breutelia affinis*
   Capsule elliptical; leaves smooth, with a hair point ..... *Grimmia*
5. Capsule subglobose, oblique or erect 6
   Capsule more or less oval or cylindrical 7
6. Leaves short; lamina one-layered; plant soft, bright green or glaucous *Philonotis*
   Leaves long and narrow; lamina two-layered especially above ... *Bartramia*
7. Peristome teeth (exostome) 16, grouped in pairs; plants usually on bark of trees 8
   Peristome teeth equidistant 10
8. Calyptra relatively persistent, large, mitriform, plicate, usually hairy 9
   Calyptra soon falling, cucullate, smooth ..... *Zygodon*
9. Shoots mostly creeping; calyptra crenate at base, usually very hairy *Macromitrium tenue*
   Shoots mostly erect, plants tufted; calyptra laciniate at base, smooth or slightly hairy ..... *Orthotrichum tasmanicum*
10. Peristome teeth divided to base, to form 32 filaments; capsule with a small but distinct struma at base ..... *Ceratodon purpureus*
    Peristome teeth divided to halfway ..... *(Dicranella dietricheae)*

I. CAPSULE SMOOTH, ERECT; PERISTOME TEETH 16, NOT OR SCARCELY DIVIDED

1. Leaves with relatively long, very lax cells 2
   Leaf cells short and small above, often long and somewhat lax at base 4

2. Leaves triangular lanceolate; exostome none or poorly developed with blunt teeth; capsule often inclined ..... *Mielichhoferia*
   Leaves wide, oblong or obovate; exostome teeth well developed tapering to a point 3
3. Peristome teeth reflexed when dry; apophysis long, purple *Tayloria octoblepharis*
   Peristome teeth erect or incurved when dry; apophysis concolorous or paler than rest of capsule ..... *Funaria*
4. Capsule long, cylindrical; calyptra very large, covering capsule completely; leaves large, with large multifid papillae on upper cells *Encalypta vulgaris*
   Capsule small, ovoid to elliptical; calyptra small; leaves smooth or with simple papillae 5
5. Leaves ovate lanceolate or ovate ..... *Pottia starckeana*
   Leaves linear lanceolate or lanceolate ..... *Weissia*

J. CAPSULE SMOOTH, ERECT; PERISTOME TEETH 16 AND DEEPLY DIVIDED OR 32

1. Peristome teeth twisted 2
   Peristome teeth straight 7
2. Leaves oblong or obovate, or with filaments on adaxial side of costa; costa in section with one layer of small thickly walled (stereid) cells abaxially . 3
   Leaves more or less tapering in the upper parts, without adaxial filaments; costa in section with two layers of stereid cells, one adaxially the other abaxially, with larger (deuter) cells between 6
3. Costa with granular filaments adaxially in upper part of leaf 4
   No granular filaments, but in one species *(Tortula papillosa)* with small globular gemmae 5
4. Margin of leaf broadly involute ..... *Aloina*
   Margin of leaf plane or narrowly revolute ..... *Crossidium*
5. Costa widened in upper half of leaf, with swollen papillose cells adaxially; peristome teeth on a short basal tube, rather little twisted, not more than one turn ..... *Desmatodon*
   Costa not widened, adaxial cells not swollen; peristome teeth on a short or long basal tube, strongly twisted, usually two or three turns ..... *Tortula*
6. (three alternatives) Leaves usually short or with recurved margins; basal hyaline cells not ascending up margin ..... *Barbula*
   Leaves long and narrow with plane margins; basal hyaline cells ascending up margins ..... *Tortella*
   Leaves flexuous, long and narrow with plane margins; basal hyaline cells not ascending up margins; perichaetial leaves long and sheathing *Barbula calycina*
7. Upper cells of leaf elongate 8
   Upper cells of leaf short, more or less quadrate 9

8. Costa excurrent, occupying most of a long fine subula; peristome teeth divided nearly or quite to base, papillose ..... *Ditrichum*
   Costa ceasing in or below apex; peristome teeth divided to midway or more, the basal intact plates vertically striate ..... *Dicranella jamesonii*
9. Leaves circinate when dry, plicate, margin sinuous or vaguely toothed, bistratose abova; seta short (3-5 mm) ..... *Ptychomitrium australe*
   Leaves twisted around stem or on themselves, margin entire, unistratose; seta relatively long 10
10. Leaf margin recurved, basal hyaline cells not ascending margins ... *Barbula*
    Leaf margin plane; basal hyaline cells ascending up margins ..... *Tortella*

K. CAPSULE SMOOTH, INCLINED OR PENDULOUS, WITH A PERISTOME

1. Seta bent or curved downwards when moist 2
   Seta straight except where it joins the capsule 3
2. Peristome single; leaves lanceolate, usually with a hair point; leaf cells small, thickly walled ..... *Grimmia*
   Peristome double; leaves ovate, apex green; leaf cells large, thinly walled *Funaria*
3. Leaves linear to linear setaceous or subulate 4
   Leaves not setaceous nor subulate 6
4. Capsule inclined with a very long apophysis, at least half length of capsule *(Trematodon)*
   Capsule inclined or pendulous; apophysis less than half length of capsule . 5
5. Capsule inclined, clavate; leaf cells wider ..... *Orthodontium*
   Capsule pendulous, pyriform; leaf cells very narrow; rhizoids purple *Leptobryum pyriforme*
6. Peristome usually poorly developed, with exostome rudimentary and an endostome of 16 slender processes from a short membrane *Mielichhoferia*
   Peristome, especially exostome, well developed 7
7. Cells truncate hexagonal; peristome curved spirally ..... *Funaria*
   Cells rhomboidal or rhomboidal hexagonal, more or less pointed; peristome not curved 8
8. Endostome a membrane bearing narrow processes ..... *Brachymenium*
   Endostome bearing rather broad processes and narrow cilia ..... *Bryum*

L. LEAVES WITH NO COSTA OR COSTA SHORT AND DOUBLE; LEAF CELLS ELONGATED

1. Leaves concave, orbicular or oblong, rounded to obtuse at apex 2
   Leaves acuminate or with a long narrow point, not concave 3
2. Basal angle of leaf with a conspicuous group of large, hyaline, thinly walled cells; upper leaf cells 50-80 x 4-6 μm..... *Acrocladium chlamydophyllum*
   Cells at basal angle of leaf small, dark, subquadrate to rounded, chlorophyllose, incrassate; cell in mid leaf 10-25 x 2-8 μm, shorter above ..... *Lembophyllum divulsum*

3. Leaves large, spreading, abruptly contracted above to a long coarsely serrate point; no auricles, but cells at basal angles of leaves wider and coloured orange ..... *Ptychomnion aciculare*
   Leaves smaller, gradually acuminate with clearly defined basal auricles ... 4
4. Leaves with 3-8 large, inflated, pellucid cells at base angles; operculum with a long slender beak ..... *Sematophyllum*
   Leaves with basal auricles formed of a small to large number of small, opaque cells, with thick walls; operculum conical or shortly rostrate *Hypnum*

M. PLANTS WITH GEMMAE OR FILAMENTS ON THE LEAVES OR ON THE STEM OR IN THE LEAF AXILS OR WITH MINIATURE BRANCHES

1. Plants pleurocarpous, rather richly branched, with paraphyllia on stems Refer to S2
   Plants acrocarpous, little branched, without paraphyllia 2
2. (three alternatives)—Gemmae resemble miniature leaves, clustered at the apex of the shoot or in the axils of the leaves ..... *Tortula pagorum*
   Miniature branches produced from stem between leaves, detached and shed from older part of stem, crowded at apex ..... *Philonotis tenuis*
   Gemmae or filaments on the adaxial surface of the costa or on the stem between the upper leaves 3
3. Spherical gemmae on upper adaxial region of costa 4
   Filaments on adaxial surface of the costa or on the stem (often detached) . 5
4. Leaf with a border of elongated cells; leaf cells each with 3-4 papillae on each surface ..... *Calyptopogon mnioides*
   Leaf without a border; leaf cells each with one central mamilla on each surface ..... *Tortula papillosa*
5. Leaves in three ranks, lanceolate acuminate, slightly undulate; clavate gemmae on younger parts of stem ..... *Leptodontium paradoxum*
   Leaves in more than three ranks, spathulate or oblong, blunt or acute 6
6. Leaves oblong lanceolate, acute or shortly acuminate; filamentous gemmae, usually with 6-8 cells, borne on the stem among the upper leaves; plants on trees or rock ..... *Zygodon*
   Leaves more or less spathulate and blunt, with or without a long hyaline awn; upper adaxial part of costa covered densely with filaments; plants terrestrial 7
7. Margin of leaf widely inflexed ..... *Aloina*
   Margin of leaf plane or narrowly revolute ..... *Crossidium*

N. COSTA WIDE, AT LEAST ONE THIRD OF THE BASE OF THE LEAF, OR GREATLY SWOLLEN IN UPPER PART OF LEAF

1. Plants minute; upper leaves with costa greatly swollen and glistening *Tortula oleaginosa*
   Plants small to large; costa not swollen distally 2

2. Plants silvery, the costa consisting of two or more layers of empty hyaline cells (leucocysts) enclosing narrow chlorophyllose cells *(Leucobryum candidum)*

Plants green to brownish, the costa not as above 3

3. Leaves rigid, often with coloured or hyaline dilated alar cells, some with hair points; rhizoids brown or reddish brown ..... *Campylopus*

Leaves flexuous, slenderly setaceous, without special alar cells; rhizoids purple, bearing purple tubers ..... *Leptobryum pyriforme*

O. LEAF CELLS WIDE, THE UPPER ONES USUALLY NOT LESS THAN 20 μM WIDE

1. Upper cells of leaf short, quadrate or roundish ..... *Pottia*

Upper cells of leaf elongated 2

2. Upper cells mostly with roughly pointed ends 3

Upper cells flattened at their ends 4

3. Leaves small, closely imbricate; costa stout, reddish brown, excurrent as a stout point ..... *Brachymenium preissianum*

Leaves larger, rarely imbricate; if imbricate costa not excurrent .... *Bryum*

4. Leaves obovate, entire, piliferous, costa usually reaching apex or excurrent; stem with fairly abundant pinkish rhizoids ..... *Tayloria octoblepharis*

Leaves oblong, obovate, concave, serrate or entire, scarcely piliferous; rhizoids basal, brownish ..... **Funaria, Physcomitrium*

P. LEAVES OBTUSE AND ENTIRE, OR BLUNTLY APICULATE: COSTA CEASING BELOW OR AT APEX

1. Upper leaf cells papillose 2

Upper leaf cells smooth 5

2. Upper part of costa bearing numerous filaments ..... See J4

Upper part of costa without filaments 3

3. Leaves wide, large, obovate, with coarse, multifid papillae *Encalypta vulgaris*

Leaves smaller; papillae simple 4

4. Margin of leaf recurved; costa percurrent or excurrent as a short mucro *Desmatodon*

Margin of leaf plane; costa failing below apex ..... *Gymnostomum*

5. Plants very small, julaceous; leaves apiculate, upper margin with small double teeth ..... *Eccremidium*

Plants larger, not julaceous; apex blunt 6

6. Leaves concave; upper cells elongated, rhomboid or hexagonal .... *Bryum*

Leaves flat; upper cells isodiametric, hexagonal; lower cells elongated, rectangular ..... *(Barbula ehrenbergii)*

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*Hardly to be separated by a key without fruit.

Q. LEAF WITH EXCURRENT COSTA OR WITH A LONG, FINE SUBULATE POINT INTO WHICH THE COSTA RUNS

1. Upper cells of leaf not twice as long as wide, usually quadrate or hexagonal often with the corners rounded 2
   Upper cells of leaf elongate or with pointed ends 8
2. Leaves with an ovate sheathing base contracting abruptly to a long, fine subula; cells rectangular ..... *Ditrichum*
   Leaves, ovate, lanceolate or spathulate, not subulate 3
3. Margin of leaf plane or narrowly incurved 4
   Margin of leaf narrowly recurved 5
4. Small plants with slender leaves ..... *Weissia* (see also *Trichostomum)*
   Robust plants with wider and longer leaves; basal hyaline cells of leaf ascending higher at margin than at costa ..... *Tortella*
5. Leaves ovate or obovate 6
   Leaves ovate lanceolate, lanceolate or linear 7
6. Usually robust; leaves aristate with a narrow excurrent costa ..... *Tortula*
   Usually small; costa thickened and widened in upper part of leaf and excurrent as a very short mucro ..... *Desmatodon*
7. Leaves more or less toothed at apex ..... *Ceratodon purpureus*
   Leaves entire at apex ..... *Barbula*
8. Leaves papillose (strictly mamillose) serrate 9
   Leaves smooth 10
9. Leaves long and narrow, rigid or flexuous, acutely serrate; bistratose above; some species with a sheathing leaf base ..... *Bartramia*
   Leaves shorter and wider, softer, serrulate ..... *Philonotis*
10. Leaves lanceolate subulate, often falcate; alar cells distinct, enlarged and coloured ..... *Dicranoloma*
    Leaves ovate to lanceolate; alar cells not distinct ..... *Bryum*

R. ACROCARPOUS: COSTA NOT EXCURRENT

1. Basal cells of leaf sinuose or nodulose ..... *Grimmia apocarpa*
   Basal cells of leaf not sinuose or nodulose 2
2. Upper cells of leaf elongate or pointed at the ends 3
   Upper cells of leaf short, usually quadrate or rounded 8
3. Leaves large, acuminate, plicate below, with rows of quadrate cells at the basal margin ..... *Breutelia affinis*
   Leaves smaller, not plicate 4
4. Leaf cells mamillose; plants glaucous green ..... *Philonotis scabrifolia*
   Leaf cells smooth 5
5. Leaves narrow, linear or setaceous 6
   Leaves ovate to lanceolate 7
6. Leaves sharply serrate near apex; costa very wide below; cells very narrow ..... *Leptobryum pyriforme*
   Leaves entire or only bluntly toothed; costa narrow; cells wider
   Orthodontium

7. Leaves lanceolate; costa ceasing below apex ..... *Mielichhoferia*
   Leaves usually ovate, often concave; costa often reaching apex ..... *Bryum*
8. Upper cells of leaf papillose 9
   Upper cells of leaf smooth 13
9. Leaves in three ranks; adaxial cells over upper part of costa like cells of lamina 10
   Leaves not in three ranks, spirally disposed; adaxial cells over upper part of costa different from those of lamina, usually being elongated 11
10. Leaves erect when dry, closely appressed to stem, usually clearly in three ranks; papillae high, spicate or branched ..... *Triquetrella papillata*
    Leaves twisted spirally around stem when dry, obscurely in three ranks; papillae low, simple and rounded ..... *Anomodon tasmanicus*
11. Growing on bark of trees; upper cells incrassate, round or oval *Orthotrichum tasmanicum*
    Growing on soil; upper cells not incrassate, irregularly angled or rounded 12
12. Basal cells of leaf rectangular, hyaline, thinly walled; alar region not decurrent ..... *Barbula*
    Basal cells elongated, each bearing one or two rows of papillae; alar region decurrent ..... *Leptodontium paradoxum*
13. Stems creeping, branched more or less pinnately; leaves rather opaque *Macromitrium tenue*
    Stems erect, plants in rather dense tufts; leaves pellucid 14
14. Cells more or less regularly quadrate; costa reaching the toothed leaf apex ..... *Ceratodon purpureus*
    Cells rounded, hexagonal or rhomboid; margin entire 15
15. Margins of leaf plane, bistratose above; no gemmae; apex of leaf slightly cucullate ..... *Ptychomitrium australe*
    Margins revolute from base to above middle of leaf; cylindrical gemmae, 6-8 cells long, present in upper leaf axils; apex of leaf straight, shortly pointed ..... *Zygodon*

S. PLEUROCARPOUS MOSSES; LEAVES WITH ONE COSTA; CELLS SHORT

1. Stem covered with green paraphyllia between the leaves 2
   Stem without paraphyllia 3
2. Leaves large, squarrose and recurved, longly acuminate; cells smooth *Cratoneuropsis decussata*
   Leaves small, squarrose on main stem, suberect on branches; cells papillose ..... *Thuidium furfurosum*
3. Leaves bordered with narrow cells; plant somewhat dendroid *Hypopterygium rotulatum*
   Leaves without a differentiated border; plant not dendroid 4
4. Green to shining silvery green; leaves with quadrate cells at base, extending adaxially over costa and ascending to margin obliquely; upper cells hexagonal and pointed to linear rhomboid 5
   Plant dull green; cells elliptical, uniform to base; costa stout *Pseudoleskea imbricata*

5. Basal quadrate cells extending 8-10 cells up costa and 22-30 cells up margin; cells in mid leaf 50-100 μm long; margin entire ..... *Ischyrodon lepturus*

   Basal quadrate cells extending 2-4 cells up costa and 10-14 cells up margin; cells in mid leaf 30-40 μm long; margin dentate ..... *Fabronia australis*

T. PLEUROCARPOUS MOSSES; LEAVES COSTATE; LEAF CELLS LONG, AT LEAST 3 × 1

1. Aquatic plants with long, finely tapering leaves 2
   Terrestrial plants with shortly acuminate leaves 3
2. Leaves falcato-secund or circinate; cells at basal angles inflated, forming distinct, hyaline, decurrent auricles ..... *Drepanocladus*
   Leaves spreading or almost squarrose; cells at basal angles enlarged, quadrate hexagonal, but not forming distinct or hyaline auricles *Leptodictyum riparium*
3. Leaves often dimorphous; costa, especially of branch leaves, usually ending as a spine projecting abaxially; branch leaves with short cells at blunt apex; operculum longly rostrate ..... *Eurhynchium*
   Leaves not dimorphous; costa not extending in a spine; branch leaves with elongate apical cells; operculum shortly conical or rostrate 4
4. Leaves small, usually 0·5 mm long (to 1 mm); costa weak; margin serrulate ..... *Amblystegium serpens*
   Leaves large, usually 2-3 mm long 5
5. Leaves mostly somewhat striate longitudinally, ovate lanceolate, shortly pointed; leaves not, or rarely and obscurely, complanate; operculum blunt or acute to apiculate ..... *Brachythecium rutabulum*
   Leaves smooth, ovate or ovate lanceolate with a fine attenuated point, usually somewhat complanate; operculum obliquely longly rostrate *Rhynchostegium tenuifolium*

THE CLASSIFICATION OF MOSSES

Hedwig (1801) was the first to devise anything like a natural system of classification, founded almost entirely on characters of the peristome and of the male and female reproductive organs and their surrounding leaves, constituting the so-called male and female, or hermaphrodite, flowers. The use of reproductive structures parallels Linnaeus's sexual system of classification though, as we now know, the reproductive organs are scarcely homologous. The soundness of Hedwig's system is manifested by the survival of a substantial number of his 35 genera, many retaining much the same basic concepts. However, Hedwig's system was artificial, grouping species that are very distantly related and separating others that are obviously related. Clearly unnatural genera include *Gymnostomum,* which lacks a peristome and brings together such species as *Pottia truncata* and *Leptobryum pyriforme.* Likewise, *Phascum* was a receptacle for all cleistocarpous mosses. Nevertheless it was a good attempt at systematy of the mosses and the first truly scientific treatment of them. Therefore it has been chosen as the publication from which nomenclature of mosses dates.

The next change of any significance dates from the monumental Bryologia Europaea of Bruch, Schimper and Guembel (1836-55), with its fine plates of drawings. They gave a greater value to characters of the gametophyte than had previous authors. The huge subclass of Bryales was divided primarily into the Acrocarpi and Pleurocarpi based on the position of the perichaetium and the large genus *Hypnum* was subdivided largely on vegetative characters. Thus the number of genera was increased, for Europe alone, to 135. This compares with 789 genera in 100 families listed for the whole world by Crosby and Magill (1977) and with 81 genera in 33 families in South Australia.

The gradual acceptance of the theory of evolution profoundly influenced classification. Resemblances and differences came to mean something different from what had been held previously. For resemblances may or may not indicate relationship and differences may be more apparent than real. Classification attempts to bring out relationships between mosses that are thought to be due to relationship in descent. The difficulties are immense. Persistent is the belief that similarities in reproductive structures are more fundamental, based on the axiom that reproduction is more conservative than the adjuncts of growth and metabolism manifested in vegetative structures.

There has been an increasing reliance at lower levels in major classification on characters of the gametophyte, to a relatively greater degree than is customary for flowering plants. However, the peristome has continued to hold a dominant position at higher levels. Characters of the gametophyte have helped the recognition that cleistocarpous mosses, in which the sporophyte is generally reduced to an almost or quite sessile, spherical to elliptical capsule, lacking a defined operculum and consequently any peristome, are mostly (but not in the Archidiaceae) reduced and simplified from more highly developed ones, now

arranged in several distinct families. Likewise, the gymnostomous character is frequently found by reduction in quite unrelated families and stages of reduction even feature within the same genus *(Pottia, Funaria)*. A major contribution to the principles of classification was the careful study by Philibert (1884-1902) of the minute structure of the peristome. His papers, originally often diffuse and encumbered with irrelevancies, have more recently been published, as an abridged translation, by Taylor (1962). These researches showed that certain peristome characters were basic and must exercise a dominant role in classification. The essential similarity of the diplolepideous peristome throughout the Bryoid and Hypnoid affinities and the basic difference between the haplolepideous and diplolepideous peristomes (see p.15) are resemblances and differences that take precedence over resemblances and differences in the gametophyte.

The most modern classification, influenced by this work, was originated by Fleischer (1906-8) in his scholarly treatment of the mosses of Buitenzorg. A further, somewhat revised, classification was published by Fleischer (1920) and adopted almost in entirety by Brotherus (1924-5). Dixon (1932) made but little departure from Fleischer's system and this is followed in the arrangement in this book. There follows a conspectus of the characters of the major subdivisions down to Order, with a listing of the families known to be represented in South Australia.

Class MUSCI

Subclass **SPHAGNOPSIDA** Order **SPHAGNALES**

Spores developed from a dome shaped layer of cells, the amphithecium, capping a columella developed from the endothecium. Capsule opening by an operculum. No peristome. Capsule elevated at maturity on a pseudopodium. Family **SPHAGNACEAE** 1 gen, 1 sp.

Subclass **ANDREAEOPSIDA** Order **ANDREAEALES**

Spores and columella developed from the endothecium, the archesporium dome shaped covering the columella. Spore sac not separated from wall of capsule by an air cavity. Capsule elevated at maturity on a pseudopodium. Capsule dehiscing by four (sometimes 8-10) longitudinal valves. No operculum. Family **ANDREAEACEAE** (not in South Australia).

Subclass **ARCHIDIOPSIDA** Order **ARCHIDIALES**

Sporophyte a globular sporangium on a large foot, no seta. Spores large, developed from the endothecium. No columella. No operculum. No air cavity. Family **ARCHIDIACEAE.** 1 gen, 2 spp.

Subclass **BRYOPSIDA**

Spores and columella developed from the endothecium, the archesporium barrel shaped and penetrated by the columella. Spore sac separated from capsule wall by an air cavity. Capsule dehiscing by an operculum or irregularly.

Clan **NEMATODONTEAE**

Peristome teeth composed of whole cells or membranes derived from several (more than three) concentric layers of cells of the sporogonium. Teeth not transversely barred. Five orders, of which one in South Australia.

Order **POLYTRICHALES**

Mostly tall perennial mosses. Leaves narrow, often with longitudinal lamellae on the adaxial side of the costa. Capsule erect to horizontal. Calyptra cucullate, smooth, spinulose or with a felt of deflexed hairs. Peristome of 32 to 36 horseshoe shaped teeth united above by a membrane or a brush of very numerous filiform bristles. Families **POLYTRICHACEAE** 1 gen, 1 sp.; **DAWSONIACEAE** 1 gen, 1 sp.

Clan **ARTHRODONTEAE**

Peristome teeth (when present) thin, membranous, derived from two or three layers of cells of the sporogonium. Teeth transversely barred and articulate.

Subclan **HAPLOLEPIDEAE**

Peristome teeth single (or none by reduction) formed of two layers of plates at the base derived from two layers of cells (PPL and IPL). The outer layer composed of a vertical row of transversely rectangular plates separated by transverse bars (trabeculae). The inner layer composed of two vertical rows of plates separated by a fine vertical, often zigzag, line and short horizontal lines. Almost exclusively acrocarpous mosses, the perichaetium being apical, though it may appear lateral by innovation below the perichaetium. Five orders, four in South Australia.

Order **FISSIDENTALES**

Leaves distichous, complanate, equitant, composed when well developed of a basal sheathing lamina, a dorsal and an apical lamina. Fruit lateral or terminal. Mostly terrestrial. Family **FISSIDENTACEAE** 1 gen, 13 spp.

Order **GRIMMIALES**

Mostly rupestral mosses, forming dense cushions. Leaves often with a hyaline point; cells usually minute, opaque, thickly walled. Seta often cygneous. Outer surface of peristome teeth without striae, upper part divided irregularly into two or three parts, not following the walls, but rather gaps where thickening is deposited irregularly. Family **GRIMMIACEAE.** 1 gen, 5 spp.

Order **DICRANALES**

Plants terrestrial or rupestral, small to large in size, mostly perennial. Leaves narrow, subulate to broadly lanceolate, usually smooth. Cells small, never lax, mostly quadrate or rectangular, walls thick in many, alar cells often differentiated. Acrocarpous. Capsule usually elongate. Outer face of peristome typically with broad basal plates, prominent trabeculae and vertical striolations. Peristome teeth usually split above, sometimes to the base, into two lanceolate or filiform divisions. Calyptra cucullate. Families **DITRICHACEAE** 4 gen, 8 spp., **DICRANACEAE** 5 gen, 11 spp.

Order **POTTIALES**

Mostly small terrestrial mosses, often annual. Leaves linear to broadly ovate-lanceolate or ovate. Upper cells of leaf usually isodiametrical, commonly small, opaque and papillose; lower cells towards base of leaf often longer, thinner walled and smooth. Acrocarpous. Capsule generally on a long thin seta, elliptical or cylindrical, erect; seta sometimes very short and capsule globose. Peristome of 16 straight or spirally twisted teeth, entire or each divided into two filiform branches, sometimes borne on a basal tubular membrane. Sometimes gymnostomous, sometimes cleistocarpous. Calyptra usually cucullate, narrow. Families **POTTIACEAE** 17 gen, 52 spp; **BRYOBARTRAMIACEAE** 1 gen, 1 sp.

Subclan **HETEROLEPIDEAE**

Peristome teeth very variable, single or double, haplolepideous or diplolepideous, or none.

Order **ENCALYPTALES**

Terrestrial or rupestral mosses growing in tufts. Leaves broad, more or less spathulate; cells strongly papillose in upper part of leaf. Capsule cylindrical, erect covered by a large campanulate calyptra. Family **ENCALYPTACEAE** 1 gen, 1 sp.

Subclan **DIPLOLEPIDEAE**

Peristome normally double, but single or none by reduction, when perfect derived from three layers of cells (OPL, PPL and IPL). Each tooth of the outer peristome (exostome) consists of two layers of plates, the outer layer of two vertical series separated by a thin vertical line usually more or less zigzag, the inner layer of a single vertical series bearing trabeculae. The inner peristome (endostome) is usually more delicate, often composed of a basal cylinder prolonged above into 16 processes, commonly narrower than exostome teeth and either opposite them or, much more frequently, alternating with them. Filiform cilia often occur between the processes. Plants often pleurocarpous, the perichaetium being a lateral branch arising from the stem.

Order **ORTHOTRICHALES**

Plants rupestral or arboreal, tufted or creeping to form mats; leaves variable in shape, commonly spathulate or lanceolate, often papillose. Exostome teeth usually broad and short, often united in 8 pairs. Calyptra usually large, campanulate or mitriform, rarely cucullate, often plicate, often hairy. Families **PTYCHOMITRIACEAE** 1 gen, 1 sp.; **ORTHOTRICHACEAE** 4 gen, 6 spp.

Order **FUNARIALES**

Plants mostly terrestrial, small, mostly annual or biennial. Leaves broad, ovate or spathulate, often forming a terminal rosette; leaf cells very lax, smooth, with thin walls. Acrocarpous. Capsule usually wide, operculum flat or conical, rarely rostrate. Calyptra generally inflated, sometimes fringed below. Peristome

usually double, but single or none by loss; exostome teeth sometimes joined in pairs; endostome processes opposite to the exostome teeth; exostome without a basal membrane and without cilia.
Families **GIGASPERMACEAE** 1 gen, 1 sp; **FUNARIACEAE** 4 gen, 14 spp; **EPHEMERACEAE** 1 gen, 1 sp; **SPLACHNACEAE** 1 gen, 1 sp.

Order **EUBRYALES**
Perennial, often vigorous plants, in tufts or mats or dendroid or pendent. Leaves various, from broadly ovate and soft to lanceolate or subulate and rigid, acrocarpous or pleurocarpous (none in South Australia). Capsule often inclined or pendent. Peristome double, bryoid, with an endostome consisting of a basal tubular membrane bearing 16 keeled, lanceolate processes, more or less perforate or split in the median longitudinal line; cilia present or rudimentary, sometimes none. Outer layer of exostome teeth usually finely papillate. Calyptra cucullate.

EUBRYALES ACROCARPI Families **BRYACEAE** 5 gen, 18+ spp; **(MITTENIACEAE)** (1 gen, 1 sp); **BARTRAMIACEAE** 4 gen, 6+ spp.

Order **ISOBRYALES**
Pleurocarpous mosses, mostly with a creeping, rhizomatous primary stem bearing erect or pendent secondary stems. Leaves with a single costa or none. Capsule immersed or exserted, erect and generally symmetrical. Endostome usually imperfect or absent. Calyptra small, usually cucullate, often hairy.
Families **RHACOPILACEAE** 1 gen, 1 sp; **CRYPHAEACEAE** 1 gen, 1 sp; **HEDWIGIACEAE** 1 gen, 2 spp; **PTYCHOMNIACEAE** 1 gen, 1 sp; **LEMBOPHYLLACEAE** 1 gen, 1 sp.

Order **HOOKERIALES**
Mosses mostly in moist habitats. Stems usually soft in texture, the epidermis generally of lax cells. Shoots often complanate. Leaves often with a double costa; cells typically large. Peristome generally double and perfect, the endostome mostly without cilia. Calyptra conical or mitriform, often fringed at the base and hairy elsewhere. Families **HOOKERIACEAE** 3 gen, 4 spp; **HYPOPTERYGIACEAE** 1 gen, 1 sp.

Order **HYPNOBRYALES**
Mosses mostly terricolous or corticolous, with a primary rhizomatous stem. Stems with or without paraphyllia. Leaves with a single costa or a short and double costa or none; leaves often complanate or secund. Leaf cells mostly elongate and smooth, more rarely isodiametric, small and papillose; alar cells often differentiated. Capsule exserted, erect or more commonly curved. Peristome usually well developed, hypnoid, with the outer plates of the exostome striate.

Families **THUIDIACEAE** 1 gen, 1 sp; **LESKEACEAE** 2 gen, 2 spp; **AMBLYSTEGIACEAE** 5 gen, 6 spp; **BRACHYTHECIACEAE** 3 gen, 4 spp; **FABRONIACEAE** 2 gen, 2 spp; **SEMATOPHYLLACEAE** 1 gen, 3 spp; **HYPNACEAE** 1 gen, 1 sp.

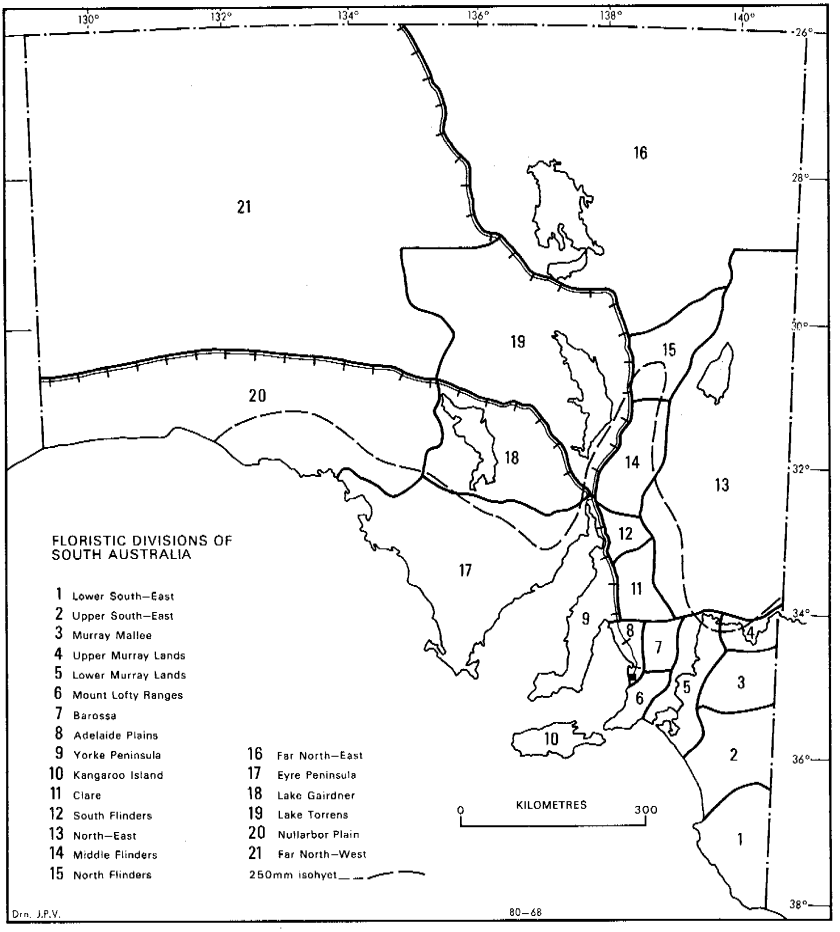


Fig. 3. Map of South Australia showing botanical provinces.

FLORISTIC DIVISIONS OF SOUTH AUSTRALIA

Various subdivisions of the State have been used for exhibiting the distribution of species. Specht *et al.* (1974, p. 238) used eleven rather broad geographical regions with boundaries determined broadly by a synthesis of topographical, rainfall and geographical criteria. The State Herbarium of South Australia has a division of the State into thirteen regions separated along lines of longitude and latitude. Fisher (1978) used the sixteen meteorological districts. All these maps suffer from the difficulty of easy recognition on the ground of boundaries, and it has been considered useful to define provinces whose boundaries are defined on the ground by State borders, the coast and artifacts such as railways, roads and tracks. The following defines twenty-one provinces, many of which reflect more or less natural attributes. Greater subdivision is suggested for the wetter areas and those with a more diverse topography. Given these, the known distribution of species can be defined by listing the numbers assigned to the provinces. This is done for each species. Future subdivision may prove desirable.

1. *Lower South-East:* Boundary with 2 the road N.E. from Kingston to Bordertown, thence by Dukes Highway (route 8) to Victorian border.
2. *Upper South-East:* Boundary with 5 the road from between Wood's Well and Magrath Flat to Coonalpyn, thence to Moorlands on route 8 and separated from 3 by route 12 through Pinnaroo to Victorian border; see also 1.
3. *Murray Mallee:* Boundary with 5 the road from Moorlands to Wynarka and Karoonda, thence following the Waikerie railway to Mantung and thence separated from 4 by the road to Pata, Taplan and the Victorian border; see also 2.
4. *Upper Murray Lands:* The boundary with 5 the railway line from Mantung to Waikerie and the road to Taylorville; the boundary with 13 the road from Taylorville to Overland Corner and the Old Coach Road to Renmark North, thence via Cooltong to the New South Wales border; see also 3.
5. *Lower Murray Lands:* Boundary with 13 the road from Taylorville west to Morgan and Bower; boundary with 7 the road south from Bower to Sedan and thence the railway as far as the Birdwood to Mannum Road; boundary with 6 the railway south to Monarto South, thence by road through Woodchester and Strathalbyn to Goolwa and the coast; see also 2, 3 and 4.
6. *Mount Lofty Ranges:* Boundary with 7 the Mannum Road through Birdwood and Gumeracha, as far west as Tea Tree Gully; boundary with 8 a line from Tea Tree Gully south along the eastern built up area below the hill slopes, to include the eastern suburbs to South Road, then via Majors Road to coast south of Marino; see also 5.
7. *Barossa:* Boundary with 8 the road north from Tea Tree Gully via One Tree Hill to Gawler, thence by route 32 to Riverton; boundary with 11 the road from Riverton east through Eudunda to Bower; see also 5 and 6.

8. *Adelaide Plains:* Boundary with 11 the road from Riverton through Rhynie and Balaklava to Port Wakefield; see also 6 and 7.
9. *Yorke Peninsula:* Boundary with 11 the railway from Port Wakefield to Bowmans and north to Meriton; boundary with 12 the railway from Meriton to Port Pirie.
10. *Kangaroo Island.*
11. *Clare:* Boundary with 13 the road from Sutherland to Robertstown and Burra and then the railway from Burra north to Peterborough; boundary with 12 the railway from Peterborough to Crystal Brook and thence the road to Meriton; see also 7, 8 and 9.
12. *South Flinders:* Separated from 13 by railway from Peterborough to Orroroo; separated from 14 by road west from Orroroo to Wilmington and, via Horrocks Pass, to Port Augusta; see also 9 and 11.
13. *North-East:* The boundary with 14 formed by the road from Orroroo to 'Belton' H.S., 'Baratta' H.S., thence due north to Martin's Well and 'Wirrealpa' H.S.; the boundary with 15 is the road from 'Wirrealpa' H.S. to 'Balcanoona' H.S. and 'Moolawatana' H.S. to the Strzelecki Track north of 'Mt. Hopeless' H.S.; the boundary with 16 is the Strzelecki Track to 'Murti Murti' H.S., thence to the border with Queensland near 'Bollards Lagoon' H.S.; see also 4, 5, 11 and 12.
14. *Middle Flinders:* The boundary with 15 is the road from Parachilna to Blinman and 'Wirrealpa' H.S.; the boundary with 19 is the railway from Port Augusta to Parachilna; see also 12 and 13.
15. *North Flinders:* The boundary with 19 is the railway from Parachilna to Lyndhurst; the boundary with 16 is the road from Lyndhurst to the Strzelecki Track via Blanchewater Ruins; see also 13 and 14.
16. *Far North-East:* The boundary with 19 is the railway line from Lyndhurst to Marree, thence to William Creek; the boundary with 21 is the railway line from William Creek via Oodnadatta to the border with the Northern Territory; see also 13 and 15.
17. *Eyre Peninsula:* The boundary with 18 is the road from Port Augusta to Iron Knob, thence the road via 'Siam' H.S., 'Nonning' H.S., 'Thurlga' H.S. and 'Yardea' H.S. to 'Hitalba' H.S., the boundary with 20 is the road to Yantanabie and then the railway line to Ceduna and the coast.
18. *Lake Gairdner:* The boundary with 19 is the railway line from Port Augusta to Kingoonya; the boundary with 20 is the road from 'Hiltaba' H.S., via 'Lake Everard' H.S., Blue Dam and 'Kokatha' H.S. to Kingoonya; see also 17.
19. *Lake Torrens:* The boundary with 21 is the road to Coober Pedy, thence the track to William Creek; see also 14, 15 and 16.
20. *Nullarbor Plain:* The boundary with 21 is the railway from Kingoonya to the Western Australian border near Deakin; see also 17 and 18.
21. *Far North-West:* For boundaries see 16, 18, 19 and 20.

SYSTEMATIC TREATMENT OF SOUTH AUSTRALIAN MOSSES

Class **MUSCI**

Subclass **SPHAGNOPSIDA**, a distinct subclass of mosses comprising one genus

Order **SPHAGNALES**

Family **SPHAGNACEAE** Dum. 1829, *Anal. Fam. Pl.* p.68.

SPHAGNUM Linnaeus 1753, *Spec. Plant.* p.1106

Lectotype: *S. palustre* Linn. fid. Britton in N. C. Britton 1916, *Fl. Bermuda* p.431.

Robust mosses developing from a thallose protonema, growing in wet acid habitats, especially peat bogs, swamps and the margins of pools and ditches. The stems vary much in length, consisting (fig. 4 is a section) of a central axis of thinly walled cells surrounded by a woody cylinder of slender, thickly walled tough cells and, on the exterior, by one or more layers of large hyaline cells. Branches are borne in fascicles, associated with every fourth leaf on the stem. Each fascicle has three or more branches some being divergent and stout while others are pendent and slender, adhering to the stem. Branches form dense heads at the apex of the stem, but fascicles are spaced out on the older parts of the stem. Stem leaves and branch leaves are different in shape; there is no costa in any leaf. The cells of the branch leaves are of two kinds. The larger are hyaline (leucocysts), dead at maturity, rhomboid or sinuously elliptical, with round pores and spiral thickenings on the inside of the cell walls. The smaller (chlorocysts) are very narrow, densely packed with chloroplasts, several (normally six) surrounding each leucocyst and embedded between them and may be covered adaxially or abaxially or both or neither. The cells of the stem leaves have fewer spiral thickenings and pores, or may lack them. The capsule is brown, globose, borne on a pseudopodium formed from the apex of a special short branch; the operculum is convex or flattened, dehiscence is explosive and there is no peristome; the calyptra is fragile and irregular. Antheridia are borne in the axils of leaves, usually coloured yellowish or reddish, towards the ends of some branches.

The genus has a reputation for being very difficult taxonomically and has been subject to excessive splitting into micro-species, especially by Warnstorf (1911). Watts (1912) listed the Australian species recognised by Warnstorf, to a total of 29 plus several varieties; only one, *S. dubiosum* Warnst. in the section *Subsecunda,* was reported for South Australia. Willis (1952,1955) has examined the types of the species and reduced them to four species: *S. australe* Mitt. (=*S. antarcticum* Mitt.), *S. cristatum* Hampe, *S. falcatulum* Besch. and *S. subsecundum* Nees, with a possible fifth, *S. beccarii* Hampe. However, what has passed in Australia for the boreal *S. subsecundum* is a different species. It occurs in South Australia and *S cristatum* has also been reported doubtfully.

There are two fairly distinct subgenera;

INOPHLOEA. Plants usually with robust, turgid branches and broad, concave, obtuse, cucullate branch leaves, commonly roughened at the back near the apex, due to resorption of the walls of leucocysts, and bordered by a row of cells resorbed along their outer margins and appearing linear and, in section, as a furrow; cortical cells of stems and branches reinforced on the inside by spiral fibrils. *S. cristatum, S. beccarii.*

LITHOPHLOEA. Plants usually with more slender branches, with narrower, mostly pointed leaves, not cucullate nor roughened at the back of the apex; the border of the branch leaves consists of linear cells in two or three rows (only exceptionally of a single row of cells resorbed at their margins); cortical cells of stems and branches not fibrillose.

The two subgenera are bridged by the boreal *S. compactum* and related species. Hence, it has become usual to separate the genus into smaller, more homogeneous, sections of which the following are Australian:

Rigida (S. australe)
Cuspidata (S. falcatulum)
Subsecunda (S. molliculum)
Palustria or *Sphagnum (S. cristatum, S. beccarii)*

Sphagnum molliculum Mitt. 1860, *J. Proc. Linn. Soc.* **4**:99
Type: Tasmania

S. subsecundum auct. Aust. *non* Nees.
S. cymbifolioides C. Mu¨ll. 1851, *Bot. Zeit.* **9**:546 *hom. illeg.*
S. dubiosum Warnst. 1891, *Hedwigia* **30**:20. Type: Newfoundland?

Fig. 4*

Plants aquatic, in pools, ditches and swamps, tall and rather slender, 10-25 cm, high; green, reddish brown or orange. Stems dark brown or pale green. Epidermal cells of stem (h) in one layer, without fibrils or (but rarely) pores. Stem leaves (b) fairly large, oblong lingulate, rounded at the apex, the margin there finely toothed or fringed; cells all narrow, the marginal ones extremely so forming a border narrow above and much wider towards the base; all cells fibrillose (except a very few near the base), but not porose. Branches usually three in a fascicle (a), the divergent ones spreading or deflexed, somewhat flagelliform; retort cells slightly recurved at apex. Branch leaves (c) subsecund, cymbiform, very concave, narrowly ovate to oblong lanceolate, acuminate to an obtuse apex having 6-7 teeth (d); leucocysts (e, f) narrow, spirally fibrillose with about 9-12 turns per cell; no pores, or only very rarely, on adaxial side of leucocysts (e); 6-10 or 12 pores per leucocyst (f) on the abaxial side of the upper cells, scattered along the edges, fewer and smaller pores (to 1 or 2) in the lower cells. Chlorocysts in section (g) elliptical to narrowly elliptical, reaching both sides of the leaf, but with thick walls above and below.

*The text figures are described by inserting the figure number(s) under the species citation and the letters (a onwards) in the appropriate places in the description.

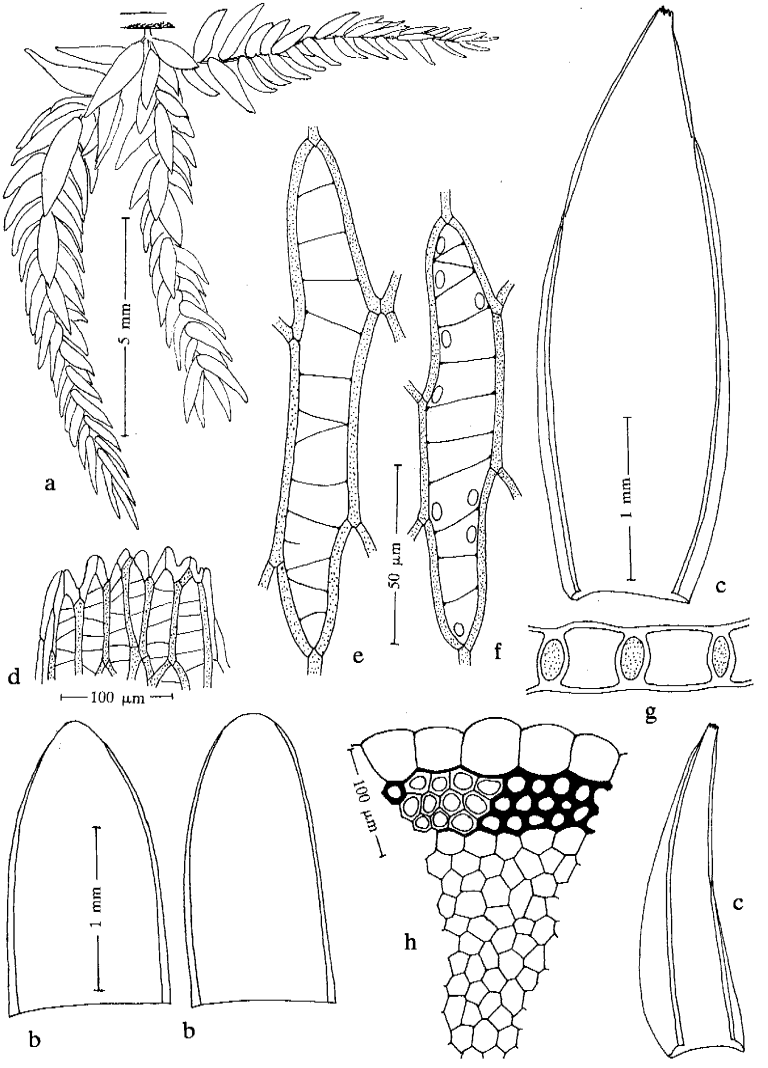


Fig. 4. *Sphagnum molliculum*

Distribution: Australia (W.A., S.A., Vic., Tas); rare in South Australia (1, 6).

Differs from *S. subsecundum* Nees in the shape of the stem leaves (which are triangular or triangular-lingulate in *S.subsecundum*) with fibrils in all or nearly all leucocysts, but no pores, and in having fewer pores on the abaxial surface of the leucocysts of branch leaves. Only the relatively slender variety has been found in South Australia.

Subclass **ARCHIDIOPSIDA**
Order **ARCHIDIALES**

Family **ARCHIDIACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.5.

ARCHIDIUM Brid. 1827, *Bryol. Univ.* **1**:747 the only genus.

Type species: *A.phascoides* Brid. = *A.alternifolium* (Dicks. *ex* Hedw.) Schimp.

Small yellowish green to green perennial plants, forming low turfs or small tufts on soil, usually in open situations. Branched by innovations formed in the axils of the perichaetial leaves or the upper stem leaves. Stems terete, about 0·5 cm tall, with a central cylinder of large cells with thin walls and a cortex of thinly walled cells becoming smaller and with thicker walls outward. Leaves ovate-lanceolate, cells hexagonal or rhomboid above, rectangular below; costa reaching near to apex of leaf or excurrent as a hair point; costa in section of undifferentiated cells, all thickly walled. Perichaetial leaves similar, but larger and more delicate. Mature sporophyte globose 200-750 μm diameter, sessile without a seta; capsule wall a single layer of yellowish rather transparent cells, which may develop dark spots with age. Calyptra very thin, saccate, tearing irregularly; spores large, globular to polyhedral by mutual pressure, 50-300 μm in diameter, usually 16 to 32 per capsule, smooth or finely punctulate, pale yellow to pale orange, released by irregular rupture or rotting of capsule wall; no columella; no seta. Three species in Australia.

The embryogeny and structure of the sporophyte of *Archidium* is unique among mosses and shows no evidence of reduction to an extreme cleistocarpous state from mosses with columella and aerenchyma, as do other cleistocarpous species, such as *Ephemerum*. In *Archidium*, as described by Snider (1975), the zygote first divides transversely into an upper and lower cell. The latter, by numerous divisions, produces an enormous foot, which is embedded in the apex of the gametophyte. The upper cell produces the capsule and neither the upper nor the lower cell contribute to a seta. The upper cell forms a two-sided apical cell and this forms two rows of cells, three to five cells high. In section, the two cells appear as about equal (fig. 5a) and then each divides unequally by an oblique wall (fig. 5b). A second division, by walls at an angle to the first, results in an endothecium of two cells surrounded by an amphithecium of four cells, as seen in section (fig. 5c). Thus, unlike the Bryopsida, there is no quadrant stage before the endothecium is defined. Moreover, the further divisions (fig. 5d, e) in the amphithecium of *Archidium* do not occur by regular alternation of periclinal

and anticlinal walls. Ultimately the amphithecium comprises three layers of cells, with the same or differing numbers in successive layers (fig. 5f). When the three layers of the amphithecium are completed, the endothecial cells, as seen in section, undergo two unequal divisions, similar to the initial formation of endothecium and amphithecium. There results two inner and four outer cells (fig. 5f). The latter ultimately develops into the spore sac, of one layer of cells. The inner two tiers of endothecial cells undergo several more, rather random, divisions, the lower tiers contributing to sterile tissue connecting the capsule to the foot. The remaining endothecial cells constitute the archesporium, and no columella is differentiated. Any or all of these endothecial cells may become a spore mother cell. In the subgenus *Archidium*, to which the Australian species belong, only a limited number of the cells do so. The remaining sterile cells are gradually resorbed, apparently serving as nutritive tissue for the developing spores. In the subgenus *Archidiella* (one species only, in S.W. Africa), all of the archesporial cells become spore mother cells, so the spores are smaller and more numerous.

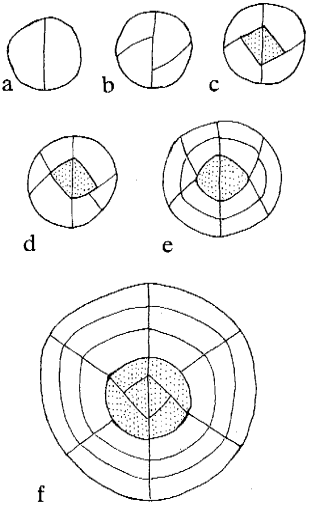


Fig. 5. Development of the capsule in the Archidiopsida. Endothecium shaded.

Key to species:

1. Median cells of most upper stem and perichaetial leaves uniform, rhombic hexagonal to elongately rhomboidal; alar cells of upper stem leaves quadrate, much smaller than medium cells, in 7 to 8 rows of differential cells extending up margin; costa of stem leaves strongly excurrent, usually forming a hair point. ..... *A.rothii*

   Median cells of most upper stem and perichaetial leaves irregular, from quadrate to shortly rectangular to rhomboidal; alar cells of stem leaves quadrate to shortly rectangular, only slightly smaller than median cells.

2. Upper margins of most stem and perichaetial leaves papillose denticulate, the teeth consisting of projecting upper and lower ends of adjacent marginal cells, appearing as two celled or double teeth. ..... *A.clavatum*

   Upper margins of stem and perichaetial leaves entire ..... *A.stellatum*

Archidium stellatum Stone 1973, *Muelleria* **2**:192.

Holotype: Australia, Victoria, mallee country near Neilborough, on bare light brown earth at roadside. I. G. Stone 30, 14.ix.1968 in Herb. MEL 1011755.

Figs 6, 7

Stems erect, about 3-4 mm tall, with terminal perichaetia, branching within perichaetium, usually from base of innermost perichaetial leaves. Innovations short, erect, somewhat julaceous, radiating stellately, becoming fertile at apex. Stem and branch leaves (a) more or less erect, very small below (less than 0·1 mm) larger upwards (0·35-0·8 mm long), subdeltoid or ovate to ovate

Fig. 6. *Archidium stellatum* (After Stone, 1973) x19

lanceolate, acuminate, concave. Costa failing below apex or percurrent. Cells (b, c) quadrangular to shortly rectangular, becoming oblique towards the apex, 8 μm wide above (c) widening to 10 μm below; walls firm to incrassate. Perichaetial leaves (d) 5 to 8 in number, 1-2 mm long x 0·5-1 mm wide, concave, ovate, quickly narrowed to a short point; margin entire; costa percurrent; basal cells narrower towards the margin where there is a band of narrow, thinly walled cells; median cells (e) irregularly rectangular to rhomboidal, the marginal row shortly rectangular; upper cells rhomboidal, 8-10 μm wide, marginal ones paler and shorter. Capsules 1 to several per plant, 0·35-0·45 mm diameter, immersed, sessile with a short thick foot in a cup shaped vaginula, cleistocarpous; exothecial cells pale, but becoming dark brown and shiny on top when capsule ripe; calyptra small, fleeting; spores few, 100-120 x 140-150 μm, thickly walled, smooth or finely sculptured, mature September to November. Antheridia 3 to 4, clavate, about 200 μm long, surrounded by 4 to 5 small (0·25-0·4 mm long), concave, costate leaves, borne on slender lateral branches having few leaves.

Distribution: Endemic to Australia (S.A., Vic.); abundant in suitable habitats in South Australia (6, 8, 11).

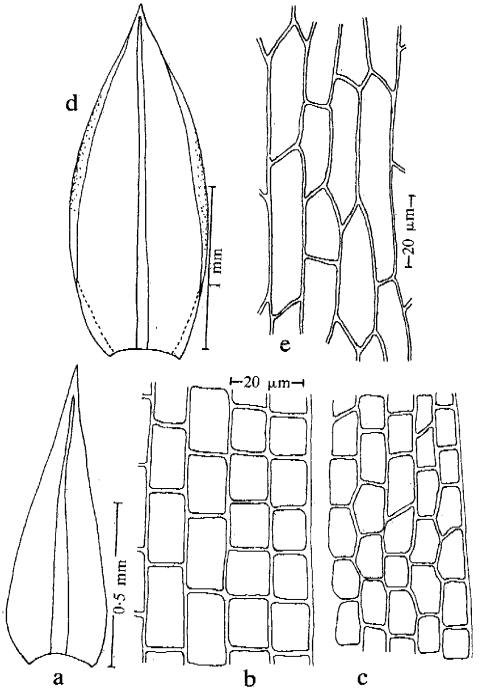


Fig. 7. *Archidium stellatum*

(**Archidium clavatum** Stone 1973, *Muelleria* **2**:192. Recorded from only one locality in Victoria, but perhaps overlooked).

Archidium rothil Watts ex Roth 1914, *Hedwigia* **54**:267, Pl.10, Fig.6.

Type: Australia, Queensland, Alice Springs, W. W. Watts, in Herb. N.S.W.(?)

Fig. 8

Stems branched from axils of stem leaves. Stem leaves (a) more or less erect, ovate to ovate lanceolate, acuminate, 0·6-0·9 x 0·3-0·5 mm, margin entire; costa excurrent as a strong, minutely spinulose point; median and upper cells (b) rhombic hexagonal to rhomboidal, 35-60 x 11-14 μm, basal cells (c) quadrate to shortly rectangular, 15-25 x 16-23 μm, alar region of 2 to 4 rows of quadrate cells

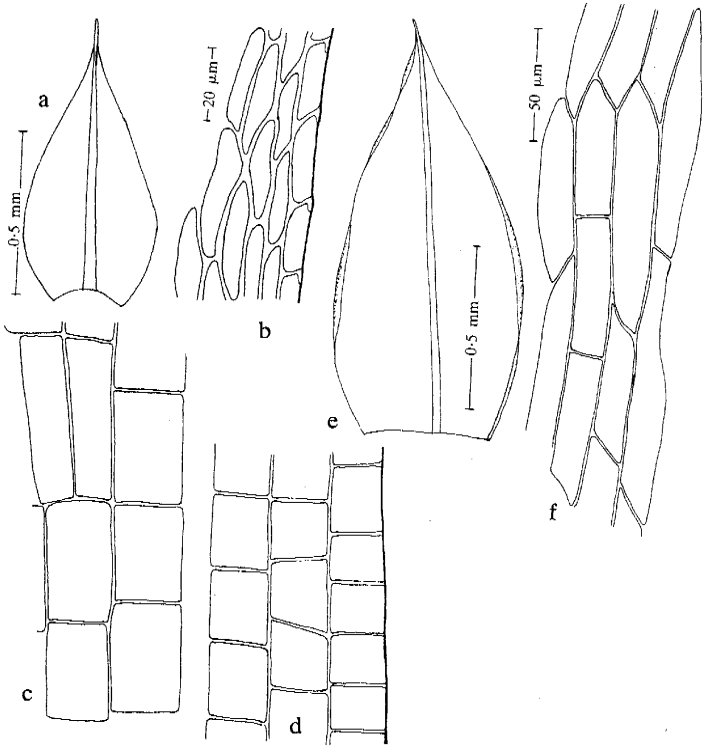


Fig. 8. *Archidium rothii*

(d), smaller than inner cells (c) and extending about a third of the way up the leaf at margin. Autoecious, the perichaetia and perigonia sessile or nearly so in the axils of the stem leaves, 1 to 4 per stem. Perichaetial leaves (e) to 1 x 0·35-0·55 mm, ovate, abruptly and shortly acuminate, margins entire; costa weak, percurrent to excurrent; median and upper cells (f) with thin walls, lax, rhomboidal, 45-80 x 13-20 μm, basal cells quadrate to rectangular, 34-60 x 13-18 μm. Spores about 16 per capsule, spherical, 130-150 μm diameter, wall pale buff, very finely punctulate.

Distribution: Endemic to Australia (Qld., N.T.). Uncommon, in intermittently moist habitats.

Subclass **BRYOPSIDA**
Clan **NEMATODONTEAE**
Order **POLYTRICHALES**

Plants usually large, growing on soil, the simple or slightly branched, erect, leafy stems arising from a creeping underground rhizome. Leaves usually narrow, often sheathing at the base and then abruptly contracted to a tapering blade; costa usually wide, bearing longitudinal, parallel, chlorophyllose, usually numerous, lamellae on the adaxial surface. Lamellae one cell thick and usually a few cells high, the uppermost row often differing structurally from the rest. Usually dioecious; the male and female heads terminal, surrounded by modified leaves, which differ from foliage leaves by enlargement of the sheath and (in the perigonial leaves) reduction in the blade. The flower-like antheridial inflorescences are indeterminate, ultimately pierced by a continuation of the stem, so marking successive seasons of growth. Capsule borne on a long seta, large, cylindrical, prismatic or bilateral. Calyptra narrow, cucullate, spinulose at the apex or hairy. Peristome (in Australian species) of 32 or 64 short, ligulate teeth joined at their apices by the epiphragm, or of a brush of filaments; teeth or filaments composed of whole cells.

The larger members of this order have a more highly developed anatomy than in any other mosses and show approaches to the structure of vascular plants (Tansley and Chick, 1901). These features are described in detail below under the respective species. Smith (1971) has reviewed all of the genera and their major subdivisions. It has been customary to divide the order into two families, the Polytrichaceae and the Dawsoniaceae, the latter with one genus *(Dawsonia)* in Australia, New Zealand, New Guinea, Moluccas, Celebes, Borneo and the Philippines. Smith includes *Dawsonia* in Polytrichaceae to emphasise the unity of the group, similar in anatomy of the gametophyte, rather than separated on the specialised peristome. In his recent monograph of the genus, van Zanten (1973) also places *Dawsonia* in the Polytrichaceae, citing especially the work of Lorch (1931) and Goebel (1906). The unique peristome brush of *Dawsonia* is the main or only character separating it from the rest of the Polytrichaceae. Goebel (1906) found that the peristome filaments of *Dawsonia* are joined at their bases by U-shaped cells, like those of the peristome teeth in Polytrichaceae. He also considered *Dawsonia* to be the more primitive because

the upper part of the columella is not formed into an epiphragm. It is also possible to regard, with Smith (1971) and van Zanten (1973), the *Dawsonia* peristome and its lack of epiphragm as derived. South Australia has but two species, which will be described rather fully, omitting family and generic descriptions.

Family **POLYTRICHACEAE** Schwaegr in Willd. 1830, *Sp. Pl.* ed. 4. **5** (2):1

Dioecious. Plants gregarious, growing on soil, green to greenish brown. Stems 2-10 cm. tall, usually simple, erect, arising from a prostrate underground rhizome. Rhizome, in section, rounded or triangular with rounded corners, bearing scale leaves along the ridges and densely clothed outside with matted rhizoids. Cortex of rhizome with a surface layer of small cells with thick walls enclosing several layers of parenchyma, interrupted opposite each angle by a group of longitudinally elongate, thickly walled cells, the hypodermal strands. Cortex bounded internally by an endodermis, with Casparian strips, enclosing a pericycle; endodermis and pericycle often incomplete. Rhizome with a central compact cylinder (stereom) with a triradial shape in section, corresponding to xylem, with thinner walled cells (leptom), corresponding to phloem, in the bays. The lobes lie opposite to the external faces of the rhizome and alternate with the hypodermal strands. The structure resembles that of a triarch root. The stereom is composed of elongated cells, the more numerous narrow and thickly walled (stereids) with fewer, larger, water conducting elements (hydroids) scattered among the stereids. The hydroids have delicate, much tapered, end walls; the leptoids of the leptom resemble the sieve tubes of phloem.

POLYTRICHUM Hedw. 1801, *Spec. Musc.* 88

Type species: *P. commune* Hedw. 1801

Polytrichum juniperinum Hedw. 1801, *Spec. Musc.* p.89, Plate 18, Figs. 6-10.
Type: Switzerland
P. longipilum C. Müll. 1897, *Hedwigia* **36**:343. Type: Fowler's Bay, S. Aust.

Fig. 9; Plate 1A, C

The aerial stems are differently organised internally, though there is a transition zone from the rhizome. The central core consists only of hydroids (the hydrom cylinder) surrounded by a layer of hydroids with thinner walls (hydrom mantle) and then a complex layer of leptoids, hydroids and starch parenchyma cells, the leptoids being disposed in discrete longitudinal strands. Outside is a wide cortex with several layers of thickly walled cells (sclereids forming sclerenchyma) at the outside and no distinct epidermis; numerous leaf traces traverse the cortex and connect the costa of the leaf to the central core of the stem. Lower part of stem clothed with appressed scale leaves, each consisting of a sheathing base and a rudimentary blade. These pass, with transitions, into the

crowded leaves, 5-8 mm long (a), erect and appressed when dry, more or less spreading to recurved when moist. Leaf lanceolate or linear lanceolate from an oval sheathing base. Costa very wide in blade and excurrent in a short or long, arista, dentate on the back and often lower down. Arista normally red and dentate, rarely hyaline near the tip, occasionally almost smooth. Costa narrower in leaf sheath; sheath abruptly contracted to blade. Cells of the sheath narrowly rhomboid, wider and usually yellowish towards costa, hyaline at the margin; cells at the shoulder narrower and thicker walled, forming the "swelling" or "hinge" tissue. The costa bears about 40 lamellae, each of 5-7 rows of cells, crenulate in side view (b) and with the terminal cell in transverse section (c) enlarged and narrowed to a rounded point with a very thick wall. Cells of the incurved margin of the relatively broad lamina very incrassate, with the lumen transversely elliptical or linear oblong and slightly curved.

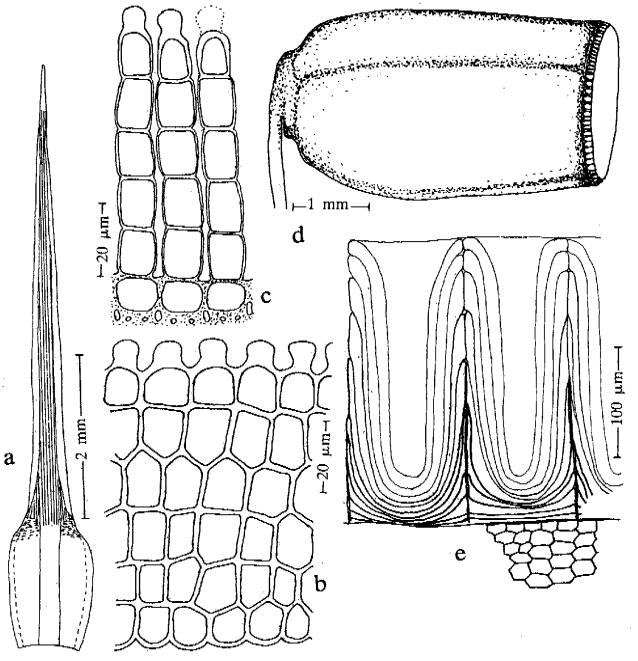


Fig. 9. *Polytrichum juniperinum*

The costa, in section, shows an arc of large cells, the deuters (actually leptoids), with which small central cells (actually hydroids) alternate on the abaxial side. The relative disposition of xylem and phloem elements is the

converse of that in vascular plants. Abaxially the central cells are each bounded by three large parenchyma cells, the socii, which are parenchyma cells with transverse end walls. Patches of stereids are present, a small one adaxially and a larger one abaxially. Larger cells constitute the epidermis, the free outer walls of the abaxial epidermis being thickened; the adaxial epidermal cells bear the lamellae. The leptoids and hydroids of the costa pass into the leaf trace in the cortex of the stem, the stereids merging with the sclerenchyma at the periphery of the stem. As the leaf trace passes inward, it loses lateral elements of the hydroids and leptoids. At the point where there are only about four hydroids, the trace is near the leptoid bundles and the leptoids of the trace link up with one or two of these bundles. As the hydroids pass further in they merge with the hydrom mantle.

Seta 2-5 cm long, stout, red shining; internally with an axial hydroid strand surrounded by a cylinder of cells with thick walls and a cortex with air spaces. Capsule (d) 2·5-3·5 mm long, tetragonally oblong or almost cubic with rather pronounced angles and a distinct apophysis, erect when young, becoming horizontal or cernuous at maturity. Exothecial cells mamillate, with a pit in the centre of each cell. Apophysis distinct, bearing stomata. Operculum with a short erect or slightly curved beak. Calyptra large, covering the capsule, densely felted with hairs, brown above and light yellow or dirty white below. Peristome teeth 64, narrow, joined at the top by an epiphragm so that the ripe capsule is a censer, like a poppy capsule, with a circlet of holes. Spores 8-10 μm diameter, smooth.

Central portion of the capsule traversed by a cylinder of sterile tissue, the columella, which is abruptly widened above the sporogenous tissue and its associated air spaces. The peristome teeth (e) are bundles of U-shaped, thickly walled cells. The peristome is formed from a cylinder of four concentric layers of 64 cells, each several cells high. The 64 cells undergo a basipetal curvature of their horizontal walls to form the U-shaped elements of the mature peristome. Each tooth is formed of the opposed halves of two adjacent sets of U-shaped cells. The inner surface of each tooth has a prominent wing-like crest, the cells of which often form projecting spurs. From the underside of the epiphragm, 64 sac shaped processes hang down, alternating with the peristome teeth. When the operculum is shed, these sacs block the spaces between the teeth until, quite soon, they dry out and collapse.

Male plants less robust than female, with shorter leaves; the leaves of the apical perigonium are very short and wide, cuspidate and coloured.

Distribution: Cosmopolitan in temperate north and south hemispheres, including Australia (S.A., Vic., Tas., N.S.W., Qld) and New Zealand. Common in South Australia (1, 2, 6, 7, 10).

There is some variation between different populations, especially between geographical areas. In New Zealand plants the leaves are usually reddish brown or purplish in colour (*P.rubiginosum* C. Müll.). Apart from the name *P.juniperinum* Willd., no fewer than nine other names (eight by Carl Müller) have been proposed for Australian material. Walther (1934) has studied the variability of this and related species globally. He found that in the gametophyte

there were no consistent differences between southern and northern specimens, although the southern hemisphere plants tended to have red colouration, often longer awns, broader leaves and narrow paraphyses. Distinct differences were found between sporophytes, in capsule size and angularity and in the shape of the peristome teeth, enough to separate three varieties, as follows:

var. *holarcticum* Walther 1934, l.c. p.149.
Capsule large, sharply angled, almost winged, peristome teeth wide, ratio of width to length about 0·4-0·5. Distribution holarctic.

var. *australe* Walther 1934, l.c. p.149.
Capsule large, sharply angled, almost winged, peristome teeth narrow, ratio of width to length about 0·3 to less than 0·4. In Australia, New Zealand, New Guinea and southern part of South America.

var. *alpinum* Schimp. ex Walther 1934, l.c. p.150.
Capsule small, obtusely angled, peristome teeth narrow. Alpine in Europe. Asia Minor and California.

The var. *holarcticum* Walther is a *nomen illeg. incl. type sp.* and is therefore a synonym of *P.juniperinum* Willd. The var. *australe* Walther is a *hom. illeg.* of **P. juniperinum** var. **australe** C. Müll. 1868 in Zett., *Oefv. K. Vet. Ak. Foerh.* **24**:573; this is the earliest name cited by Walther for his variety and may be used for the Australian plant.

Family **DAWSONIACEAE** Broth. 1905, Nat.Pfl. **1** (3):698

DAWSONIA R. Brown 1811, *Trans. Linn. Soc.* **10**:315

Dawsonia longiseta Hampe 1860, *Linnaea* **30**:634.

Type: N.S.W. near Parramatta, coll. W.Woolls.

D. appressa Hampe 1860, *Linnaea* **30**:635. Type: S. Aust. on the River Onkaparinga, coll. F. von. Mueller.

Fig. 10; Plate 1B

Stems simple, 1-3 cm tall, three angled, with dense white tomentum (rhizoids) at the base, bearing scale leaves below, densely leafy above. Leaves (a) spreading when moist, somewhat glaucous green, narrowly lingulate, often slightly curved and symmetrical, margin incurved when dry. Base wide 2 × 1·5 mm sheathing, almost scarious except for the brown costa, contracting abruptly to the blade, 6-7 mm long by 0·75-1 mm wide at its base. Margin of leaf dentate, the free lamina 3-5 cells wide, strongly inflexed, almost cucullate at apex; cells of lamina rectangular, very incrassate, teeth large.

Costa excurrent in a dentate arista, bearing numerous lamellae, up to about 80 in the widest part. Lamellae up to 65 μm high, of 4 to 7 rows of cells; margin evenly crenate in side view of lamella (b), through projecting cells. Marginal cells of lamellae (c) 20 × 15 μm, the outer walls thickened strongly to about 5 μm, usually elongated normally to the leaf; lower cells of lamellae quadrate to hexagonal, mainly 12 μm wide, walls moderately thick.

Perichaetial leaves with a much reduced lamina and usually no lamellae; apex obtuse and jaggedly toothed or finely acute. Seta orange red, to 3·5 cm tall. Calyptra cucullate 8 × 2 mm, densely covered with orange to crimson hairs. Capsule (d) ovate, 5 × 2 mm, inclined to horizontal, dorsiventral, with two moderately sharp angles and a concave upper surface. When empty, the capsule rolls in, with the two sharp angles often overlapping one another. Operculum with a cylindrical base tapering to a short beak. Peristome a brush about 1·5 mm long, of silky or dirty white, papillose filaments (e, f), slightly twisted apically. Peristome teeth in several concentric rows, united at the base. Peristome formed from about eight concentric layers of cells; the cells divide unequally, the smaller cells developing thickened walls and becoming the filaments. The larger cells in this zone disintegrate, allowing the filaments to separate. The base of the peristome, where the filaments are united, is composed of quadrate cells, whereas the cells of the filaments have very oblique end walls (e, f), the cells

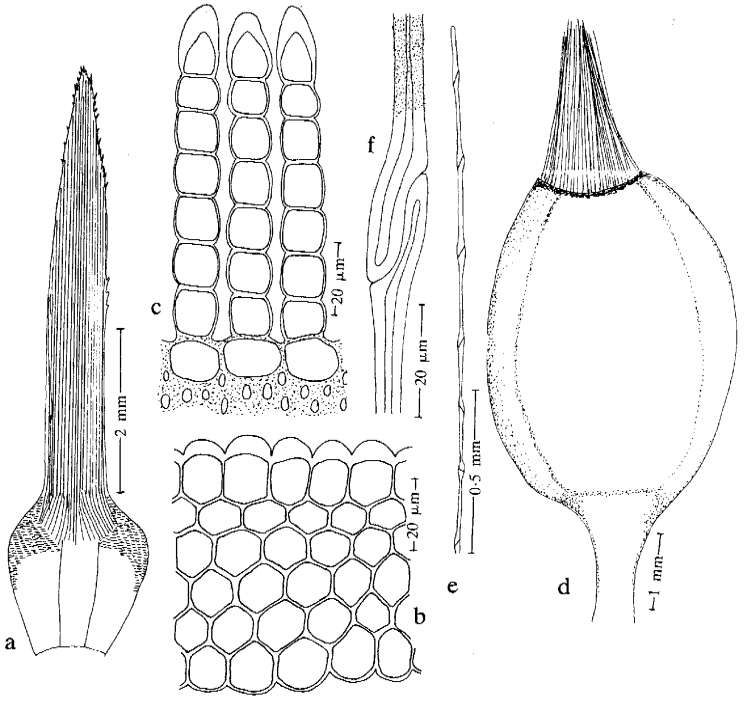


Fig. 10. *Dawsonia longiseta*

being increasingly long apically. The columella is not widened above the sporogenous zone and there is no epiphragm. Spores small, 5-8 mm diameter, smooth. Growing on soil in moist, shady situations on road or river banks, only in regions of high rainfall.

Distribution: Australia (S.A., Vic., Tas., N.S.W., Qld). Very rare in South Australia (6).

Hampe distinguished his *D.appressa* from *D.longiseta* on the basis of the longer stem, almost clavate from the appressed leaves when dry, the shorter leaves and seta and smaller capsule. Burges (1949) from examination of a wide range of specimens concluded it was merely a form of a rather variable *D.longiseta.*

Subclass **BRYOPSIDA**
Clan **ARTHRODONTEAE,**
Subclan **HAPLOLEPIDEAE**

Order **FISSIDENTALES**

Family **FISSIDENTACEAE** Schimp. 1855, Coroll. Bry. Eur. p.20

Plants mostly small (under 2 cm) with distichous, flattened, equitant, alternating leaves in one plane. Stem with or without a central strand. The basal portion of each leaf clasps the stem and also the leaf next above, unless the insertion of each is distant. The two clasping blades (vaginant laminae) constitute the true leaf and have above them a continuation (apical, upper or superior lamina) which extends to the apex on the adaxial side of the costa. The distinction between vaginant and apical laminae is often obscure. Sometimes the two vaginant laminae join in a suture running from costa to margin, so that the vaginant portion of the leaf is cymbiform (boat shaped). Sometimes they join at the costa or by a short suture extending part way from costa to margin. Then one vaginant lamina, obviously the front (or ventral) one in decumbent stems, appears smaller than the back (or dorsal) one. The abaxial side of the costa is winged from apex towards the base by another lamina (dorsal or inferior lamina). The dorsal lamina may extend to the base of the costa or only part way. The leaves usually have a well developed costa, but there is at first sight none in the subgenus *Polypodiopsis* of *Fissidens*, represented in Australia by *F.dealbatus* Hook.f. et Wils. Nevertheless, in transverse section the leaves of *F.dealbatus* show a series of unthickened cells along the junction of the vaginant and dorsal laminae. These are more numerous near the base of the leaf and cease just before the distal end of the vaginant laminae. They are the vestiges of a costa. Leaf cells small, usually irregularly hexagonal and nearly isodiametric. Sporophyte lateral or terminal with the seta several times longer than the perichaetial leaves except in the subgenus *Octodiceras*. Capsules oblong to ovoid, erect and symmetrical to cernuous and bent, smooth. Peristome single, dicranoid, of sixteen forked, highly coloured teeth; divisions subulate, straight, usually very densely and highly papillose, the papillae tending to a spiral arrangement; teeth strongly incurved when moist; operculum conical and

apiculate to longly rostrate; calyptra usually barely covering operculum, smooth and entire, sometimes split on one side, rarely mitriform.

The peculiar leaf structure is nearly unique among mosses. Only *Bryoxiphium* and *Sorapilla* (of which one species occurs in Queensland) have leaves of similar structure. The accepted interpretation is due to Robert Brown (1819) who proposed that the vaginant laminae represent the true leaf, with the addition of apical and dorsal wings as outgrowths. It is well supported by the anatomical and ontogenetic studies of Salmon (1899). The earlier formed leaves on the stem have the additional wings greatly reduced in size (figs. 15, 18) and sometimes even absent (figs. 15, 18); in some species the additional wings are poorly developed (fig. 16). Moreover, the perigonial leaves have the more ordinary form and are moderately concave, not even navicular.

Many other genera of mosses display outgrowths, usually from the costa, such as the adaxial lamellae in *Polytrichum* and *Pterygoneuron*, the abaxial ridges in *Campylopus* and the adaxial filaments in *Crossidium*.

The family has been divided into four or five, or even up to eight, genera, but it is now usual to treat all species in one genus, divided into subgenera and sections. The classification applicable to South Australian species is as follows:

FISSIDENS Hedw. 1801, *Spec.Musc.* p.152.

Type species *F.exilis* Hedw. or *F.bryoides* Hedw.

F.exilis is the first species described in the genus by Hedwig and is recognised as the type by Grout 1936, *Moss Fl. N.Am.* 1:8. Britton 1916, in N. L. Britton, *Fl. Bermuda* p.435, recognises *F.bryoides*, the second of Hedwig's species.

Subgenus EUFISSIDENS Mitt. 1889, *Musc. Austr. Amer.* p.581.

Stem with a central strand. Leaves with or without a border; costa more or less strong. Seta usually elongated and terminal; peristome divisions usually thickened spirally.

Section BRYOIDIUM C.Müll. 1900, *Gen. Musc. Fr.* p.56

Small plants, mostly bright green, mostly on soil; leaves soft, bordered throughout, border of one layer of cells; cells of lamina hexagonal, thinly walled, pellucid, smooth. *F.pungens, F.leptocladus.*

Section PACHYLOMIDIUM C.Müll. 1900, *Gen. Musc. Fr.* p.60.

Fairly robust, calcicolous plants growing in water; leaves bordered throughout, border thickened with two to several layers of cells; cells of lamina hexagonal, thinly walled, pellucid. *F.crassipes, F.rigidulus.*

Section HETEROCAULON C.Müll. 1900, *Gen. Musc. Fr.* p.55.

Small to very small, gregarious mosses growing on soil; stems of two kinds; the sterile with minute leaves of rhombic oval shape, with the dorsal lamina not or scarcely developed; the fertile smaller with larger leaves, with a dorsal lamina often not reaching base of costa and apex of leaf often hooked; border often present on vaginant laminae of leaves on fertile stems; lamina cells small, pellucid, hexagonal. *F.taylorii, F.splachnifolius.*

Section SEMILIMBIDIUM C. Müll. 1900, *Gen. Musc. Fr.* p.60.

Small, slender plants, growing on soil; leaves usually bordered only on vaginant lamina; cells of lamina small, densely papillose, opaque. *F.vittatus, F.hebetatus, F.subhumilis.*

Section ALOMA C. Müll. 1900, *Gen. Musc. Fr.* p.61.

Small mosses growing gregariously or as mats on soil; leaves soft, without any border, but margin crenulate; cells of lamina pellucid. *F.tenellus.*

Section CRENULARIA C. Müll. 1900, *Gen. Musc. Fr.* p.62.

Plants slender to minute, on soil; leaves without a border, but margin crenulate or denticulate; cells of lamina small, densely papillose. *F.humilis.*

Section AMBLYOTHALLIA C. Müll. 1900, *Gen. Musc. Fr.* p.63.

Small to medium sized plants; leaves rather firm, without a border, usually the margin entire; cells of lamina small, pellucid to obscure. *F.asplenioides, F.oblongifolius.*

Subgenus OCTODICERAS (Brid.) Mitt. 1869, *Musc. Austr. Amer.* p.581.

Robust to slender, flaccid, submerged water mosses; stem without a central strand; leaves elongated, linear, no border, apical lamina usually much longer than vaginant lamina. Capsule borne laterally on a very short seta, on a short seta, on a short branch, small, oval, symmetrical, without stomata. *F.fontanus.*

Key to species of *Fissidens*

1. Margin of leaf not bordered 2
   Margin of leaf bordered, at least on the vaginant laminae of mature leaves 11
2. Cells of leaf bearing one or more papillae or else mamillose 3
   Cells of leaf smooth or with minute papillae (sometimes difficult to see) or merely bulging 6
3. Cells each with several papillae 4
   Cells each with one papilla or else mamillose 5
4. Apex of leaf bluntly rotundate, costa ceasing well below the apex ..... *F.hebetatus*
   Apex of leaf acute, costa reaching the apex, the leaf with a large acute terminal cell ..... *F.humilis*
5. Small plants, to 2 mm tall; margin crenulate, usually strongly denticulate on the vaginant laminae; cells clear and pellucid, each with one large papilla ..... *F.tenellus*
   Robust plants, 1-1·5 cm tall; margin finely crenulate only; cells rather obscure, mamillose ..... *F.oblongifolius*
6. Soft aquatic plants, with very long linear leaves, to 5 mm; apical lamina much longer than vaginant laminae; cells very large, to 30 × 20 μm, thinly walled ..... *F.fontanus*
   Plants firmer, not aquatic; apical lamina not longer than vaginant laminae; cells small 7

7. Leaves large, to 2-3 mm long, oblong lingulate, rather obtuse or bluntly acute; costa ceasing below apex; dorsal lamina well developed 8
   Leaves small, usually less than 1 mm long; leaf either acute with the costa usually excurrent as a cusp or roundedly obtuse with the costa ceasing well below the apex 9
8. Vaginant laminae joining at the costa; cells smooth ..... *F.asplenioides*
   Vaginant laminae joining at or near the margin; cells mamillose *F.oblongifolius*
9. Apex rounded obtuse; costa ceasing well below apex of the leaf; dorsal lamina well developed, but ceasing abruptly well above base of costa; cells papillose ..... *F.hebetatus*
   Apex acute; costa ceasing below apex or reaching apex of the leaf or excurrent in a mucro; dorsal lamina very narrow to wide, tapering towards the base of the costa 10
10. Costa extending into an abruptly recurved apex ..... *F.splachnifolius*
    Costa often extending to a straight or incurved apex ..... *F.taylorii*
11. Border of elongated cells present only on the vaginant laminae 12
    Leaf bordered throughout, though often ceasing near the apex and sometimes narrow except on vaginant laminae 14
12. Border becoming intramarginal in lower half of vaginant lamina or near the base to form a vitta; cells of lamina small, papillose 13
    Border of vaginant lamina entirely marginal; cells smooth 9
13. Vaginant laminae joining at the costa; several rows of isodiametric cells outside vitta near base ..... *F.vittatus*
    Vaginant laminae joining near the margin; usually only one row of isodiametric cells outside vitta near the base ..... *F.subhumilis*
14. Aquatic or semiaquatic; border of two or more layers of cells 15
    On damp earth, not aquatic; border of only one layer of cells 16
15. Lamina cells large, thinly walled, 12-18 μm diameter; plants small, less than 1·5 cm tall ..... *F.crassipes*
    Lamina cells small, obscure, thickly walled, 6-9 μm diameter, plants large, usually more than 2 cm tall ..... *F.rigidulus*
16. Border becoming intramarginal in the lower half of the vaginant laminae *F.vittatus*
    Border entirely marginal in vaginant lamina 17
17. Plant small; leaves lanceolate with a broad border extending to the apex and usually merging with the excurrent costa; lamina cells large, 10 μm diameter, pellucid ..... *F.pungens*
    Plant medium sized; leaves oblong lanceolate, border relatively narrower, less distinct and usually disappearing below the apex of the leaf; lamina cells small, about 6 μm diameter, obscure ..... *F.leptocladus*

Fissidens pungens C.Müll. et Hampe 1855, *Linnaea* **26**:502.

Type: South Australia, Barossa Ranges, Planty (?Plenty) Creek, F. von Mueller.

Fig. 11.

Very small plants, growing in dense masses on damp earth. Stems short, procumbent or suberect, simple or rarely once branched, 2-4 mm long, crisped when dry. Sterile shoots with about 10 pairs of leaves, roughly equal in size. Fertile shoots with about 3 pairs of leaves, the upper ones being much longer than the lower ones. Leaves (a) 0·75 mm to nearly 2 mm long on fertile shoots, oblong-lanceolate or linear-lanceolate, acute, entire, distinctly and usually strongly bordered throughout. Costa robust, more or less bent on leaving the vaginant laminae, confluent with the border at the apex (b). Apex of vaginant laminae on the leafy margin (c). Cells thinly walled and pellucid, roughly hexagonal, about 10 μm wide, lax and more or less elongate in the vaginant lamina. Seta terminal, bent at junction with vaginula, usually about 5 mm long, but variable. Capsule up to 1 mm long, but generally less, ovate, erect or inclined, slightly asymmetrical. Operculum bluntly or acutely beaked, about two-thirds of the length of the theca. Teeth of peristome divided into two spirally thickened prongs. Spores 9-14 μm diameter. Probably dioecious.

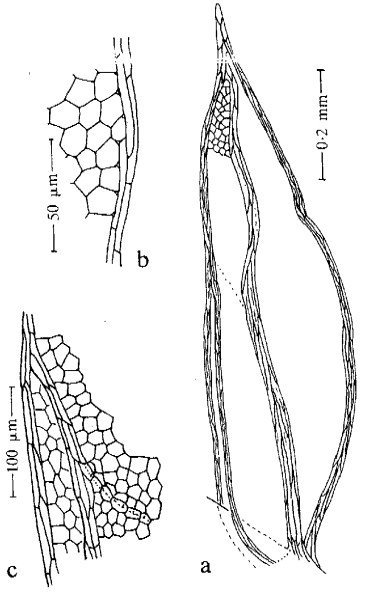


Fig. 11. *Fissidens pungens*

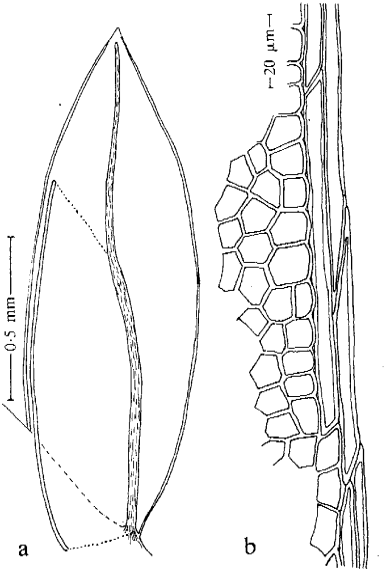


Fig. 12. *Fissidens leptocladus*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand. Fairly common (1, 6, 7, 10, 11)

The drawings (Plate XVII) in F. von Mueller (1864) hardly represent this species. The leaves are not characteristic in shape and totally lack the strong border. The drawings probably represent *F.basilaris* C. Müll. et Hampe, which was mixed with the type of *F.pungens*. *F.basilaris* is a synonym of *F.taylorii* C. Müll., even though *F.basilaris* was described as being dioecious.

Fissidens leptocladus C. Müll. ex Rodway 1913, *Pap. Proc. R.Soc. Tas.* for **1912**:136.

Type: Tasmania

Fig. 12

Usually rather densely gregarious, sometimes in tufts, on damp ground or rock, but also often sparingly mixed with other small species. Stems 0·5-2 cm tall, suberect with leaves often falcate and secund when dry, simple or occasionally singly branched; barren stems sometimes as much as 2 cm, with many pairs of leaves; fertile stems shorter, with about six pairs of leaves. Leaves (a) 1 to 1·5 mm long, oblong lanceolate, narrowed at the apex, acute, leaves of small plants may be narrowly lanceolate. Vaginant laminae half length of leaf or longer, with their apices being near the leaf margin. Leaf (a) with a hyaline border throughout, but border sometimes indistinct and thin in the upper and dorsal laminae, never as stout as in *F.pungens*. Costa continuous to near apex. Cells (b) all small, dark and obscure, isodiametric, 6 μm, cells of border elongated. Seta terminal, 4 mm long or less, sometimes bent at junction with vaginula. Capsule up to 0·9 mm long, oblong-ovate, suberect, symmetrical, with a distinct, somewhat enlarged neck. Operculum rostrate, beak erect or inclined. Spores 10-14 μm. Dioecious.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., N.T.), New Zealand. Fairly common (1, 5, 6, 10, 12, 15)

Fissidens crassipes Wils. ex B.S.G. 1849, *Bryol. Eur.* **1**:197.

Type: British

Fig. 13

In dark green dense tufts on rocks, roots or logs, usually aquatic. Tall, 1-5 cm high, rather rigid, often with tufts of red rhizoids in axils of the leaves. Leaves (a) oblong ligulate, shortly and obtusely acuminate at the apex. Border (b) thick, ceasing below the minutely serrulate apex (c), often irregularly nodulose or denticulate and frequently tinged with red, just intramarginal near base of vaginant laminae. Costa thick, sometimes reddish, ceasing in the apex. Dorsal lamina narrowed below and usually ceasing above the base. Vaginant laminae generally more than half length of leaf; apices at margin of leaf. Cells (b, c, d) large, 12-18 μm wide, rather lax and irregular, with thin walls, deep green with chloroplasts and opaque. Dioecious. Male inflorescence terminal, conspicuous. Sporophyte terminal, seta short, thick, reddish flexuose and often geniculate. Theca erect or inclined. Operculum acutely conical. Spores 20-25 μm diameter.

Distribution: Europe, Asia from the Middle East through India to China and Japan, North and Central Africa, North America, Australia (S.A., Vic., N.S.W., A.C.T., Qld, N.T.). Rare (6), in Rivers Onkaparinga and Finniss.

Fissidens rigidulus Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:61.

Type: New Zealand

Fig. 14

Robust, stiff, in dense dark green mats in aquatic or semiaquatic habitats, such as wet rocks in streams, the spray zone of waterfalls or ponds. Stems 2-6 cm long, suberect, branched or not, dark green; fronds narrow, densely leafy. Leaves (a) 2·5-4 × 0·6-0·7 mm, rigid, usually somewhat secund when moist and strongly so, and curled and twisted, when dry. Border stiff, yellow, of several layers of elongated, thickly walled cells, except at the apex and sometimes at the base of the dorsal lamina, where it disappears. Vaginant laminae three-fifths of the length of the leaf, pointed, joining at the margin. Dorsal lamina reaching the

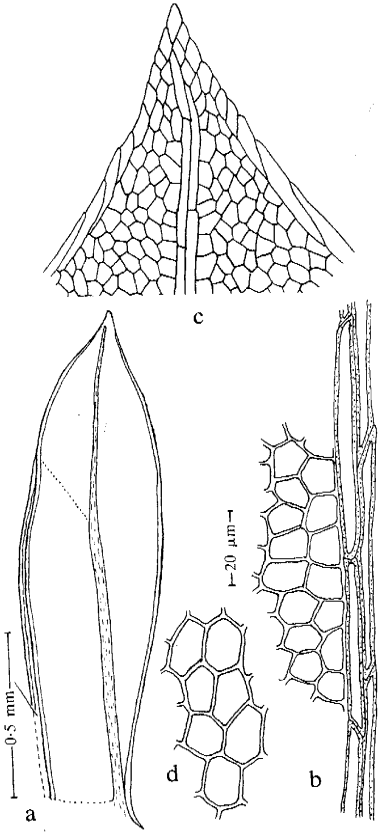


Fig. 13. *Fissidens crassipes*

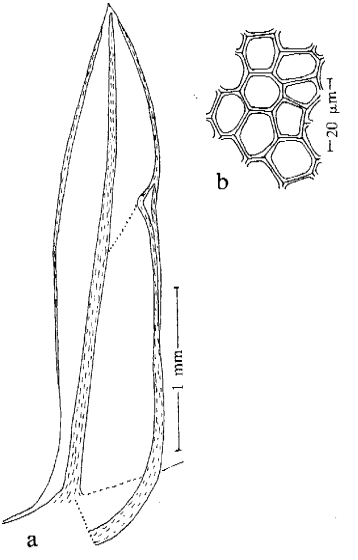


Fig. 14. *Fissidens rigidulus*

base of the costa and then shortly decurrent on the stem. Costa very strong, yellowish or reddish, disappearing at the apex of the leaf or percurrent. Lamina cells (b) very small, obscure, 6-9 μm diameter, irregularly quadrate to hexagonal. Seta terminal, slender, flexuous, 4-8 mm long. Capsule small, 1 mm or less long, erect or inclined, ovate oblong, usually rather asymmetrical. Spores about 20 μm diameter. Operculum with a beak about half as long as the capsule. Dioecious.

Distribution: New Zealand, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), South America. In South Australia (1) so far known only from Ewen's Pond, deeply submerged.

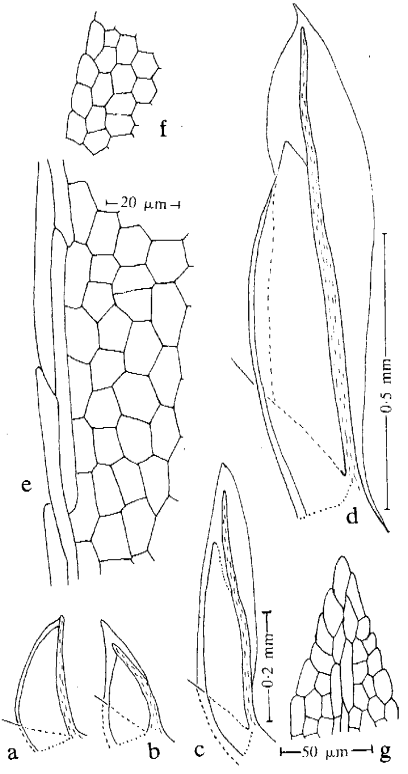


Fig. 15. *Fissidens taylorii*

Fissidens taylorii C.Müll, 1848, *Syn.* **1**:65, founded on *F.pygmaeus* Taylor.

F.pygmaeus Tayl. 1846, *London J. Bot.*, **5**:66, *hom. illeg.*

Type: Western Australia, Swan River, J. Drummond.

F.basilaris C.Müll. et Hampe 1855, *Linnaea* **26**:501.

Type: South Australia, Barossa Range, F. von Mueller.

Fig. 15

Growing gregariously in troops or scattered on damp earth. Plants minute, usually not more than 2 mm high; but sometimes to 7 mm tall. Stems erect, simple, the sterile and fertile ones mixed and arising from matted rhizoids. Sterile stems with 6-10 (to 15) pairs of tiny leaves, about equal in size, with the dorsal lamina very narrow (b) or sometimes lacking (a) and with the vaginant lamina relatively large and sometimes forming nearly the whole of the leaf, terminating near the costa (c) or on it in lower leaves (a). Fertile stems very short, with lower leaves very short and upper leaves (d) very much longer, reaching 1 mm. Dorsal lamina absent in lower leaves and narrow in upper ones. Costa usually reaching to the leaf apex, and occasionally excurrent as a cuspidate point through suppression of the dorsal and upper laminae. Border only on vaginant laminae, but sometimes very weak; upper part of border vaguely and bluntly toothed (e). Cells (e, f) thinly walled and pellucid, 8-12 × 9-16 mm, margin faintly denticulate near apex (g). Seta 2-4 mm long, terminal. Capsule about 0·75 mm long, erect or nearly so, symmetrical or nearly so, oblong, with a distinct neck. Operculum with a short inclined beak. Teeth of peristome entire or interruptedly split on the median line or divided from the apex into two spirally thickened forks. Spores large, 16-22 μm diameter. Rhizautoecious.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., N.T.), New Zealand. Common (1, 3, 6, 7, 11, 12, 14, 15, 17); very variable and probably a complex of several species; one form has very wide and short leaves with no border.

Fissidens splachnifolius Hornsch. 1841, *Linnaea* **15**:145.

Type: South Africa, Table Mountain.

F.bifrons Schimp. ex C.Müll. 1859, *Bot. Zeit.* **17**:198.

Fig. 16

Growing on damp soil in dense patches or as scattered stems. Plants small to minute, usually 2-4 mm tall, but sometimes to nearly 1 cm. Leaves (a, b) widely spaced on the sterile stems, short and wide, cultriform, with the apex abruptly recurved. Vaginant laminae composing most of the leaf, joining at or very near the costa and with only a very small apical lamina. Dorsal lamina narrow, 2 to 6 cells wide, tapering to one cell very near to the base of the leaf; no border. Costa strong, bent abruptly at the terminus of the vaginant laminae and excurrent as a mucro. Cells (c) small, 6-8 μm diameter, irregularly quadrate to polygonal, margin crenate. Fertile stems shorter with larger leaves, often partly bordered on the vaginant laminae of the perichaetial leaves, the border sometimes intramarginal. Capsule slightly curved.

Distribution: South Africa, Australia (W.A., S.A., Vic.). Rare in S.A. (6) or overlooked.

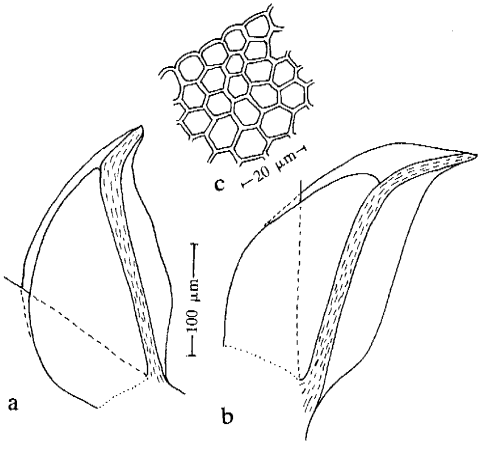


Fig. 16. *Fissidens splachnifolius*

Fissidens vittatus Hook.f. et Wils. 1859, *Fl. Tasm.* **2**:167.

Type: Tasmania.

Fig. 17

Growing in tufts or mats on earth or rock, often on calcareous rock, often near streams. Stems erect, simple, slender, 8 mm high or less, incurved at apex, sometimes almost circinately. Innovations arise from axils of leaves in middle to upper part of stem. Leaves 1 mm or more long, in 10 to 15 pairs, somewhat undulate, usually secund, often incurved even when moist, widely oblong-lingulate, with a rather broad point, apiculate through the slightly excurrent costa. Vaginant lamina at least half length of leaf, terminating at the costa. Dorsal lamina gradually narrowed towards base of leaf. Border of narrow cells (b) becoming conspicuous, but intramarginal, towards the base of the vaginant laminae, the wide band of narrow cells in this region appearing as a vitta. Elsewhere the border of narrow cells less conspicuous, narrower (b) and often failing. Cells above (d) about 6 µm diameter, rounded, dense and obscure, those at the base (e) larger and clearer. Basal parts of vaginant laminae with margins finely crenate (f) or coarsely crenate dentate (g) in different specimens. Seta terminal, about 5 mm long. Capsule held horizontally, about 1 mm long, shortly oblong and asymmetrical. Peristome teeth deeply divided, with segments

spirally thickened. Spores green, 20-22 μm. Operculum with a straight beak, about half length of theca.

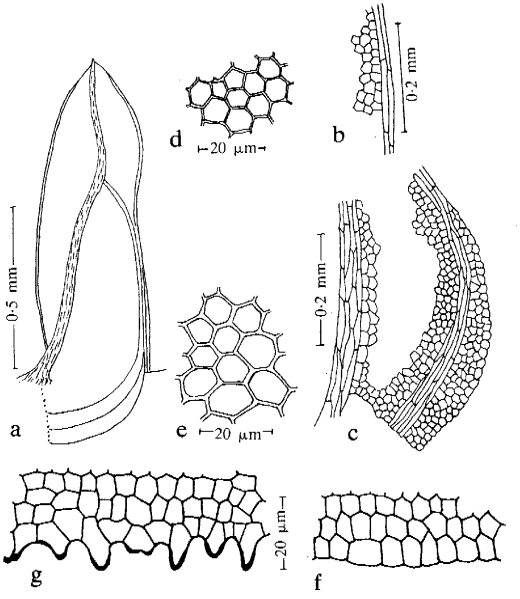


Fig. 17. *Fissidens vittatus*

Distribution: Australia (W.A., S.A., Tas., Vic., N.S.W., A.C.T.) New Zealand. Common in S.A. (6-8, 12, 14, 15, 17, 18, 20). The variation shown by the margin of the vaginant laminae is striking in its extremes, but not obviously correlated with any other differences.

Fissidens hebetatus Catcheside sp. nov.

Plantae gregariae, humillimae, virides. Caulis ad 4 mm longus. Folia ad 1 mm longa, 0·3 mm lata, oblongo-lanceolata, apice obtuso-rotundata, costa bene infra summum folii soluta. Lamina vaginans circa ¾ folii attingens, in folia perichaetialia limbatis tenuibus. Laminae dorsalis et apicalis marginibus crenulatis. Cellulae parvae, 8-10 μm, irregulariter hexagonae, papillosae. Fructus terminalis; seta ad 2 mm longa; capsula erecta.

Type: Australia, Northern Territory, Nourlangie Camp, Alligator River, on termite mound in shade; coll. M. Lazarides and L. Adams no. 303, 23.iii.1965, CANB 162836.

Fig. 18

Small, pale green plants in loose mats on soils, wet sandstone or termite mounds. Stems 2-4 mm tall, simple, erect or decumbent, often reddish. Leaves

much reduced (a,b) at base of stem, larger upwards, reaching to 1 x 0·3 mm, sometimes in 3 to 5, but up to 18 pairs, the upper leaves (c, d) oblong lanceolate, blunt or obtuse with a rounded apex, erecto-patent, straight. Vaginant laminae of perichaetial (e,f) leaves with a border, variable in development and extent but never reaching the distal end. Border of shortly oblong cells (i, j) in 1-2 rows. Vaginant laminae extending two-thirds to three-quarters up the leaf, the

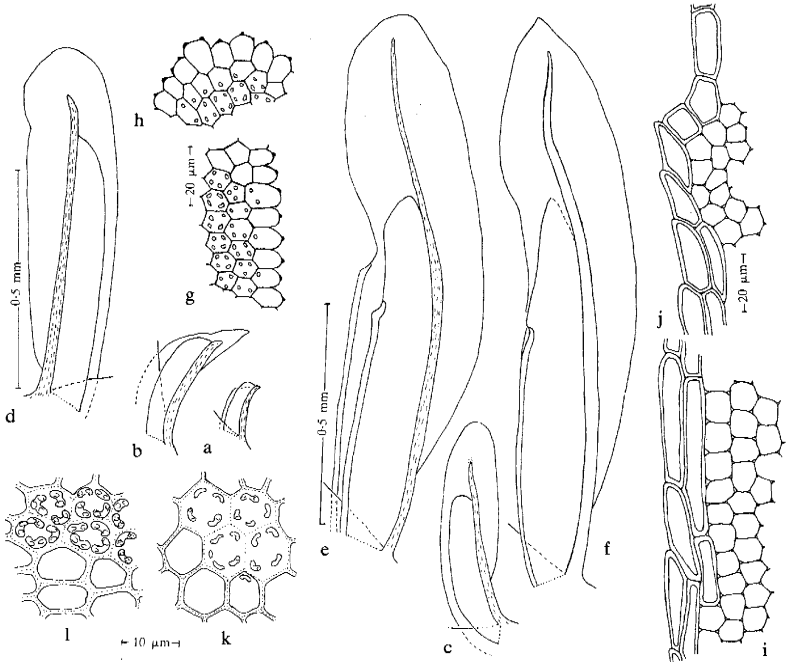


Fig. 18. *Fissidens hebetatus*

blades joining near the costa often opposite to a shallow to deep notch in the margin; when distinctly bordered, the border ends at near a small shoulder (e, j). Dorsal lamina fairly wide, ceasing abruptly well short of the stem in lower leaves (c, d) but tapering to the base in upper leaves (e, f). Costa stout below, often reddish, tapering and ceasing well below the apex. Leaf border (i) when present obscurely denticulate, of oblong cells with thick walls; margins of dorsal (g) and apical (h) laminae crenulate from projecting marginal cells, bearing

small marginal papillae. Cells small, surface bulging somewhat, with 3-4 usually small low papillae per cell, or the papillae larger, cells hexagonal or irregularly polygonal, 8-10 μm diameter. Perichaetium terminal, seta to 2 mm tall, straight. Capsule oblong, 0·5 x 0·3 mm, rounded at the base. Exothecial cells more or less quadrate to hexagonal, the longitudinal walls thickened, the angles slightly more so. Spores 16-18 μm, pale brown, finely echinulate.

Distribution: Northern Territory (King's Canyon, Tallaputta Springs, Jasper Gorge, Simpson's Gap, Oenpelli, Nourlangie, Sleisbeck Uranium Field, Reedy Creek), Western Australia (Adcock Gorge). Likely to occur in the desert mountains of S.A. Populations differ in size of the papillae, but not otherwise. *F.hebetatus* is similar to *F.brassii* Bartr. from Papua New Guinea, but in that species the blades of the vaginant laminae join at the margin and the dorsal lamina terminates abruptly halfway down the costa.

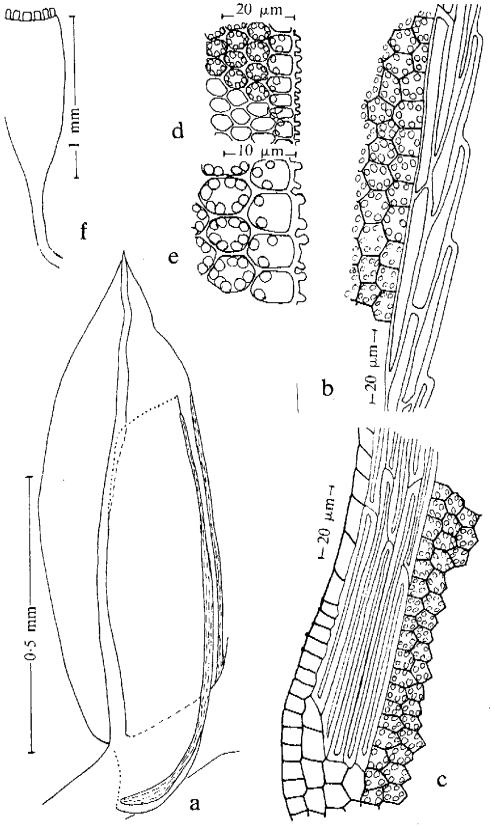


Fig. 19. *Fissidens subhumilis*

Fissidens subhumilis Catcheside sp. nov.

Species *F.humili* Dixon et Watts similis, sed lamina vaginans limbata, e cellulis angustissimis hyalinis constructa, ad basin intramarginalis.

Type: Australia, Northern Territory, George Creek, 10 miles south of Adelaide River, frequent on damp earth on bank, in permanent shade; coll. M. Lazarides and L. Adams no. 256, 17.iii.1965, CANB 162816.

Fig. 19

Plants small, to 2 mm tall, with several pairs of leaves. Leaves (a) when mature oblong lanceolate, acuminate, apex acute, costa just excurrent. Vaginant laminae reaching nearly three-quarters of the way up the leaf, the blades joining near the margin, bordered. Border extending nearly the whole length of the vaginant laminae, composed of 2-4(-5) rows of very long hyaline cells with thick walls (b), distinctly denticulate; border becoming intramarginal near the base (c), with one row of nearly quadrate chlorophyllose cells, about 10-15 in number, outside the vitta of narrow cells; sometimes there is a second short row of 1-4 quadrate cells also outside the vitta. Lamina cells (d, e) 5-6 μm diameter in upper part of the leaf, walls rather thick, densely papillose. Seta terminal, 3 mm long; capsule (f) oblong, about 1 mm long, tapered at the base; exothecial cells polygonal, walls thin with moderate trigones; spores 12-16 μm diameter, very finely papillose.

Distribution: Northern Territory, known only from the type, but the species may be widely spread and overlooked.

Fissidens tenellus Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:61.

Type: New Zealand

Fig. 20

Very small plants, growing gregariously on damp earth, generally in shade, often near streams. Stems about 2 mm high, suberect or decumbent, simple. Leaves (a, b) 0·5-1·5 mm long, in 3 to 7 pairs, oblong lanceolate or linear lanceolate, more or less sharply acute and sometimes tapering to a fine point. Length of vaginant laminae variable, usually not much more than half length of leaf, terminating near margin (a) or about halfway into costa (b). Costa reaching near to apex (e). Leaves unbordered, margin (c, d) crenulate, or denticulate throughout. Coarsely crenate-denticulate (f) on the vaginant lamina. Cells (g, h) about 8 μm diameter, four to six angled, clear and pellucid, each with a single large papilla; cells at the base longer, oblong. Seta 1-6 mm long, terminal, sometimes geniculate below. Capsule 0·6-0·8 mm long, erect, symmetrical, narrowly oblong. Spores 9-12 μm. Operculum with a fine beak equal in length to the theca.

Distribution: New Zealand, Australia (S.A., Vic., Tas., N.S.W., Qld). Rather uncommon (6), usually mixed with other small species of *Fissidens*.

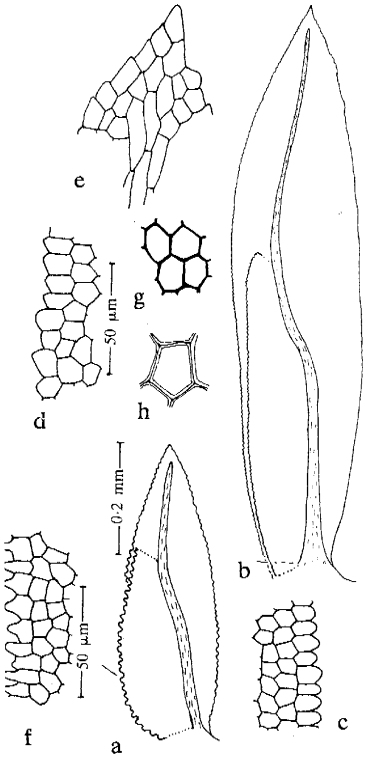


Fig. 20. *Fissidens tenellus*

Fissidens humilis Dixon et Watts 1916, *Proc. Linn. Soc. N.S.W.* **41**:384.
Type: Australia, New South Wales, on silt near the Harbour, Newcastle, leg. Chas L. Burgess (ex herb. W. H. Burrell)

Fig. 21

Small, pale to dark green, dull plants growing in dense tufts on soil. Stems 3-5 mm tall, generally simple, erect or decumbent. Leaves small below, gradually larger above (a), reaching 1·5 x 0·25 mm, in up to 18 pairs, oblong linear-lanceolate, acute, erecto-patent and subfalcate when moist. Vaginant laminae longer than apical lamina, occupying nearly the whole leaf in the small, lower ones; in mature leaves, the vaginant laminae join about midway between the costa and the margin. Dorsal lamina narrow below, tapering to the base of the costa. Costa slender to strong and red, ceasing below the apex or just reaching it. Leaves not bordered, entire except for the projecting papillae (c) or

indistinctly crenulate near the apex (b), usually ending in one large triangular hyaline cell, which is sometimes the terminus of the costa. Cells of vaginant laminae (d) about 5-7 μm diameter, roundish quadrate, subpellucid, smaller in apical and dorsal laminae, each bearing 4 to 7 papillae. Autoecious, the perigonium on the end of a short branch, bearing 3 to 4 pairs of short broad leaves, mostly of vaginant laminae. Perichaetium terminal, seta to 3-4 mm or more, sharply bent at base, yellowish. Capsule suberect, symmetrical, ovate oblong, brownish. Spores about 15 μm diameter, smooth. Operculum rostrate, slightly curved, two-thirds or more of the length of the capsule. Peristome teeth purple, densely papillose, indistinctly trabeculate. Calyptra long, mitriform.

Distribution: Australia (Vic., N.S.W., Qld, N.T.), New Zealand. Rare, but probably overlooked; at several localities in Macdonnell Ranges.

The original description placed the species in the section *Amblyothallia* and did not mention the prominent papillae on the leaf cells. The species is apparently widely spread but uncommon and displays some variation. Compared with the Northern Territory plants (fig. 21), those of Eastern Australia and New Zealand have relatively longer and narrower linear lanceolate leaves, gradually and finely acuminate.

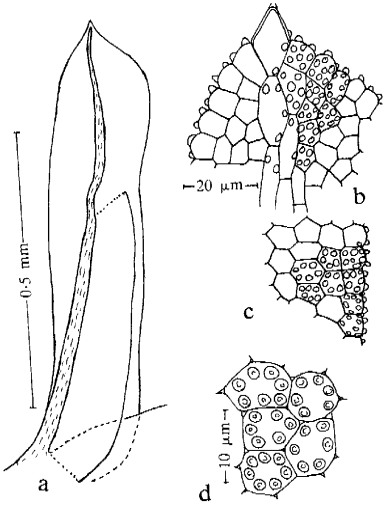


Fig. 21. *Fissidens humilis*

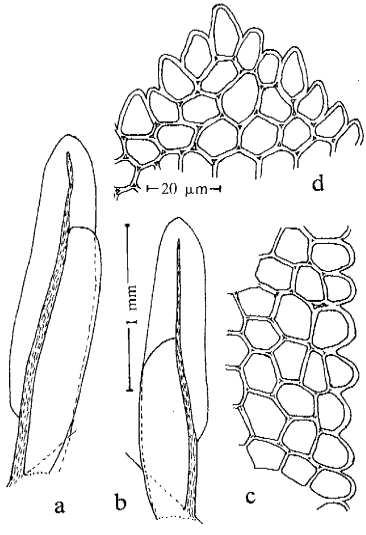


Fig. 22. *Fissidens asplenioides*

Fissidens asplenioides Hedw. 1801, *Spec. Musc.* p.156

Type: Jamaica, coll. Swartz.

Fig. 22

Growing in dense mats, on banks or on rocks; yellow green to green in colour. Stems up to 3 cm, nearly erect, simple or sparingly branched. Leaves (a, b) 2-3 mm long, crowded, in many pairs, oblong lingulate; when dry, leaves incurved falcate with the tips circinately inrolled. Blades of vaginant laminae meeting at the costa. Costa fairly strong, ceasing well below the apex, usually bent and sinuose above the vaginant lamina. Leaves without a border, margin (c) crenate by projection of cells, crenate dentate near the apex (d). Cells (d) 8-10 μm diameter, rounded. Seta terminal, short, usually not more than 5 mm, flexuose. Capsule 1-1·5 mm long, inclined, oblong. Operculum conical rostrate, as long as the theca and with an inclined beak. Teeth of peristome split, the prongs vertically striolate below, papillose above. Spores 14-16 μm. Dioecious.

Distribution: Northern Hemisphere. Tropical and subtropical regions of the Southern Hemisphere; Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand. Fairly common (6) in moist habitats.

Fissidens oblongifolius Hook.f. et Wils. 1844, *London J. Bot.* **3**:547.

Type: New Zealand.

Fig. 23

Growing in dense mats on clay in moist habitats. Stems 1-1·5 cm long, decumbent, simple or branched sparingly. Leaves (a) 2-3·5 mm long, crowded, narrow with parallel sides, hardly altered when dry. Apex obtuse or acute, costa ceasing below or in apex, often sinuous in the upper part. Margin not bordered, more or less crenulate or denticulate by projecting cells (b). Cells rather small, about 8 μm wide, rounded, rather obscure, mamillose, densely chlorophyllose. Vaginant laminae uniting at margin of leaf. Autoecious, with the perigonium axillary on the fruiting stem. Sporophyte terminal, seta about 6 mm long, slender, twisted and flexuous in the upper part. Capsule 1 mm long or more, gibbous at the back and with a wide mouth. Segments of peristome teeth papillate, striolate vertically and slightly nodose. Operculum with a fine inclined beak as long as the capsule.

Distribution: Australia (S.A., Vic., Tas., N.S.W., Qld), New Zealand. Rare (6) in moist and shady situations.

Fissidens fontanus (Pyl.) Steud. 1824, *Nomencl. Bot.* **2**:166.

Type: Europe.

F.muelleri (Hampe) Mitt. 1883, *Trans. Proc. R. Soc. Vict.* **19**:91.

Type: R. Murray.

Fig. 24

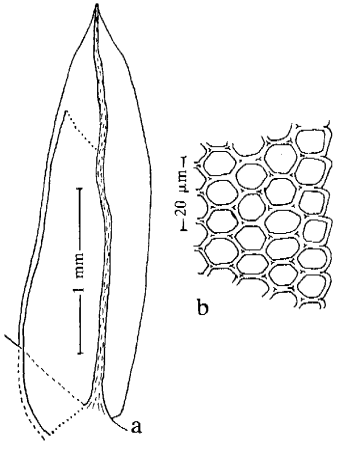


Fig. 23. *Fissidens oblongifolius*

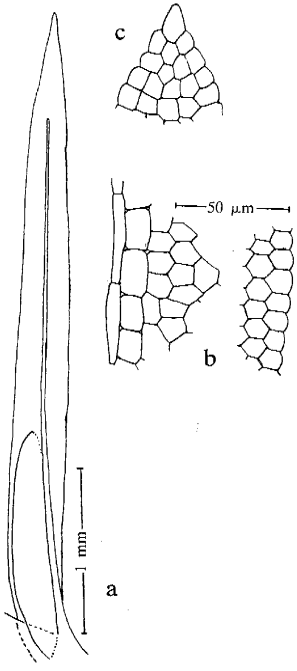


Fig. 24. *Fissidens fontanus*

Aquatic, on stones or tree roots in rivers and swamps. Stems long, 5-10 cm, freely branched, soft, delicate and straggling. Leaves (a) distantly spaced, narrowly oblong-lanceolate, to 5 mm long, entire or minutely crenulate (b). Apex of the leaf (c) acute. Vaginant laminae about a quarter to a third of the length of the leaf, terminating in diverse places, but usually near to the costa. Dorsal lamina not reaching the base of the costa. Costa narrow and weak, except at the base, ceasing well below the apex of the leaf. Cells large, increasing in size from margin towards costa, reaching to 30 × 20 µm, rather thinly walled. Seta lateral, very short, bent. Capsule erect, minute.

Distribution: Australia (S.A., Vic., Tas., N.S.W., Qld), New Zealand, Europe, North and South America. Rare or overlooked, in R. Murray and swamps of South East (1, 4 or 5)

Plants from various parts of the world, given different names, appear not to differ appreciably from one another.

Order **GRIMMIALES**

Family **GRIMMIACEAE** Arnott 1825, *Disp. Méth. Mousses* p.19

GRIMMIA Hedw. 1801, *Spec. Musc.* p.75

Lectotype: *G.plagiopodia* Hedw. cf. B.S.G. 1845, *Bryol. Eur.* 3:99, etc.

Hedwig included species now placed in *Seligeria* and *Coscinodon* as well as *Schistidium,* treated here as a subgenus of *Grimmia.*

Plants in tufts or cushions or mats on rocks. Autoecious or dioecious, acrocarpous. Stems usually short and dichotomously branched. Leaves lanceolate, acuminate, usually with a hair point, sometimes obtuse with or without a hair point; leaves often with two layers of cells above, especially at the entire margin. Basal cells of leaf quadrate to linear, walls thickened, sometimes to give a sinuose appearance to some cells; upper cells quadrate to rounded, papillose or smooth. Seta straight or curved, the capsule immersed or well exserted; calyptra smooth, cucullate or mitriform; peristome teeth 16, entire or variously perforated or split at apex.

Subgenus SCHISTIDIUM

Capsule immersed, borne on a short erect seta, mouth wide; columella attached to operculum and falling with it. *G.apocarpa.*

Subgenus EU-GRIMMIA

Capsule exserted, borne on an arcuate or straight seta; columella free from operculum and persistent. *G.pulvinata, G.orbicularis, G.trichophylla, G.laevigata.*

Key to species:

1. Leaf with a long hyaline awn; capsule emergent on a short or long seta. . . . 2
   Leaf with a short hyaline tip or none; capsule nearly sessile immersed in the terminal leaves . . . . . *G.apocarpa,* p.86
2. Seta straight, short; margin of leaf plane; leaf slightly convex abaxially, costa not protruding very much. . . . . *G.laevigata,* p.89
   Seta arcuate, fairly long; one or both margins of leaf recurved below; leaf strongly folded longitudinally about the prominent costa which projects abaxially 3
3. Leaves ovate lanceolate to lanceolate, abruptly narrowed to hair point, appressed but hardly twisted when dry; plants greenish grey, very hoary; inner basal cells of leaf all relatively short, 2-4 times as long as wide, the longitudinal walls nearly uniformly thickened; fruit common
   G.pulvinata, p.87
   G.orbicularis, p.88
   Leaves lanceolate to narrowly lanceolate, tapering gradually to the acute apex, somewhat twisted around the stem when dry; plants yellowish brown, less hoary; most inner basal cells long and relatively narrow, 4-8 times as long as wide, the longitudinal walls unevenly thickened, appearing somewhat sinuose; fruit rare . . . . . *G.trichophylla,* p.88

Grimmia apocarpa Hedw. 1801, *Spec. Musc.* p.76.

Type: Germany, on rocks at Schiffenberg near Giessen, coll. Dillenius.

Schistidium apocarpum (Hedw.) B.S.G. 1845, *Bryol. Eur.* **3**:7.

Fig. 25

In loose tufts on rocks, frequently semiaquatic or even submerged intermittently. Stems erect and rigid, short or tall, brown or olive-green above and much darker below, 1-4 cm long, usually with erect branches through innovation; sometimes simple. Leaves (a) appressed or slightly spreading, 1·5-2·5 mm long, ovate-lanceolate, shortly acute; margin recurved, mostly bistratose above. Costa reaching the apex or failing below it; hair point short or none; basal cells shortly oblong; middle cells (b) of lamina slightly sinuose; upper cells (c) rounded or subquadrate, incrassate, somewhat irregularly thickened. Perichaetial leaves (d) much larger; capsule (d) immersed, symmetrical on a very short, straight seta, oval oblong, mouth wide when dry; peristome teeth inserted below the rim, erect when dry, deep red, entire or sometimes rimose; operculum (d) bright red, rostellate; spores 10-16 μm. Autoecious.

Distribution: Practically cosmopolitan. Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Fairly common on rocks in moist habitats (6, 7).

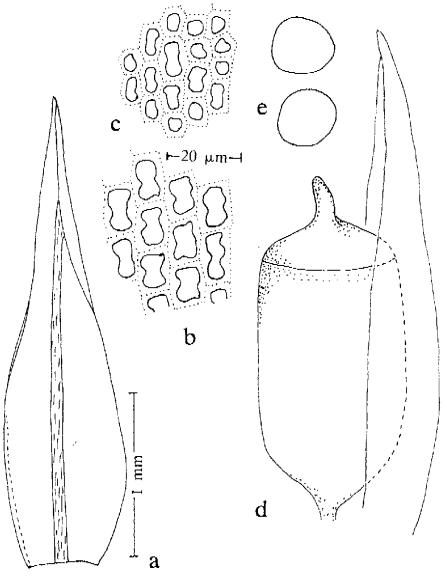


Fig. 25. *Grimmia apocarpa*

Grimmia pulvinata (Hedw.) Sm. 1867, *Engl. Bot.* **24**:plate 1728.

Basionym: *Fissidens pulvinata* Hedw. 1801, *Spec. Musc.* p.158

Type: Europe.

Grimmia callosa C.Müll. et Hampe 1853, *Linnaea* **26**:498.

Type: South Australia, Barossa Range, coll. F. von Mueller.

Fig. 26 a-g; Plate 2A

In dense hairy cushions on rocks, especially basic ones, as well as walls, mortar, etc. Stems to 2 cm high, but usually short, simple or with several branches above. Leaves erect, appressed when dry, erecto patent when moist; leaves (a) broadly oblong lanceolate with a wide apex, but sometimes narrower and more acute, 1·5-2 mm long, concave but not carinate, margins recurved below, usually bistratose above (b); hyaline point long, slender, slightly denticulate; cells subquadrate, rounded above (c), with sinuose incrassate walls throughout the lamina, except at the base (d, e) where they are shortly oblong and relatively thinner walled, the inner cells (e) incrassate and somewhat

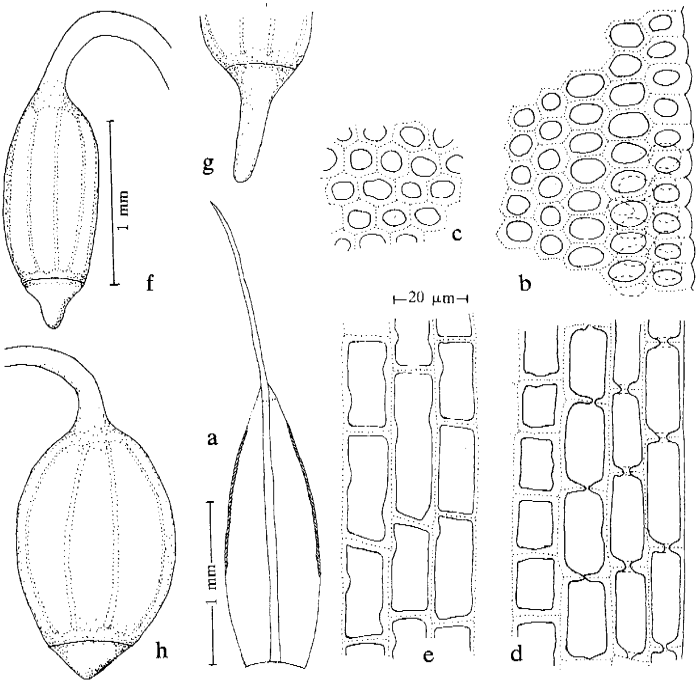


Fig. 26. *Grimmia pulvinata* (a-g) and *Grimmia orbicularis* (h)

sinuose; cells near basal margin (d) with porose transverse walls. Seta short, cygneous when moist, erect and flexuose when dry; capsule oblong to ovate, wide mouthed, and striate; peristome teeth split and perforated above; operculum beaked (f, g). Autoecious.

Distribution: Virtually cosmopolitan; Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Common (6-8, 11, 12, 14, 15, 17) on rocks and walls; usually with fruit.

South Australian specimens have a rostellate operculum (f), rather than the rostrate one (g) seen in most European specimens. Ours are var. **africana** (Hedw.) Hook. f. et Wils. 1854, *Fl. Nov.Zel.* **2** : 75, the type being from the Cape of Good Hope.

Grimmia orbicularis Bruch *ex* Wils. 1844, *Engl. Bot.* Suppl. **4**:n.2888.

Type: Europe.

Fig. 26h

Close to *G.pulvinata* with leaves of similar shape, but not or hardly bistratose above, basal cells rather longer and mid-leaf cells larger, 10-12 μm wide. Capsule subglobose, ovoid or very broadly ellipsoid; operculum mamillate (not rostrate) and obtuse; seta cygneous when dry.

Distribution; Europe, Siberia, S.W. Asia, North and South America, Australia (S.A.). Hoary cushions on basic rocks. Recently recognised in the Flinders Ranges (15).

Grimmia trichophylla Greville 1824, *Fl. Edinensis,* p.235.

Type: Scotland, Edinburgh, on stone walls at foot of Arthur's Seat, coll. Greville.

Grimmia crispatula C.Müll. et Hampe 1853, *Linnaea* **26**:499.

Type: South Australia, Fifth Creek, Mt. Lofty Ranges, coll. F. von Mueller.

Fig. 27

Dioecious. Robust plants on rocks in deep, dense tufts, yellowish at the tips and hoary with the long hyaline leaf apices, brown or blackish below. Stems to 3-4 cm high, radiculose below, but easily separating; leaves (a) narrowly lanceolate, carinate, about 2·5 mm long by 0·4 mm wide, gradually tapering and ending in a long, smooth or denticulate to spinulose, hyaline hair point about half as long as the leaf, erect, twisted when dry, erect to spreading when moist, the lower leaves smaller with shorter hair points; costa distinct, very prominent dorsally; basal leaf cells long and narrow towards the costa (c), 8 to 10 times as long as broad, with incrassate, slightly sinuose walls, rapidly shorter and broader towards margins (b), 3-4 rows at margins pellucid, rectangular or linear with straight walls, all rapidly shortening upwards (d, e) and becoming sinuosely rectangular; upper cells (e) 5-7 μm wide by 10-18 μm long, very sinuose with thick pellucid walls, in one layer except 2 or 3 marginal rows (d) which are

bistratose. Seta cygneous both moist and dry, yellow, 3-4 mm long; capsule plicate, yellowish when young, becoming light brown with age, oval oblong, 1·3 mm long by 0·6 mm wide; peristome teeth pale red, papillose, irregularly 2-3 cleft; annulus broad; operculum red, 0·4 mm long, conic rostrate, slightly oblique; calyptra mitriform; spores smooth, pale yellow, 8-10 μm diameter.

Distribution: Europe, N.America, Asia Minor, N.Africa, New Zealand, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld). Rather rare (6, 12).

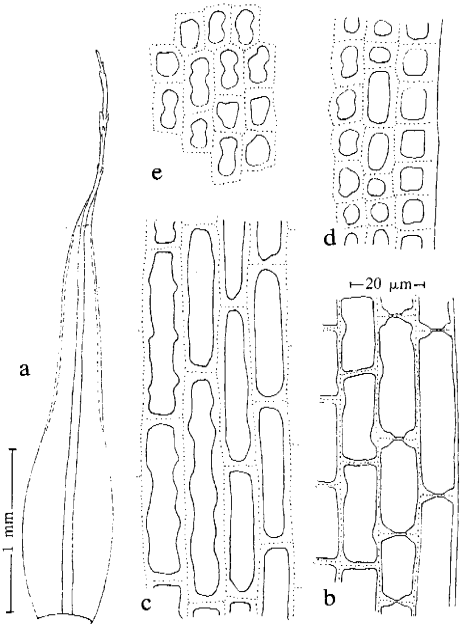


Fig. 27. *Grimmia trichophylla*

Grimmia laevigata (Brid.) Brid. 1826, *Bryol. Univ.* **1**:183.

Basionym: *Campylopus laevigatus* Brid. 1819, *Mant. Musc.* p.76.

Type: Germany.

Grimmia leucophaea Grev. 1822, *Mem. Wernerian Nat. Hist. Soc.* **4**:87.

Type: Europe.

Fig. 28; Plate 2B

Dark green plants with silvery leaf tips, in wide, loose tufts on siliceous rocks. Stems 0·5 to 1 cm high, simple or branched; leaves closely appressed when dry,

increasing in size upwards. Leaves (a) to 2 mm long, broadly ovate lanceolate or oblong oval, wide at apex, concave, bistratose (e) except at the base; margins plane (b, d) and unthickened; costa wide below, narrowing above, thin, not projecting at the back of the leaf; hair point wide at base, rough and long; cells incrassate, not sinuose, rounded and obscure above (d, e) through being in two layers, oblong or quadrate below (b, c), the marginal thickened at the corners. Seta 2 mm long, straight or slightly curved when dry; capsule about 1 mm long, erect, symmetrical, oblong, smooth; peristome teeth split at the apex; operculum with an erect beak about half the length of the capsule; calyptra mitriform, lobed at base; spores about 14 μm. Dioecious.

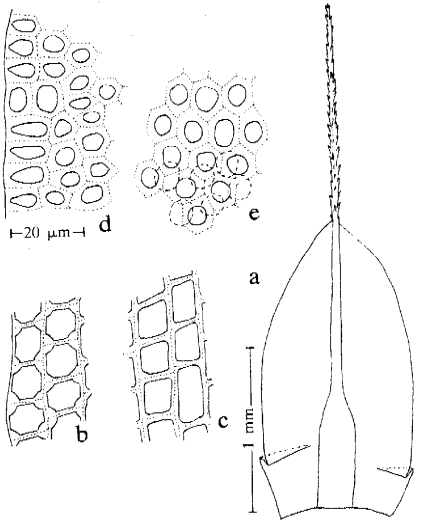


Fig. 28. *Grimmia laevigata*

Distribution: Almost cosmopolitan. Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Common on rocks, extending into very arid areas (2, 6, 7, 12, 14, 15, 17, 21).

Note: *Rhacomitrium crispulum* (Hook. f. et Wils.) Dix. occurs in Western Australia and Victoria, as well as N.S.W., Tas. and A.C.T., and may be expected on rocks at higher elevations. The stems are fairly long and recumbent, with the tips of the shoots and branches curving upwards. The leaves are lanceolate, 2-3 mm long, plicate on one side below. The cells in the lower half of the leaf are long and narrow, with very sinuously strongly thickened longitudinal walls. The upper cells are shorter, but often with walls irregularly thickened.

Order **DICRANALES**

Family **DITRICHACEAE** Limpr. in Rabenh. 1887, *Kryptogamen-Fl.* ed. 2 **4**:482

Plants generally small, stem with a central strand. Leaves usually lanceolate, acuminate or subulate, the upper leaves much longer than the lower ones; costa running into the subula or excurrent, in section with deuter cells between two stereid layers; cells smooth, quadrate to elongate in upper part of leaf, longer below, without differentiated alar cells. Capsule on a short or long seta, immersed or emergent and cleistocarpous or longly exserted and stegocarpous, globose to cylindrical, straight or somewhat curved; operculum conical; annulus of large cells or none; peristome teeth 16, bifid nearly to the base or perforated, papillose above, striate below; calyptra usually cucullate, sometimes mitriform.

DITRICHUM Hampe 1867, *Flora* **50**:181 *nom. cons.*

Type: *D.homomallum* (Hedw.) Hampe 1867, *Flora* **50**:182

Plants slender, in tufts. Leaves longly subulate from a wide or narrow base, rigid or flexuose, sometimes falcate secund; costa broad, percurrent or excurrent. Cells smooth, basal ones mostly elongated, not differentiated at the alar angles; upper cells short or long. Seta long, often flexuose; capsule erect or inclined, oval, oblong or cylindrical, symmetrical or asymmetrical; peristome teeth 16, entire or divided into two filiform papillose segments; operculum beaked; calyptra cucullate.

Key to South Australian species:

1. Leaf base very broad, contracted abruptly to the subula, with small dark cells at the shoulders; cells of subula all short, not more than about twice as long as wide. ..... *D.cylindricarpum*, p.92

   Leaf base narrow, passing gradually into the subula, no distinct shoulders with small cells; cells of subula long and narrow, about four to six times as long as wide, except for the marginal row ..... *D.difficile*, p.91

Ditrichum difficile (Dub.) Fleisch. 1904, *Musci Fl. Buitenzorg* **1**:300.

Basionym: *Trichostomum difficile* Dub. *in* Moritzi, 1846, *Syst. Verz. Zoll. Pfl.* p.134.

Type: Java, coll. Zollinger no. 411.

Ditrichum flexifolium Hampe 1867, *Flora* **50**:182. Type: Australia.

Fig. 29

In dense mats on damp soil and clay banks at road sides, yellow green. Stems 0·5-2 cm tall, usually 1 cm or less, simple or sparingly branched. Leaves (a) 3-4 mm, widely spreading and flexuose to somewhat strict, narrowed quickly, but not abruptly, from a short oval or oblong base to a long, channelled flexuose subula; costa flattened, pale, filling the upper part of the subula and excurrent, sometimes denticulate at apex; cells (b, c) narrowly linear throughout except for the marginal row above (b); basal cells (c) narrower in a few rows at the margin. Seta 2-3 cm long, thin, yellow or reddish, flexuose; capsule (d) 2-3 mm long, inclined, ovate-cylindrical, slightly curved and asymmetrical, somewhat narrowed at the mouth, chestnut brown to orange brown; annulus wide;

peristome red brown, teeth borne on a low basal membrane and divided into two long filiform, papillose segments; operculum with a suberect subulate beak, usually not more than half length of capsule; calyptra cucullate; spores 12-16 μm very finely verrucose, colourless. Autoecious; perigonium gemmiform.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, East Indies, South Africa. Fairly common (6), generally in abundant fruit.

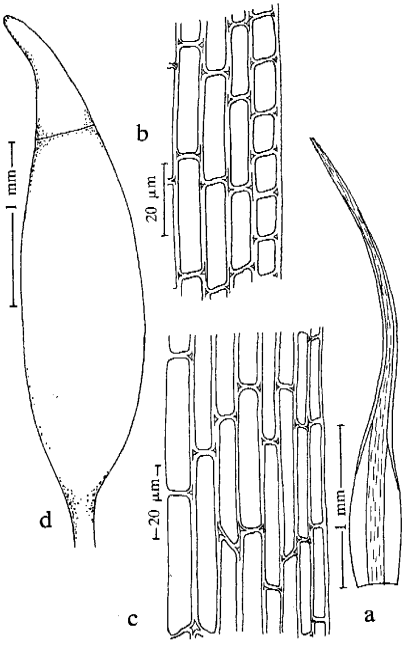


Fig. 29. *Ditrichum difficile*

Ditrichum cylindricarpum (C. Müll.) F.v.Muell. 1881, *Fragm. Phytogr. Austr. Suppl.* **11**:109.

Basionym: *Leptotrichum cylindricarpum* C. Müll. 1851, *Bot. Zeit.* **9**:551.

Type: Tasmania.

Ditrichum elongatum (Hook. f. et Wils.) Mitt. 1883, *Trans. Proc. R. Soc. Vict.* **19**:51.

Basionym: *Trichostomum elongatum* Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:176. Type: New Zealand

Fig. 30; Plate 3A

Growing in tufts on earth or rocks, in moist habitats; dull yellow green to brown. Stems 1-3 cm tall, simple or branched. Leaves usually flexuose, spreading and falcate, but sometimes more or less strict; leaves (a) 3-6 mm long, contracting abruptly from a broad and long, oblong concave base to a narrow channelled subula; costa rather wide, filling the upper part of the subula, excurrent, denticulate at the apex usually; cells elongated at the base (b, c),

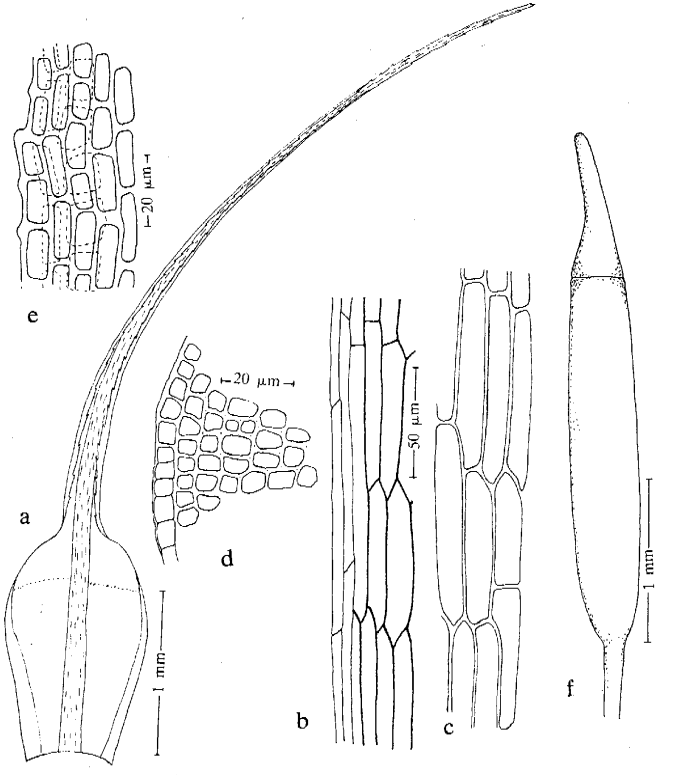


Fig. 30. *Ditrichum cylindricarpum*

thickly walled towards the costa, thinner walled towards the margin (b) where some rows are usually very narrow and hyaline; cells at shoulders of base (d) very small incrassate, quadrate or transversely rectangular in two layers (Seppelt and Stone 1977), the contents dark and dense; upper cells (e) shortly rectangular to subquadrate, in two layers, the margin denticulate. Seta 1-3 cm long, slender, red below, yellow above; capsule (f) 2·5-4 mm long, erect or inclined, very narrowly cylindrical, symmetrical, pale brown, thickened and widened at the mouth, darker at mouth and neck; peristome teeth 16, borne on a slightly

projecting basal membrane, teeth entire or split irregularly, pale brown, somewhat papillose and usually obliquely or spirally striolate; operculum with a slightly inclined beak, less than half length of capsule. Spores 14-18 μm, green. Autoecious; the perigonium gemmiform.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.) New Zealand, Chile. Rare in South Australia (6), but perhaps overlooked as it often grows in small tufts mixed with *D. difficile*.

CERATODON Brid. 1826, *Bryol. Univ.* **1**:480.

Lectotype: *C.purpureus* (Hedw.) Brid. *fid.* Lindb. 1878, *Utkast Nat. Grupp. Skand. Lavmoss.* p.34

Plants in dense tufts. Stems erect, simple or branched; leaves small, crowded, ovate-lanceolate to oblong-lanceolate, with revolute margins; costa strong, percurrent or excurrent; cells smooth, shortly rectangular at base of leaf, quadrate in upper part of leaf. Seta long; capsule inclined, strumose, sulcate when dry; peristome teeth 16, each divided nearly to the base into two filiform, papillose segments.

Ceratodon purpureus (Hedw.) Brid. 1826, *Bryol. Univ.*, **1**:480.

Basionym: *Dicranum purpureum* Hedw. 1801, *Spec. Musc.* p.136.

Type: Europe.

Fig. 31

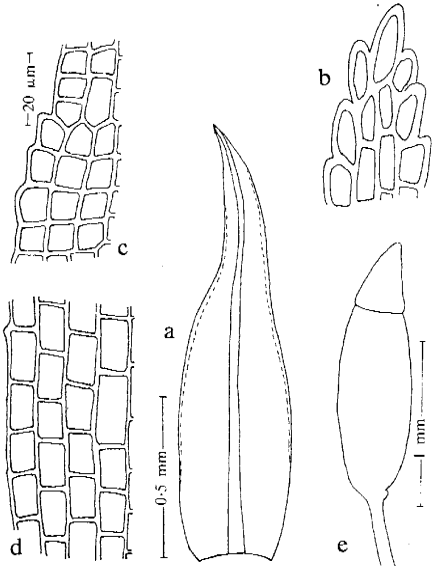


Fig. 31. *Ceratodon purpureus*

Dioecious. Small plants in dense or lax dull fulvous green patches. Stems erect, branched, usually 5-10 mm high, but frequently taller, radiculose below. Leaves (a) rather crowded, appressed and slightly curved and twisted when dry, erect to spreading when moist, ovate to linear-lanceolate, concave, 1-1·5 mm long, margin plane and denticulate for a short distance below the apex (b), then revolute to the base; costa percurrent or slightly excurrent; upper leaf cells (c) rounded, quadrate, incrassate, distinct, rectangular towards the base (d), more elongated near the costa and shorter towards the margins; perichaetial leaves sheathing, longer than the stem leaves. Seta purplish or, more rarely, yellowish, erect 10-15 mm long; capsule (e) inclined, ovoid, glossy, reddish brown, about 1·5 mm long with the operculum curved when dry and empty, cylindrical, sulcate, minutely strumose at base; peristome teeth reddish, papillose, incurved when dry, divided nearly to the base into two equal, filiform forks palely bordered below by the projecting plates of the inner surface; annulus large; operculum conical, about 0·3 to 0·5 mm long.

Distribution: Cosmopolitan; Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.). Common (1, 2, 5-8, 10, 14) on shady rocks and peaty banks, burnt logs and burnt ground. Somewhat variable.

ECCREMIDIUM Wils. 1846, *London J. Bot.*, **5**:1846.

Plants minute, forming an open or fairly compact turf on otherwise bare soil. Stems from barely 0·5 to a few mm tall, simple or sparingly branched; leaves small, ovate and imbricate so the shoot is julaceous or lanceolate and longly subulate; perichaetial leaves lanceolate, subulate and sometimes falcate. Seta short, thick, straight or arcuate bearing a globose to pyriform capsule; capsule dehiscing near its equator by a line of one or two narrow, thinly walled cells (fig. 34h); no peristome; operculum relatively large, dome shaped, with a stout apiculus; exothecial cells usually with thick walls, except for a small area of the outer wall which may project as a low mamilla; calyptra conical to campanulate, lobed at the base; spores large to very large, the surface colliculate with a tessellated pattern of domed polygons separated by grooves (fig. 34i).

There are two subgenera:

Subgenus ECCREMIDIUM Wils. *loc. cit.*

Capsule obovate to pyriform, pendulous on an arcuate seta. Shoots julaceous or not. *E.arcuatum, E.pulchellum, E.exiguum.*

Subgenus PSEUDO-PLEURIDIUM Broth. 1901, *Nat. Pfl.* **1**:297.

Capsule globose on a very short seta, straight when moist, slightly bent at apex when dry. Shoots not julaceous. *E.minutum, (E.whiteleggei).*

Key to South Australian species:

1. Fertile, with mature sporophytes 2
   Sterile 5
2. Seta strongly arcuate, with capsule pendulous; shoots julaceous or not; leaves short or long and narrow 3
   Seta straight, with capsule erect; never julaceous, leaves long and narrow . 6

3. Stems very short, less than 1 mm tall, not julaceous; leaves with a long subula, filled by the costa ..... *E.exiguum*, p.99
   Stems longer than 1 mm, julaceous, at least below; all or lower leaves short with costa scarcely reaching apex 4
4. Stems 1-3 mm, simple, the sterile stems triquetrous; lower leaves obtuse, serrulate, the teeth formed by single cells; no propagula ..... *E.arcuatum*, p.97
   Stems 3-5 (-10) mm, often with 2 or 3 branches, not triquetrous; leaves usually bluntly apiculate, usually minutely denticulate above, the teeth double formed of thickenings of walls separating two adjacent marginal cells; often with deciduous apical buds ..... *E.pulchellum*, p.97
5. Shoots julaceous 4
   Shoots not julaceous. *E.exiguum, E.minutum, (E.whiteleggei)* hardly separable without fruit .....
6. Stems very short, less than 1 mm. ..... *E.minutum*
   Stems 3-5 mm, lax and flexuous, with rather distant leaves .. *(E.whiteleggei)*

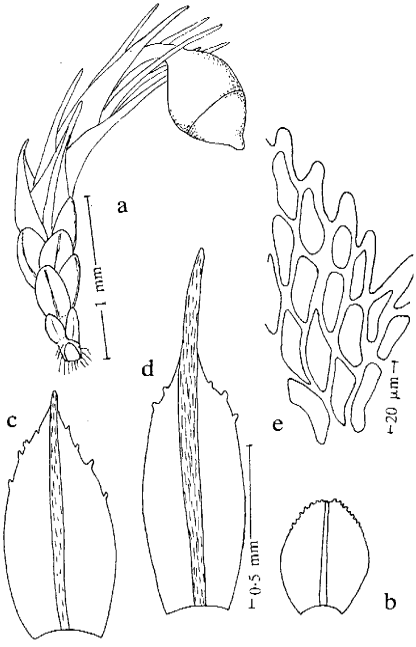


Fig. 32. *Eccremidium arcuatum*

Eccremidium arcuatum (Hook. f. et Wils.) C.Müll., 1849, *Syn.* **1**:425

Basionym: *Schistidium arcuatum* Hook f. et Wils. *in* Hook. 1848, *Icon. Plant Rar.* **8**:plate 738.

Type: Western Australia, Swan River, coll. J. Drummond.

Fig. 32

Plants greenish gold, reddish brown below; sterile plants triquetrous, fertile plants arcuate (a); stems simple. Leaves concave, becoming larger upwards, 0·2-0·7 mm long, lower leaves (b) widely oval and obtuse to cucullate, slightly keeled, apex truncate, margin (e) serrulate, the teeth blunt and bent, costa ceasing below apex or just reaching it; upper leaves (c) larger, acuminate, with an excurrent costa; cells of leaf rectangular below, 20-40 x 10 (-15) μm, thinly walled, upper cells (e) rhomboidal, thicker walled, 8-12 μm wide. Perichaetial leaves (d) falcate, to 1·4 mm long, lanceolate, narrowed quickly to a flat subula; capsule (a) red brown, theca shallow with a wide mouth; calyptra yellowish, campanulate, with flared lobes at the base; spores large, brown, about 100 μm diameter.

Distribution: Australia (W.A., S.A., Vic., N.S.W., Qld). Probably endemic. On soil in dry sclerophyll forest and shallow soils on rocks. Rare (11), overlooked. Sterile julaceous plants may be recognised by their triquetrous shoots and the characteristic marginal teeth on the leaves.

Eccremidium pulchellum (Hook. f. et Wils.) C.Müll., 1849, *Syn.* **1**:425.

Basionym: *Schistidium pulchellum* Hook. f. et Wils. *in* Hook. 1848, *Icon. Plant. Rar.* **8**: plate 738B.

Type: Western Australia, Swan River, coll. J. Drummond.

Fig. 33

Stems to 5 mm tall, or more, branched by two or three innovations basally or from below the perichaetium. Sterile stems (a) julaceous, each annual growing season ending in the production of a deciduous bud, the next year's growth from an innovation from below. The deciduous bud (Bruchknospen of Correns, 1899) separates at a zone of short cells in the stem and bears several small, closely appressed, serrulate leaves, with the cells thickly walled and somewhat sinuate; growth may occur in situ or after detachment. Leaves concave, broadly ovate, bluntly apiculate or rounded, margins entire below (c), minutely serrulate above (d), by projection of radial walls between cells; costa weak, ceasing below apex; lower cells (c) quadrate to shortly rectangular, middle and upper cells (d) irregularly rhomboidal. Perichaetial leaves ovate-lanceolate, acuminate, subulate, straight or somewhat arcuate, margins entire, costa filling the subula and sometimes excurrent; capsule with dehiscence closer to apex than in *E.arcuatum*, capsule mouth therefore small and operculum narrowly conical; calyptra deep yellow, conical, not flared nor crenate at the base; spores 60-80 μm diameter. Very rarely fertile.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., Qld, N.T.), probably New Zealand (as sterile *Pleuridium nervosum).* Rather common (1, 2, 5, 6, 10, 11, 17) on soil in sclerophyll forest.

The sterile state has often been thought to be a sterile state of *Pleuridium nervosum,* e.g. by Sainsbury (1935); the two species often grow mixed together. However, the section of the costa is different in the two. In *E.pulchellum* a pair of large cells on the adaxial and abaxial sides enclose one or two small central cells. In *Pleuridium nervosum* the costa is comparatively broad and has more numerous large adaxial and abaxial cells enclosing several to many small inner stereid cells, which are irregularly distributed.

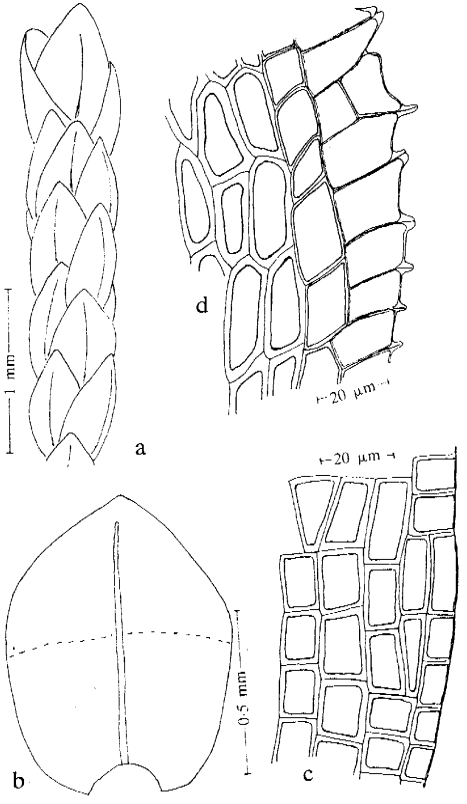


Fig. 33. *Eccremidium pulchellum*

Eccremidium exiguum (Hook. f. et Wils.) Wils. *in* Salmon 1900, *Rev. Bryol.* **27**:85-6.

Basionym: *Phascum exiguum* Hook. f. et Wils. *in* Hook. 1848, *Icon. Plant. Rar.* **8**:plate 737B.

Type: Western Australia, Swan River, coll. J. Drummond.

Stems very short, scarcely 1 mm tall, with two or three basal branches. Basal leaves very small and ecostate, upper ovate-lanceolate, concave, tapering to a long slender subula, which is sometimes flexuous and slightly secund; margin entire or slightly serrulate; costa weak below, stronger above, filling the subula; lower cells oblong, upper cells narrower, rhomboidal and with thicker walls. Seta arcuate, capsule pendulous, globose, the dehiscence near the middle; theca with a wide mouth, operculum dome shaped with a small apiculus; calyptra brownish, lobed at the base; spores 60-120 μm diameter.

Distribution: Australia (W.A., S.A.?, Vic., N.S.W.), South Africa. Rare on clay pans in mallee and in sclerophyll forests on soils subject to inundation; easily overlooked.

Eccremidium whiteleggei Broth. 1901, *Nat. Pfl.* **1**:297.

Type: N.S.W., Moroubra Bay, coll. T. Whitelegge.

Like *E.exiguum,* but stem longer, seta scarcely arcuate, capsule not pendulous; stem 3-5 mm tall, often ending in a perigonium from which arise one or two branches bearing perichaetia. Lax, leaves erecto-patent, often very distant, concave, ovate-lanceolate to acuminate, the upper ones sometimes being subulate and serrulate; costa none or very weak; cells rectangular to rhomboidal, 12-20 μm wide, four to five times as long as wide, walls thin. Seta very short, vaginula as long as the capsule; spores polyhedral, 4 to 24 in number.

Distribution: Australia (W.A., N.S.W.), perhaps New Zealand. Small slender plants likely to be overlooked.

Eccremidium minutum (Mitt.) Stone et Scott 1973, *J. Bryol.* **7**:603.

Basionym: *Bruchia minuta* Mitt. *in* Hook. f. 1859, *Fl. Tasm.* **2**:165 plate 171, fig. 4.

Type: Tasmania, coll. Archer.

Fig. 34

Plants compact, very small (a); Stem very short, usually much less than 1 mm. Lower leaves (b) ovate-acute, about 0·5 mm long or less, costa absent at base, developing above and reaching apex; upper leaves (c, d) ovate-lanceolate to lanceolate, acuminate, variably denticulate above, entire or weakly crenulate below; costa weak and ill defined; cells rhomboid above (e), 25-50 × 12-15 μm, larger and more irregular in shape below (f). Capsule globose (g), barely emergent, the dehiscence (h) slightly above the middle; operculum dome shaped with a small apiculus; mouth of theca wide; calyptra sometimes rough from the projecting ends of cells; spores (i) 50-100 μm diameter.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., Qld), New Zealand. On bare ground, clay pans, clay banks, depressions in rocks that are filled with soil and are subject to waterlogging. Rare.

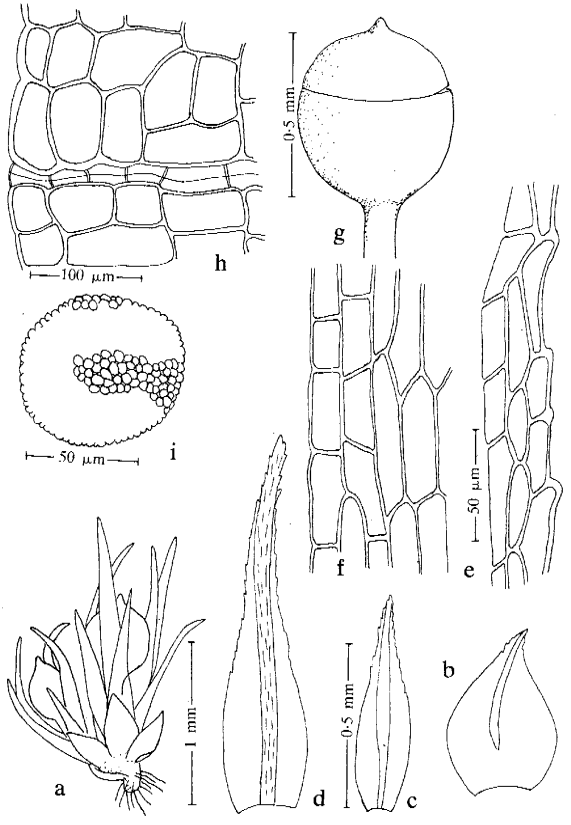


Fig. 34. *Eccremidium minutum*

PLEURIDIUM Brid. 1819, *Mant. Musc.* p.10

Small plants, terrestrial. Leaves lanceolate to lanceolate-subulate, concave, the upper ones much elongated; costa broad; cells short to rhomboid above and rectangular below, smooth. Seta very short, straight or curved; capsule immersed, ovoid to globose, bluntly pointed, cleistocarpous; in some species loosening from the seta by a hole, out of which the spores empty; cells of exothecium roundish, many angled; calyptra cucullate, covering about half of the capsule.

Pleuridium nervosum (Hook) Mitt. 1856, *Kew J. Bot.* **8**:257.

Basionym: *Phascum nervosum* Hook. 1819, *Musci Exot.* **2**:plate 105.

Type: Western Australia, Swan River, coll. J. Drummond.

Pleuridium gracilentum Mitt. 1859, *J. Linn. Soc. Bot.* **4**:165.

Fig. 35

Plants in dense mats on soil, in bare ground. Stems 3-5 mm tall, simple, rigid, julaceous below, with very long comal leaves. Lowest leaves (a) appressed, small, ovate to ovate-lanceolate, about 0·5 mm long, base broad, apex acute; higher leaves (b) becoming gradually long up the stem, reaching 3 mm long in the perichaetium (c), the upper leaves more spreading; margin entire below, usually crenate to denticulate above (e); cells rectangular to rhomboid, near the margin, more irregularly shaped and roughly hexagonal within (d), 10-12 μm wide and 2 to 4 times as long as wide; costa strong and wide, except in lowest leaves, usually just excurrent. Capsule (f) erect on a short straight seta, ovoid-oblong to almost globose, apiculate with a short blunt beak, reddish brown or orange and shiny when ripe; calyptra cucullate, about half the length of the capsule; spores 18-22 μm (25-35 μm) diameter, brown and papillate. Variable in capsule shape and spore size.

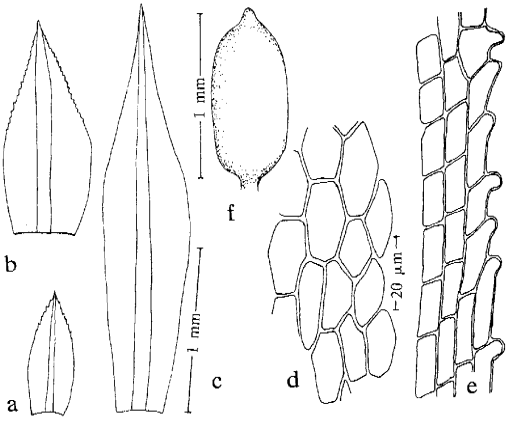


Fig. 35. *Pleuridium nervosum*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., N.T.), New Zealand, South Africa. Common (2, 6, 7, 11) on soil bare of herbs in moist and intermittently dry habitats.

Family **DICRANACEAE** Schimp. 1855. *Coroll. Bry. Eur.* p.11.

Plants large to small, stems with a central strand, often tomentose with a felt of rhizoids. Leaves fairly uniform in size, the upper rarely much larger, straight to falcate, lanceolate, acuminate; costa usually more or less excurrent, in section with stereids; cells usually smooth, the upper quadrate to elongate, the basal cells elongate, often porose, the alar cells differentiated and enlarged or not. Seta usually long, straight or arcuate; capsule stegocarpous or cleistocarpous, ovoid to cylindrical, straight or curved, smooth or striate; peristome dicranoid, with teeth of exostome lanceolate, entire or split, basal plates striate.

There are three subfamilies in South Australia:

TREMATODONTOIDEAE.

Small plants with capsules having a long or swollen apophysis, equal in length to theca. *(Trematodon), Bruchia.*

DICRANELLOIDEAE

Rather small plants with lanceolate, subulate leaves, without differentiated alar cells. *Dicranella.*

DICRANOIDEAE

Plants usually large, leaves straight to falcate, narrowly lanceolate, acuminate or subulate; basal cells commonly porose, alar cells enlarged, hyaline or coloured. *Dicranoloma, Dicnemoloma, Campylopus.*

BRUCHIA Schwaegr. 1824, *Spec. Musc.* Suppl. **2**(1):91.

Small plants, gregarious on a persistent protonema. Stems short, simple, with a central strand. Leaves subulate from a broad ovate to lanceolate base; costa stout, usually extending through the subula, in cross section with thick outer cells, inner stereid cells and a few deuter cells. Seta shorter than to a little longer than perichaetial leaves; capsules obovoid, cleistocarpous, pointed at the top, apophysis very large with numerous stomata; calyptra mitrate, lobed, covering more than a third of the capsule.

Bruchia brevipes Harvey *ex* Hook. 1840, *Icon. Plant. Rar.* **3**:plate 231

Type: South Africa

Figs 36, 47a

Small plants (a), clustered on damp soil, on a persistent, light green protonema. Stem about 1 mm tall, bearing erecto-patent, straight, stiff leaves which enlarge from below (b) upwards (c). Leaves with a pellucid sheathing base, contracted to a long narrow concave subula, often twisted; cells irregular to rectangular, the basal ones (d) 10-12 μm wide and 2-4 times as long as wide, narrower and relatively longer in the subula (e), to 5 μm wide and 4-7 times as long as wide. Margin (f) entire to irregularly denticulate; costa nearly filling subula, which tapers to one cell (e); perichaetial leaves (c) longer and more subulate, overtopping the fruit. Capsule (g) almost immersed, orange, obovoid, shortly pointed, with a large green apophysis, truncate at the base and at least a

third of the length of the capsule, borne on a short pale seta; calyptra papery, translucent, large, campanulate and lobed at the base; spores (h, fig. 47a) 35-45 μm diameter, covered with flattened spines (i) 4-5 μm long.

Distribution: Australia (W.A., S.A., Vic., N.S.W.), South Africa. Rather rare (12).

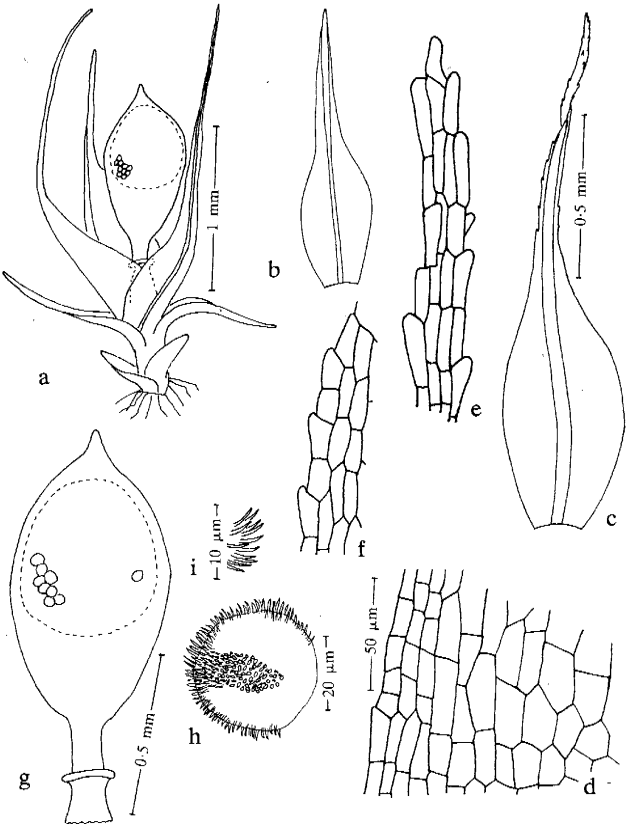


Fig. 36. *Bruchia brevipes*

DICRANELLA (C. Müll.) Schimp. 1856, *Coroll. Bryol. Eur.* p.13

Aongstroemia sect. *Dicranella* C. Müll. 1848, *Syn.* **1**:430

Lectotype: *D.grevilleana* (Brid.) Schimp. *fid.* Grout 1936, *Moss Fl.N.Amer.* **1**:54

Plants usually small, in tufts or close turfs on soil of clay or loamy banks.

Stems erect, simple or moderately branched. Leaves either gradually acuminate from an ovate-lanceolate base or rather abruptly subulate from a broad sheathing base; leaves erect, flexuous, falcate or not, spreading; costa percurrent to excurrent. Cells elongated, shorter distally, rectangular or rhomboid; alar cells not differentiated. Seta slender, erect, red; peristome red, divided to middle into papillose segments; striolate or papillose on outer face. Operculum with an oblique beak; calyptra cucullate.

Dicranella jamesoni (Mitt.) Broth. 1901, *Nat. Pfl.* **1**:311

Basionym: *Anisothecium jamesoni* Mitt. 1869, *J. Linn. Soc. Bot.* **12**:39.

Type: South America, Andes Quitenses, coll. Jameson no. 13.

Fig. 37

Plants slender, soft; stems 0·5-1 cm tall. Leaves 1-2·5 mm long, spreading, lanceolate, subulate, the lower ones (a) not sheathing, the upper ones (b) somewhat sheathing; entire (d); cells smooth clear, rectangular to rhomboid, 35-60 × 10-14 μm towards base (c), those of subula (d) shorter and narrower.

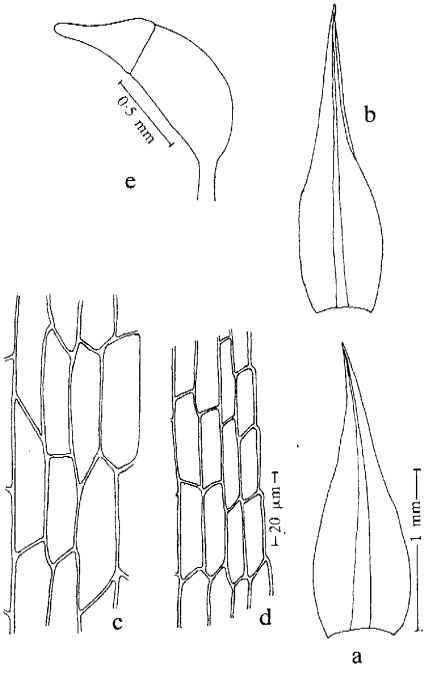


Fig. 37. *Dicranella jamesoni*

Seta to 1 cm. long, bright red; capsule (e) short, smooth, usually not more than 1 mm long, broadly oblong, inclined or nodding, slightly curved, asymmetrical, no annulus; peristome red, teeth with prominent trabeculae and vertical striae below, each divided to about half way into two segments that are papillose and paler above; operculum red brown with a bent beak about two thirds as long as the theca; spores 14-18 μm. Dioecious.

Distribution: Australia (S.A., Vic., Tas.), New Zealand, South America. Rare (6), fruit infrequent.

Dicranella dietrichiae (C. Müll.) Jaeg. is common in the eastern states and differs in the sheathing, abruptly subulate leaves and the sulcate capsules with a long slender beak to the operculum.

DICRANOLOMA Ren. 1901, *Rev. Bryol.* **28**:85

Dicranum subgen. *Dicranoloma* Ren. 1898, *Prodr. Fl. Bryol. Madagascar* p.61.

Rather rigid, mostly robust plants, glossy, growing in tufts on trees, rocks or the ground. Leaves usually falcate secund, lanceolate, subulate, usually dentate above; costa percurrent or excurrent, in section with median deuter cells and adaxial and abaxial stereid cells; cells smooth, elongated below, usually shorter above, very incrassate and porose, usually very narrowed at the margin and hyaline, at least near the leaf base, where a distinct border is formed; alar cells conspicuous, numerous, quadrate to polygonal. Seta short or long, often several together; capsule symmetrical, subcylindrical, erect or arcuate, with or without a struma; peristome teeth 16, red, striolate, divided almost to the middle into 2 to 3 pale segments; operculum with a long fine beak.

Key to South Australian species:

1. Leaves broadly ovate lanceolate; upper cells elongate, 3-5 times as long as wide ..... *D.billardieri*, p.105
   Leaves linear-lanceolate, margin inflexed above; upper cells relatively shorter, 2-4 times as long as wide ..... *D.diaphanoneurum*, p.106

Dicranoloma billardieri (Brid.) Par. 1904, *Ind. Bryol.* ed.2, **2**:24.

Basionym: *Dicranum billardieri* Brid. 1802, *Bot. Zeit. Regensburg* **1**:214.
Type: New Holland, coll. La Billardière.

Fig. 38

Loosely or densely tufted on earth or rock or on trees or logs, golden or light yellow green, glossy, robust or slender. Stems 3-10 cm tall, simple or weakly branched. Leaves (a) 5-8 mm long by 1-1·25 mm wide, regularly falcate secund, from a long, broadly ovate-lanceolate, concave base tapered gradually to a subula channelled below but more or less flattened above and somewhat twisted; margin below with a narrow hyaline border; margin of subula (b) dentate, especially apically, with rather large sharp teeth; costa narrow and weak, about 40 μm wide below, denticulate abaxially towards apex, shortly excurrent; alar cells (c, d) usually yellow in older leaves; other cells (b, e)

throughout elongate, incrassate porose, those of the lamina being longer than those of the subula. Perichaetium forming a short sheath, the innermost perichaetial leaf usually obtuse and muticous; seta long, 1·75-3 cm, flexuose; capsule 2-3·5 cm long, horizontal curved or arcuate, strumose; spores 16-22 μm.

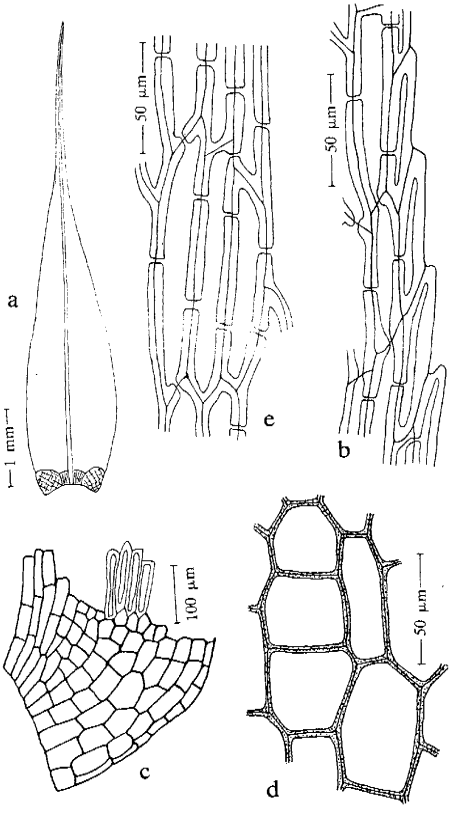


Fig. 38. *Dicranoloma billardieri*

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, S.America, S. and Central Africa. Very rare in South Australia (1).

Dicranoloma diaphanoneurum (Hampe et C.Müll.) Par.1904, *Ind. Bryol.*ed.2, **2**:26.

Basionym: *Dicranum diaphanoneurum* Hamp. et C.Müll.1870, *Linnaea* **36**:515.

Type: Western Australia, Stirling Range.

Dicranum austrinum Mitt. 1883, *Trans. Proc. R. Soc. Vict.* **19**:53.
Dicranum contortifolium Bartr. 1951, *Trans. Br. Bryol. Soc.* **1**:466.
Type: Western Australia, Nornalup.

Fig. 39; Plate 3B

Plants 2·5-3·5 cm tall, yellowish green, in dense tufts or mats on trees, logs or rocks. Leaves (a) linear-lanceolate, 5-7 mm long by 0·75-0·9 mm wide, flexuous, contorted when dry, subulate, the subula channelled, the leaf margin inflexed; margin below (b, c) with a hyaline border of long narrow cells, 70-85 x 7-9 μm thinly walled; costa fairly strong, excurrent, vaguely or distantly denticulate (d)

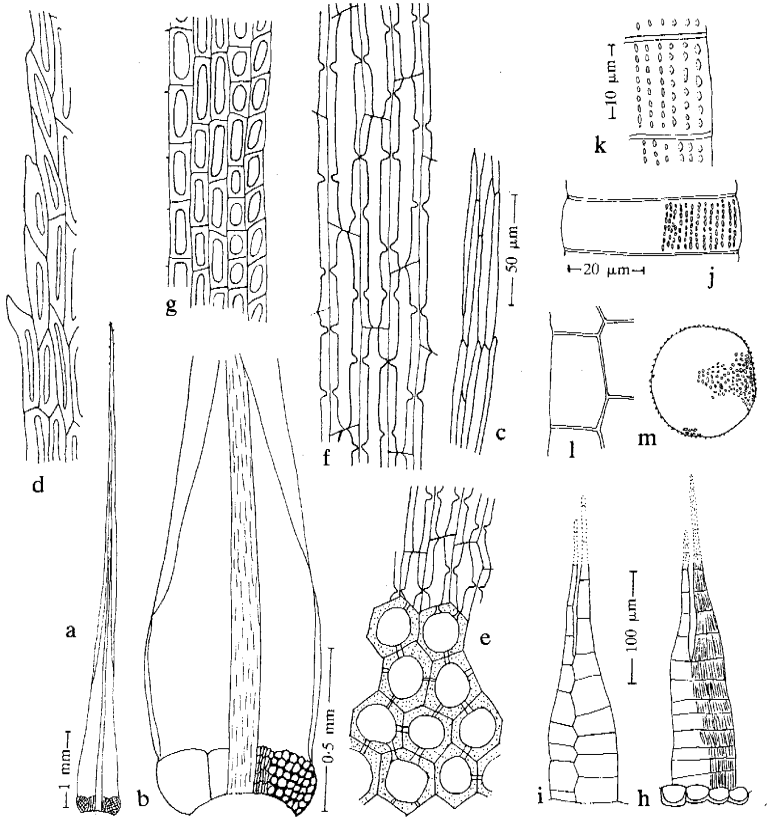


Fig. 39. *Dicranoloma diaphanoneurum*

below, more sharply dentate apically; alar cells (b, e) usually brown, polygonal, thickly walled, porose; other cells (e, f) elongate, incrassate, porose, becoming shorter, oblong and scarcely porose above (g), shortest at the margin. Seta 10-15 mm pale yellowish brown; capsule erect, cylindrical, 1·5 mm long without operculum; operculum with a long slender beak; peristome teeth (h, i) divided to about the middle, apical parts coloured or hyaline; outer surface of teeth (h) with vertical papillate striae (j, k), inner surface of teeth (i, l) smooth except for ridges between the plates; spores (m) 25-30 μm diameter.

Distribution: Australia (W.A., S.A., Vic., Tas.), New Zealand. Rare in South Australia (6), on rock.

The identity of the South Australian plant, known only sterile, is uncertain and depends upon whether *Dicranum austrinum* is really different from *D.diaphanoneurum*. I am indebted to Dr. J. H. Willis for guidance through the confusion. Mitten introduced the name *D.austrinum* for the plant designated as a variety of *Dicranum sphagni* Wahlenb. (= *Dicranum elongatum*) in Hooker's Fl. Tasm. The type is Tasmanian, without locality, sterile, and the description exceedingly brief and not distinctive, except that the leaves were entire. Mitten also cites a plant from King George Sound, Western Australia, collected by Cunningham, as being *D.austrinum*. The differences alleged may be summarised as follows:

D.austrinum: Leaf tips almost entire; elongated hyaline cells conspicuous along the basal margins. Capsule narrowly fusiform, not or but slightly grooved. Peristome strongly inflexed when dry, yellow brown only at the base, teeth divided to half way, hyaline above, tapering upwards, 0·20-0·22 mm long. On rocks.

D.diaphanoneurum: Leaf tips conspicuously toothed or barbellate; elongated hyaline cells not or hardly apparent on basal margins. Capsule subcylindrical, usually markedly grooved. Peristome slightly or not inflexed when dry, yellow brown nearly to the apex, teeth divided only to about a third, rarely to half way, not much tapered, often cohering, 0·21-0·27 mm long. On rotten wood.

The truth seems to be that none of these differences hold. The degree of dentation of the leaf tips and the conspicuousness of the basal hyaline cells varies within a specimen. The peristome characters of *D.diaphanoneurum* are seen in the type of *D.contortifolium* Bartram from Nornalup, while those of *D.austrinum*, particularly in respect of the hyaline upper parts, is seen in the Pemberton specimen (G.G. Smith no. 80), also cited by Bartram.

DICNEMOLOMA Ren. 1901, *Rev. Bryol.* **28**:86.

Leucoloma subgen. *Dicnemoloma* Ren. 1898, *Prodr. Fl. Bryol. Madag.* p.87

Type species: *Leucoloma sieberi* Mitt.

Plants rigid, in matted tufts; stems much branched. Leaves erecto-patent or secund, appressed when dry, ovate-lanceolate, acuminate, very narrowly bordered with long hyaline cells, entire, often with a hyaline hair point; costa thin; cells small, rounded-quadrate, chlorophyllose, papillose; basal cells

adjacent to nerve linear; alar cells numerous, brown. Inner perichaetial leaves abruptly subulate from a sheathing base; seta erect, red; capsule inclined, symmetrical, curved when dry; peristome teeth each divided to about the middle into two segments; operculum with an oblique beak.

Dicnemoloma pallidum (Hook.) Wijk et Marg. 1960, *Taxon* **9**:50.

Basionym: *Leucodon pallidus* Hook. 1819, *Musci Exot.* **2**:12, plate 172.

Type: Australia.

Dicnemoloma sieberianum (Hornsch) Broth. 1924, *Nat. Pfl.* ed. 2, **10**:212.

Type: Australia.

Fig. 40; Plate 3C, D

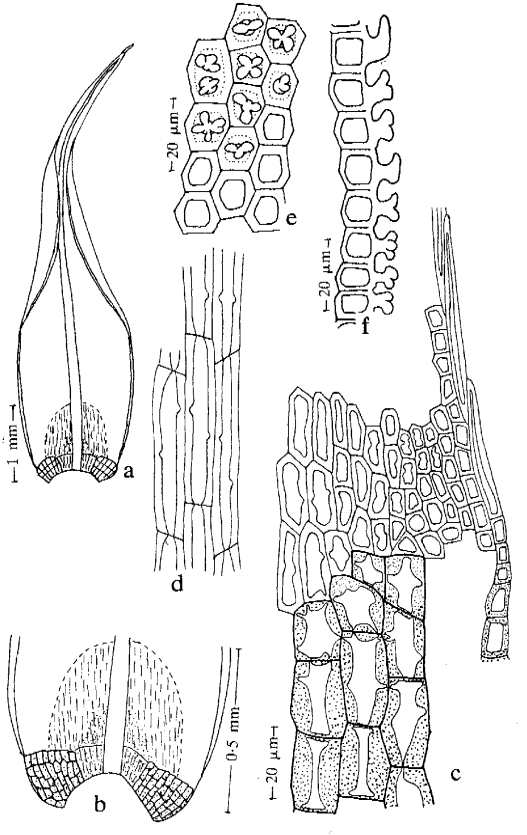


Fig. 40. *Dicnemoloma pallidum*

In tufts on rock or occasionally on soil, pale yellow-green, browner below. Stems elongate and procumbent or short and erect. Stems 2-6 cm long, flexuouse, branched dichotomously and with fasciculate short branches, crowded on the shorter stems; stems somewhat radiculose below. Leaves (a) 2-6 mm long, erect or erecto-patent, appressed or with the tips somewhat spreading, rigid; mostly subfalcate, sometimes subsecund, ovate-lanceolate, acuminate, with a concave base (b) and a convolute subula, entire; usually with a smooth hyaline hair point. Costa thin, well defined, about 50 μm wide below, ceasing shortly below the apex. Alar cells (b, c) numerous, quadrate, reddish brown; auricles well defined but not inflated; basal cells near the costa (b, d) elongated, narrow, incrassate and porose, those towards the margin (c) much shortened; marginal cells (c) in 2-3 rows very long and narrow, forming a conspicuous hyaline border extending far up the subula; cells above the basal ones (e) all short, about 10-14 μm diameter, irregularly angled, strongly papillose on the dorsal surface and margin (f). Perichaetial leaves sheathing, piliferous. Seta 1·25-2·5 cm long, slender, red. Capsule small, ovoid to subcylindrical, cernous. Operculum with a long beak.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Occasional on rocks (6, 7)

CAMPYLOPUS Brid. 1819, *Mant. Musc.* p.71

Lectotype: *C.flexuosus* (Hedw.) Brid., *cf* Pfeiff. 1873, *Nomencl. Bot.* **1**(1):572 *et* Britton 1916, *Fl. Bermuda* p.433.

Plants slender to robust, in tufts, often bronze in colour. Leaves erect to erecto-patent, from a lanceolate base, often with auricles, to a more or less elongate subulate lamina, entire or denticulate apically, often with a hyaline hair point. Costa very wide below and flattened, percurrent or excurrent apically, upper part often ridged abaxially. Alar group of cells usually inflated and coloured but sometimes hyaline, the basal cells rectangular, the upper cells rhomboid or obliquely elliptical and incrassate. Seta usually cygneous when moist. Capsule oval to elliptical, often sulcate when dry; annulus differentiated; operculum with a subulate beak. Calyptra cucullate, usually fringed at the base. Peristome either dicranoid with broad teeth, or with narrow teeth which are entire or divided part way or to the base into two densely papillose segments.

Campylopus is very difficult genus taxonomically with a large number of described species (about 650 in the World, 27 in Australia), a fair proportion of which should probably be sunk in synonymy. The genus is commonly divided into three subgenera according to the distribution of the very narrow stereid cells in the costa as seen in transverse section.

CAMPYLOPUS. Stereid cells on the abaxial side only. *C.bicolor, C.clavatus, C.introflexus, C.pallidus, C.kirkii.*

PALINOCRASPIS. Stereid cells on adaxial and abaxial sides.

PSEUDOCAMPYLOPUS. No stereid cells *C.austro-subulatus*

C.clavatus and *C.kirkii* are somewhat intermediate between *Campylopus* and *Palinocraspis.*

Key to South Australian species:

1. Leaves blunt or cucullate at the apex; no hair points 2
   Leaves with a slender subula, sometimes tubular but not cucullate at the apex; hair points common 3
2. Alar cells inflated and coloured; leaves wide, obtuse with a relatively narrow costa, usually branched above; leaf cells porose; adaxial cells of costa very incrassate and porose ..... *C.kirkii,* p.118
   Alar cells indistinct, not coloured; leaves cucullate, with a wide costa, not branched; leaf cells not porose; adaxial cells of costa thinly walled, not porose ..... *C.bicolor,* p.111
3. Plants pale green, matted below with reddish tomentum; leaves with very long and slender subula, flexuous when dry; alar cells none or weakly developed and hyaline ..... *C.pallidus,* p.116
   Plants olive, bronze or dark green, tomentum brown, whitish or very scanty; leaves with subula stiff, straight or sharply bent; alar cells distinct or none 4
4. Costa in section without stereid cells, all cells similar in size and walls relatively thin; plants rather small, soft, dark green; no alar cells *C.austro-subulatus,* p.119
   Costa in section with stereid cells centrally and abaxially; plants fairly robust, stiff, bronze green; with alar cells either inflated and coloured or hyaline 5
5. Costa rather narrow, about half width of leaf base, in section with very thick-walled cells adaxially in the subula; alar cells inflated and coloured; narrow thinly walled cells restricted to a few marginal rows at base of leaf, rest of basal cells coloured; plants with deciduous tips formed at end of growing season ..... *C.clavatus,* p.113
   Costa very broad, about three quarters width of leaf base, in section with all adaxial cells thinly walled; alar cells inconspicuous; narrow, thinly walled hyaline cells reaching costa and ascending obliquely about a third of the way up lamina; no deciduous buds; hyaline awn often bent squarrosely *C.introflexus,* p.115

Campylopus bicolor (C.Müll.) Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:69

Basionym: *Dicranum bicolor* Hornsch. *ex* C.Müll. 1848, *Syn.* **1**:392.

Type: N.S.W., Port Jackson.

Fig. 41

In dense tufts, dark yellowish brown to dark green tufts, on wet ground or rocks, darker below, not glossy. Stems to 7 cm tall, thin, not tomentose, simple or dichotomously branched with long branches, not comose, often flexuose. Leaves (a) 4-5 mm long, crowded, erect or suberect and appressed, not altered when dry, concave, ovate-lanceolate, linear-lanceolate or shortly lanceolate-subulate, apex abruptly subcucullate, no hair point. Margin plane, entire, but

leaf tip may be denticulate. Costa wide throughout, more than half width of leaf base and sometimes occupying nearly the whole width, in section (b) with very large thin-walled adaxial cells and a substereid layer abaxially; smooth abaxially or somewhat ridged above. Alar cells hyaline, not enlarged. Basal cells (c) shortly rectangular and hyaline, extending well up base, a few marginal rows narrower, very thinly walled and hyaline; all other cells (d, e) obliquely rhomboid or subvermicular, incrassate, not porose. Perichaetial leaves sheathing, shortly and rather suddenly acuminate, with obtuse apices which are

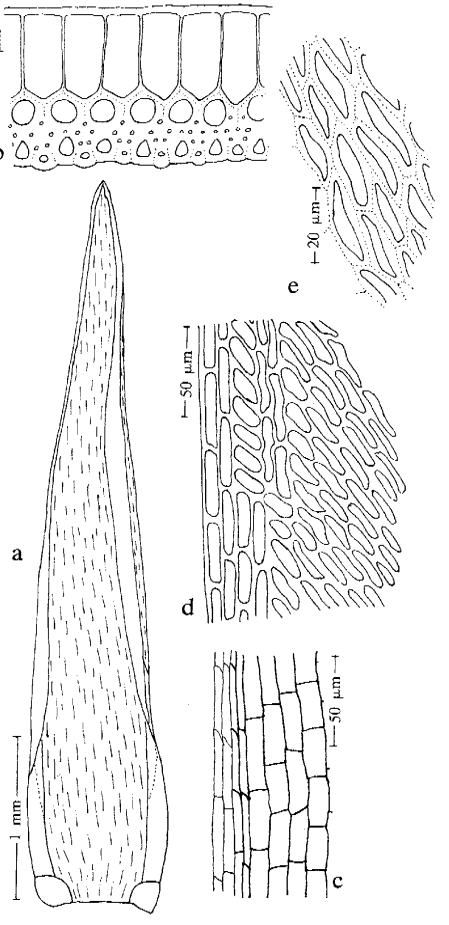


Fig. 41. *Campylopus bicolor*

narrower than in foliage leaves; fruits one per perichaetium. Seta about 0·5 cm long, erect and sharply flexuose in the middle when dry, cygneous when moist. Capsule 1-1·25 mm long, erect, oblong ovoid, rugulose at the base, cylindrical and finely plicate when dry and empty. Peristome dicranoid.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, South Africa. Rather uncommon, chiefly on wet rocks in gorges (6, 7, 14, 17).

var. **ericeticola** (C.Müll.) Dixon 1923, *Bull. N.Z. Inst.* **3**:87.
Leaves ending in a short, denticulate, hyaline point.

Distribution: Australia (S.A., Qld).

Campylopus clavatus (R.Br.) Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:69.
Basionym: *Dicranum clavatum* R. Brown in Schwaegr. 1829, *Spec. Musc. Suppl.* **3**(2): plate 255a.
Type: Tasmania.

Fig. 42; Plate 4C, D

Plants terrestrial, in dense glossy tufts, usually bronzed but sometimes yellow-green, darker below. Stems commonly 2-5 cm tall, simple or dichotomously branched, the branches sometimes short and clavate, generally densely tomentose with brown rhizoids. Leaves of vegetative plants crowded, erect or suberect and more or less appressed, with the apex of the stem somewhat cuspidate; leaves of fruiting plants often spreading above in dense comal tufts and showing those of previous seasons on older parts of stems. Leaves (a) 4-7 cm long, lanceolate, subulate from a short, rather concave, oblong base; tubular above from the inflexed margin; with a short, straight, denticulate hair point. Costa two-fifths to more than half width of leaf at base, excurrent in a short hyaline denticulate or smooth arista; closely ridged abaxially; costa in section of *Palinocraspis* type above (b, c) but of *Campylopus* structure basally (d). Adaxial costal cells (e) elongated, about 130-160 x 10 μm, outer wall very thick apically (b), abaxial cells (f) short, those in the grooves about twice as long as wide. Alar cells inflated and coloured; basal cells immediately above alar cells quadrate (g) to rectangular and coloured near costa, linear and hyaline in 1-4 rows at the margin; tapering upwards; the quadrate cells quickly giving place to obliquely rhomboidal, incrassate cells (h) throughout most of the lamina. Vegetative reproduction by deciduous shoot tips (brittle buds or Bruchknospen of Correns, 1899), each separating at an abscission layer formed of a zone of short, dark cells; buds stellate, with widely spreading narrow leaves. New shoots spring from below the abscission layer, the young shoots forming clavate branches. Fruits often numerous from a perichaetium. Seta under 1 cm long, cygneous when young, suberect and strongly flexuose when mature. Capsule 1·5-1·75 mm long, erect, narrowly elliptical or subcylindrical, symmetrical, smooth or sometimes faintly ridged when dry, pale brown, with the mouth and

neck darker, tuberculate at the base; annulate. Peristome teeth 16, inserted below the rim, divided to the base into two long filiform, densely papillose segments. Operculum with an erect beak half or more the length of the capsule. Calyptra cucullate, fringed at the base. Spores 9-11 μm.

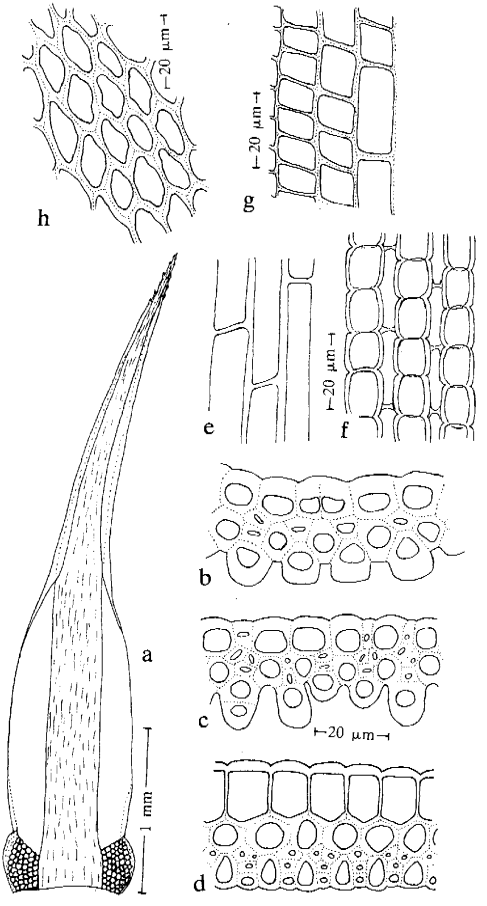


Fig. 42. *Campylopus clavatus*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand, Auckland and Campbell Islands, Chile. Common in South Australia (2, 5-8, 12, 17) in wet and dry sclerophyll forest and heathland.

Often confused with *C.introflexus*, which has a much longer zone of linear or rectangular hyaline cells, extending to the costa, above the poorly marked alar cells.

Campylopus introflexus (Hedw.) Brid. 1819, *Mant. Musc.* p.72.

Basionym: *Dicranum introflexum* Hedw. 1801, *Spec. Musc.* p.147.

Type: Presumably New Zealand or Australia ("Insularum meridionalium").

Dicranum leptocephalum C.Müll. 1851, *Bot.Zeit.* **9**:551.

Fig. 43; Plate 4A, B

Dioecious. Plants dark bronze to golden green above, brown to blackish below, in rather dense turfs. Stems 0·5-3 cm or more high, erect, rigid, more or less branched, radiculose below. Leaves (a) loosely appressed to imbricate when

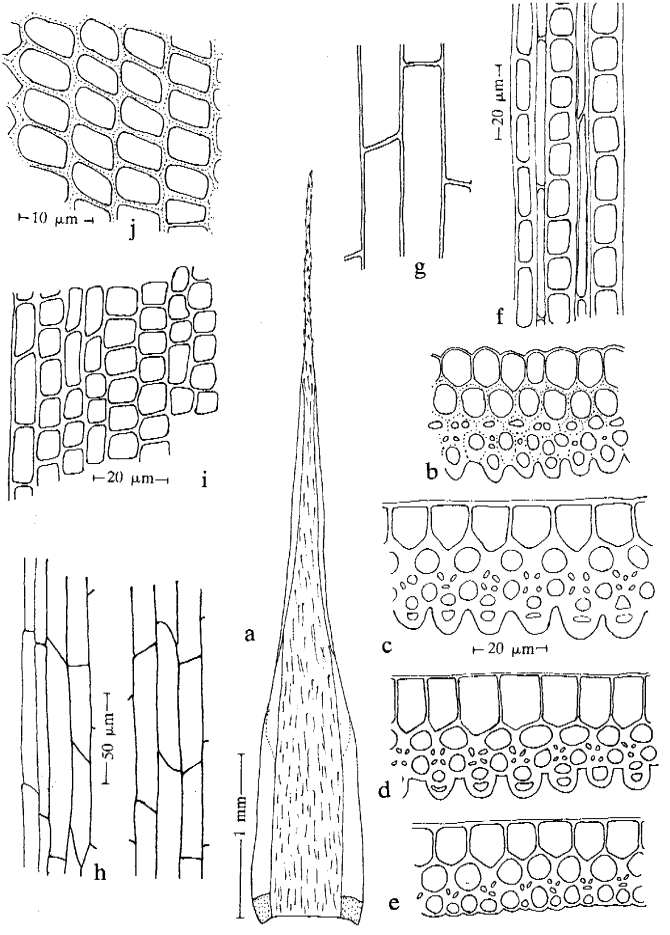


Fig. 43. *Campylopus introflexus*

dry, erect to spreading when moist, 4-6 mm long from an oblong, concave base gradually lanceolate-subulate, straight, rigid, concave, channelled to subtubulose above, usually ending in a rough hyaline awn of varying length; margin incurved and obscurely denticulate above, plane and entire below. Costa up to 300 μm wide, up to three quarters of the width of the leaf base, excurrent in a hyaline, denticulate point, usually bent at right angles when dry. Costa with numerous parallel ridges 1-2 cells high on the abaxial side, in section (b to d from subula to base) showing a layer of large cells, rectangular in surface view (g), on the adaxial surface and a stereid band mixed with larger differentiated cells on the abaxial side of the median row of deuters; cells of abaxial ridges rectangular in surface view (f) with elongated cells in the grooves. Cells of leaf base (h) rectangular thinly walled, hyaline, narrower towards margins, changing abruptly in an oblique line (dotted line in a) to the oblique, rhomboid cells of the upper lamina (j), quadrate to rectangular at margin. Alar cells inconspicuous, not inflated, hyaline or pale brown. Several fruits in a perichaetium; setae 6-9 mm long, rough near capsule, flexuous; capsule oval, slightly rugose at base, furrowed when dry; operculum obliquely shortly rostrate; peristome reddish brown, the teeth split to about halfway down; calyptra fringed at base; spores rough, to 13 μm diameter.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand, Pacific Islands, Europe, N. and S. America. Very common (1, 2, 5-7, 10, 17) on dry peaty banks and ledges, about roots and butts of trees, on rotting wood and burnt timber.

Introduced to Europe and there become widespread and there confused in the past with the native *C.pilifer* Brid. (=*C.polytrichoides* De Not.). *C.pilifer* differs in having higher ridges on the abaxial side, about 2 to 4 cells high in section, rather than 1 to 2 cells high as in *C.introflexus* (Gradstein and Sipman, 1978).

Campylopus pallidus Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:68.

Type: New Zealand.

C.torquatus Mitt. in Hook. f. 1859, *Fl. Tasm.* **2**:173. Type: Tasmania.

Fig. 44

In dense pale green tufts, shoots 0·5-4 cm tall, slender and silky, with reddish tomentum below, in sclerophyll forest, chiefly on rotting stumps or logs, or on tussocks in bogs. Leaves (a) 5-8 mm long, crowded, base concave, short and wide, ovate-lanceolate to oblong-lanceolate, tapering rapidly to a long slender flexuous subula, denticulate above and sometimes hyaline at the tip. Costa wide at the base, filling the upper part of the subula and excurrent; abaxial side of costa almost smooth, in surface view with alternating rows of longer and shorter rectangular cells (c). Alar cells weakly developed or none. All cells rather pale, the basal cells elongated rectangular or rhomboid, narrower towards the margin in a hyaline border; upper cells (b) small, irregularly subquadrate or rectangular. Fruit usually one per perichaetium; seta flexuous. Capsule 1-1·5 mm long, erect, oval, brown, grooved; operculum with a slightly curved beak at least half length of capsule; spores 13-15 μm diameter.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., Qld), New Zealand. Rare, on rotting logs in boggy or swampy ground in South Australia (6).

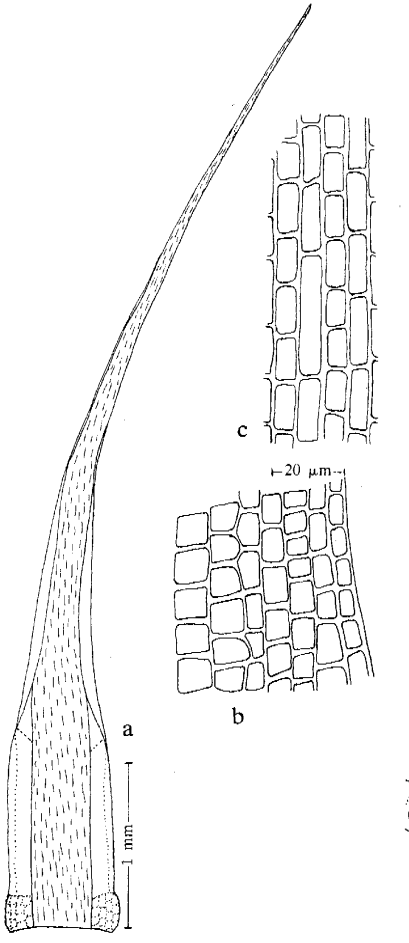


Fig. 44. *Campylopus pallidus*

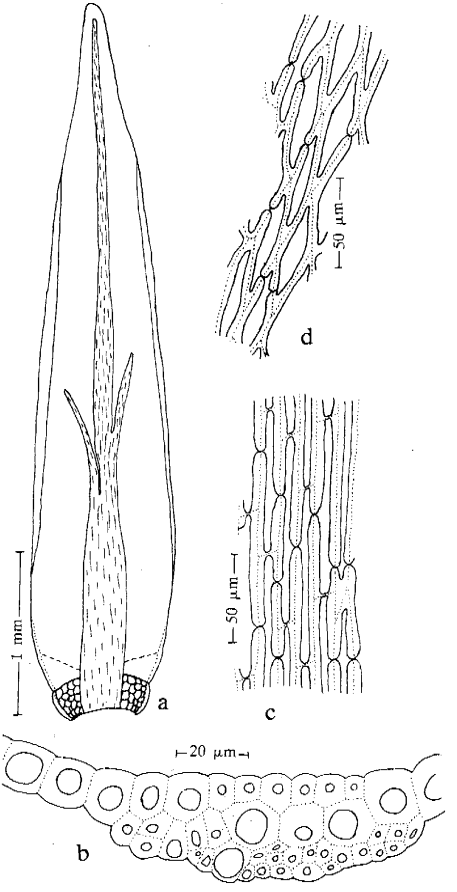


Fig. 45. *Campylopus kirkii*

Campylopus kirkii Mitt. in Beckett 1894, *Trans. Proc. N.Z.Inst.* **26**:280.
Type: New Zealand

Fig. 45

In dense tufts in bogs and other wet habitats. Stems 2-5 cm tall, yellow-green to golden above, dark brown to nearly black below, simple or sparingly branched, the taller plants usually comose, often interruptedly so; no tomentum. Leaves 4-6 mm long; stem leaves rather distant, suberect and appressed; comal leaves erecto-patent to spreading; all leaves (a) from a narrow insertion, broadly ovate-lanceolate, concave, cucullate and obtuse at the apex, without a hair point. Costa about 200 μm wide, broader at base, continuous to apex and in upper part of leaf with short branches into lamina on each side, in section (b) with all cells thickly walled; adaxial cells (c) elongated and with thick porose walls. Alar cells inflated and coloured. Basal cells thin walled, hyaline in a small triangular group, oblong or rhomboid towards costa and very narrow at margin; all other cells (d) rhomboid, very incrassate, with a very narrow vermiform lumen, walls porose. Seta about 5 mm long, flexuose. Capsule 1·5 mm long, narrowly oval furrowed. Peristome dicranoid. Operculum about half the length of the capsule, with a slightly curved beak. Calyptra cucullate, fringed basally.

Distribution: Australia (S.A., Vic., Tas.), New Zealand. Very rare (6).

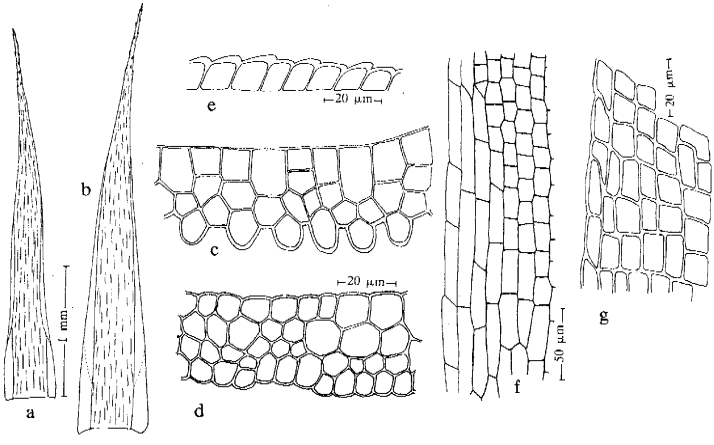


Fig. 46. *Campylopus austro-subulatus*

Campylopus austro-subulatus Broth. et Geh. 1895, *Oefv. Finsk. Vet. Ak. Foerh.* **37**:154.

Type: New Guinea, Mount Musgrave, coll. Sir W. MacGregor, comm. F. von Mueller n. 20.

Fig. 46; Plate 13C

Dioecious. Slender, tufted, shoots to 3 cm tall, compact, green to dark green, with reddish-brown rhizoids, growing on soil in sclerophyll forest. Stems slender, erect, flexuous, branches erect, often with a curved acute apex; leaves (a, b) to 2·5 mm long x 0·4-0·6 mm wide, imbricate when dry, erect when moist, lanceolate-subulate, subula canaliculate-concave, apex convolute, hyaline with a few denticulations; rest of leaf entire; costa broad, about ⅗ width of leaf base, occupying the whole leaf above, adaxial cells large, abaxial cells chlorophyllous, moderately prominent, in section (c, d) with all cells thinly walled, ridged above (c), the ridges in profile (e) slightly dentate, smooth below (d). Lamina with basal cells (f) rectangular, thinly walled, narrower and longer near the margin; upper cells (g) much shorter; alar cells flimsy, delicate hyaline.

Distribution: Australia (S.A., Vic., A.C.T.), New Guinea. Rare (6, 12, 21) or overlooked, perhaps taken for a small *C.introflexus*.

Order **POTTIALES**

Family **POTTIACEAE** B.S.G. 1843, *Bryol. Eur.* **2**:34

Small to robust plants, usually in dense tufts or turfs. Stem simple or branched, usually sympodially; usually with a central strand, but most without a hyalodermis. Leaves generally lanceolate, contorted or appressed to stem when dry; lamina generally with cells in one layer, rarely with two layers in parts. Costa single, with one or two stereid bands. Upper lamina cells isodiametric, generally papillose; basal cells usually larger, pale, oblong and smooth. Axillary hairs mostly hyaline, the basal cell or cells differentiated in some. Seta usually elongated. Capsule usually stegocarpous and elliptical to cylindrical, but cleistocarpous and subglobose in some. Exothecium differentiated in four or five layers, so that there are two or three layers outside the peristome at its base; annulus usually present. Operculum conical to rostrate, rarely small, sometimes none. Peristome teeth erect, oblique or twisted spirally, sixteen in number, often divided into 32 filaments borne on a low to high basal membrane; spores mostly spherical. Some species with rhizoid tubers or leaflike gemmae or gemmae sprouted from costal or laminal cells. The smaller, generally ephemeral, species commonly tend to have simplified sporophytes, exemplified by less elaborate to simple peristomes to no peristome at all and then by cleistocarpy, with or without differentiated exothecial cells where separation between urn and operculum might be expected.

This is one of the largest of the families of acrocarpous mosses, widely distributed and particularly adapted to xeric environments. It is the largest of the families in South Australia. The grouping of the genera within the family has changed much with time. The most recent scheme, followed in essentials below, is due to Saito (1975). His division into subfamilies is due originally to Podpera (1954). The amphithecial development has not been examined in several of the Australian genera.

Subfamily **POTTIOIDEAE**

Amphithecial derivatives in the capsule in four layers, so there are two layers outside the peristome at its base; margin of leaf usually recurved; basal cells of leaf, if distinctly differentiated, in a reversed V-shaped area, ascending higher at costa than at margin.

Divisible into four tribes:

POTTIEAE: *Pottia, Phascopsis, Phascum, Acaulon, Calyptopogon, Desmatodon, Crossidium, Aloina, Pterygoneurum, Tortula.*

BARBULEAE: *Trichostomopsis, Didymodon, Barbula.*

PLEUROWEISIEAE: *Gymnostomum.*

LEPTODONTIEAE: *Leptodontium, Triquetrella.*

Subfamily **TRICHOSTOMOIDEAE**

Amphithecial derivatives in the capsule in five layers, so there are three layers outside the peristome at its base; upper margin of leaf incurved or plane; basal cells of leaf differentiated as a hyaline V-shaped area, ascending higher at margin than at costa.

Tortella, Weissia, Tetrapterum.

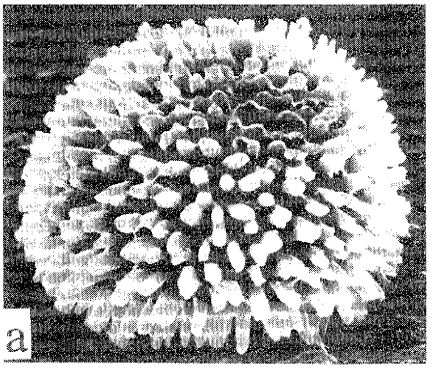
POTTIA (Reichenb.) Ehrh. ex Fuernr. 1829, *Flora* **12**(2Erg):10

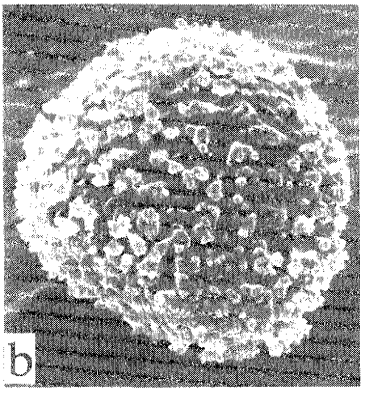
Gymnostomum sect. 1828.

Lectotype: P. truncata (Hedw.) B.S.G., *fid.* Wareham in Grout 1939, *Moss Fl. N. Am.* **1**:197.

Small plants, gregarious on soil. Stems very short. Leaves soft, often spathulate, spreading widely when moist. Costa percurrent to excurrent. Upper cells rounded-hexagonal, thinly walled, often obscure and papillose on both sides, but smooth in some species; basal cells elongate, smooth, pellucid. Perichaetial leaves usually like vegetative leaves. Seta straight, fairly long. Capsule erect, symmetrical, oval to cylindrical. Peristome none or rudimentary. Operculum conical or beaked. Calyptra cucullate. Spores generally fairly large.

Fig. 47. Scanning electron micrographs of spores: a. *Bruchia brevipes* (After Stone, 1977) x1200; b. *Pottia drummondi* (Photo I. G. Stone) x1200; c. *Phascopsis rubicunda* (Photo I. G. Stone) x1200; d. *Acaulon eremicola* (Photo I. G. Stone) x1200; e. *Bryobartramia novae-valesiae* (After Stone, 1977) x1200; f. *Goniomitrium enerve* (Photo I. G. Stone) x600.


a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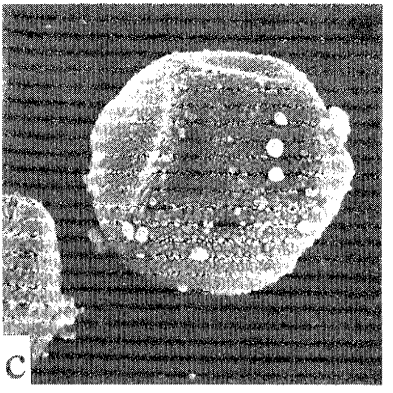
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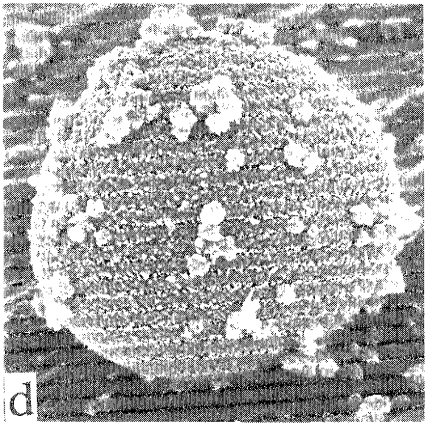
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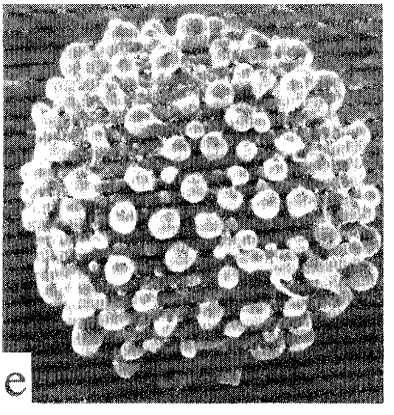
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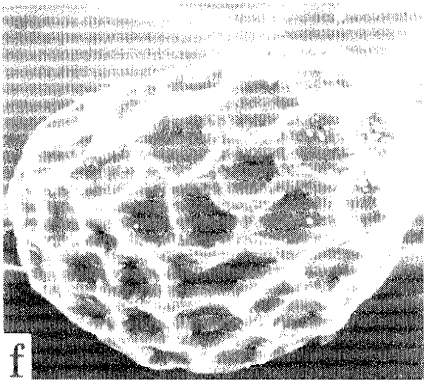

f

Key to South Australian species:

1. Cleistocarpous, capsule breaking open across the centre at an undifferentiated line ..... *P. drummondii*, p.130
   Stegocarpous, capsule with a defined operculum, shed at maturity 2
2. Upper cells pellucid, 17-20 μm across, smooth; leaf margin usually plane *P.truncata*, p.129
   Upper cells often more or less obscure, papillose; margin revolute in most 3
3. Operculum with a beak; leaves more or less obtuse; costa usually not excurrent; spores papillose, not spiny 4
   Operculum conical, blunt; leaves more or less acute; costa generally distinctly excurrent; spores spiny or tuberculate 6
4. Costa widened distally; cells bulging from adaxial surface of costa *P.brevicaulis*, p.128
   Costa not widened; its cells not protuberant 5
5. Leaf margin revolute; upper laminal cells 10-12 μm across; spores 20-22 μm diameter, sparsely papillose ..... *P.scabrifolia*, p.125
   Leaf margin plane; upper laminal cells 7-8 μm across; spores 25-27 μm diameter, densely papillose ..... *P.latzii*, p.126
6. Peristome teeth short to 120 μm tall, pale; spores clear, with large tubercles ..... *P.starckeana*, p.122
   No peristome or a mere stump; spores opaque, with spiny papillae 7
7. Capsule oval; upper laminal cells 15-18 μm across; spores 25-30 μm diameter, with large spiny papillae ..... *P.davalliana*, p.123
   Capsule nearly globose; upper lamina cells 10-12 μm across; spores 20-23 μm diameter, with more numerous small spinulose papillae *P.globosa*, p.124

Pottia starckeana (Hedw.) C.Müll, 1849, *Syn. Musc.* **1**:547.

Basionym: *Weissia starckeana* Hedw. 1801, *Spec. Musc.* p.65.

Type: Poland.

Anacalypta caespitulosa C.Müll. et Hampe 1855, *Linnaea* **26**:491.

Type: South Australia, near Mt Lofty, coll. F. v. Mueller.

Fig. 48

Paroecious. Very small, gregarious on bare ground, pale green. Stem very short, leaves (a) oblong lanceolate or very broadly ovate, variable in shape, short, acute, margin strongly revolute, nerve reddish, excurrent in a cuspidate point; upper cells (b,c) rather small, 10-15 μm, rounded hexagonal, rather incrassate, obscure, densely papillate, the papillae appearing hollow (c). Seta short, capsule (d) small, oval or shortly oblong, dark brown, shining, mouth not wide; calyptra (g,h) rough with papillae, operculum conical, obtuse or very shortly pointed. Peristome teeth (e,f) variable, more or less truncate and imperfect, of 3-6 plates, linear, flat, papillose, yellowish. Spores (i) coarsely and obtusely tuberculate, 25-30 μm diameter.

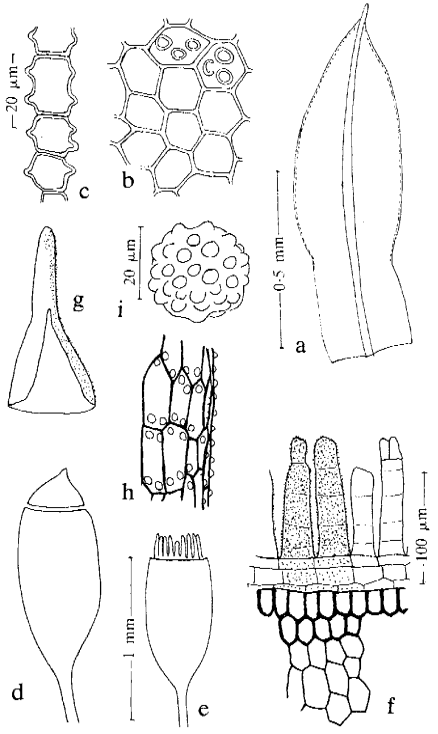


Fig. 48. *Pottia starckeana*

Distribution: Europe, S.W. Asia, N.Africa, N.America, Australia (S.A., Vic., A.C.T.), New Zealand. Common in South Australia (1, 6, 8, 12, 14, 15, 21) in urban habitats and on disturbed soil, possibly introduced.

Pottia davalliana (Sm.) C.Jens. 1923, *Danmarks Mosser* **2**:342.

Basionym: *Gymnostomum davallianum* Sm. in Drake 1805, *Ann. Bot.* **1**:577.

Type: Switzerland.

Pottia minutula (Schwaegr.) Fuernr. 1837, *Flora* **20**:287.

Fig. 49

Very small, gregarious on bare soil, reddish resembling small forms of *P.starckeana*. Leaves (a) spreading and recurved, short and broad, ovate, acute, cuspidate with the shortly excurrent reddish nerve; margin recurved; upper cells rather small, 15-18 µm across, incrassate, densely papillose, the papilla hollow. Seta very short, straight; capsule (d) small, shortly oval, mouth rather wide when capsule empty, dark brown, shining; operculum short, obtuse, conical or

mamillate; calyptra rough with papillae; spores (f) bearing rather large spiny papillae, variable in size 25-35 μm. Peristome none or quite rudimentary (e).

Distribution: Europe, North Africa, Australia (S.A., Vic., ?N.S.W.). Usually in gardens (8) and on disturbed soil in South Australia, probably introduced.

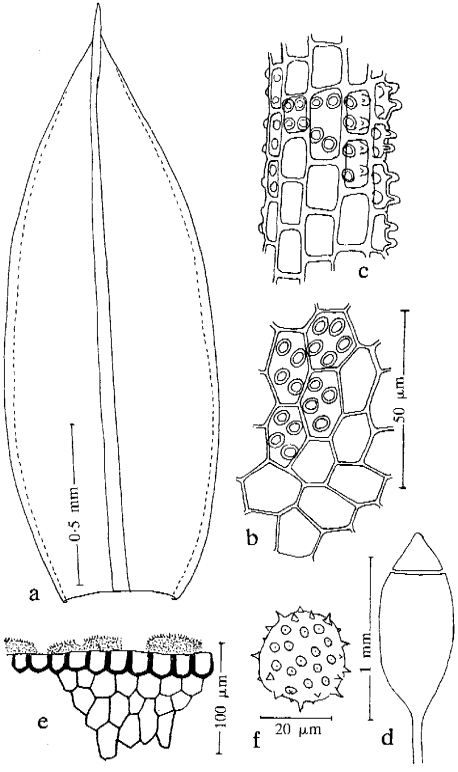


Fig. 49. *Pottia davalliana*

Pottia globosa Catcheside sp. nov.

Species humillima, *P.davallianae* (Sm.) C.Jens.similis, sed folia breviora, cellulis minoribus (10-13 μm diametro versus 12-18 μm), fructo subgloboso, sporis minoribus (22-25 μm diametro), minute spinulosis.

Type: Parachilna Gorge, Flinders Ranges, on silt, coll. D.E.A. Catcheside, Sept. 1978, in herb. D.G. Catcheside.

Fig. 50

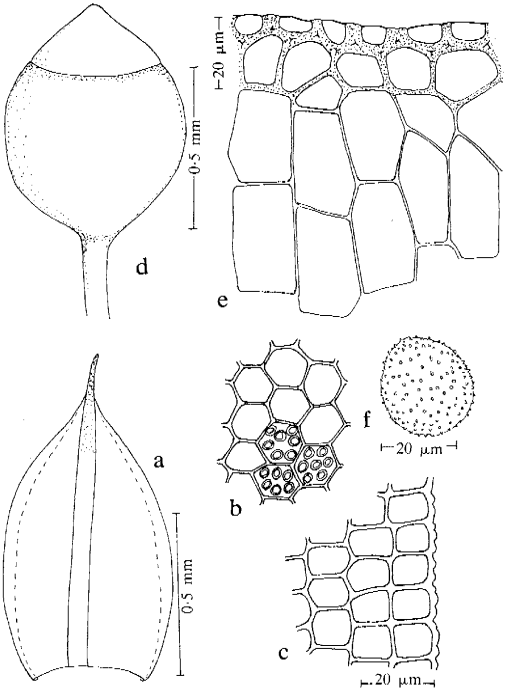


Fig. 50. *Pottia globosa*

Plants very small, stems 1-2 mm tall. Leaves (a) short, broad, ovate, to 0·9 mm long by 0·5 mm wide, margin recurved, costa strong and excurrent in a distinct coloured point. Upper laminal cells (b) hexagonal, 10-13 µm across, rather thickly walled, densely papillose, more nearly quadrate at the margin (c). Capsule (d) nearly globose with a wide mouth and a broadly conical operculum. Mouth of capsule (e) with two rows of rather small, thickly walled cells, walls brown. No peristome. Spores (f) 22-25 µm diameter, with small spinulose papillae, more numerous and much smaller than in *P.davalliana*.

Distribution: Australia (S.A.) endemic, rare (15).

Pottia scabrifolia Bartram 1951, *Trans. Br. Bryol. Soc.* **1**:467.

Type: Western Australia, Beverley, coll. W. Watts no. 34, July 1918.

Fig. 51

Autoecious. Very small, in dense tufts, green above, brownish below. Stem short, 1-2 mm high. Upper leaves (a) moderately twisted when dry, patent when moist, to 1·5 mm long, oblong, ovate or obovate, apiculate; margins (b) papillose-crenulate, recurved nearly to apex; costa strong, shortly excurrent;

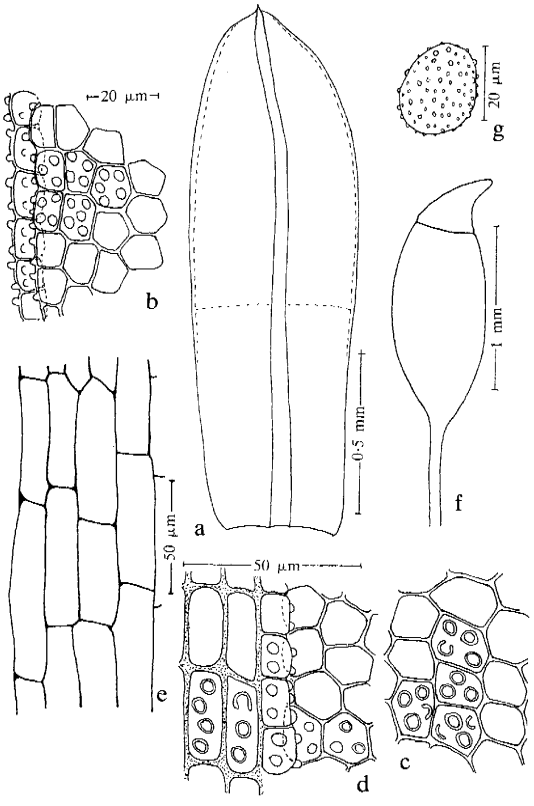


Fig. 51. *Pottia scabrifolia*

upper cells (c, d) obscure, roundish, 10-12 µm, densely papillose, basal cells (e) rectangular, hyaline, soft. Seta about 4 mm long, dark; capsule (f) erect, oblong cylindrical, 1 mm long without the operculum; no peristome; operculum obliquely conically rostrate, 0·4 mm long; spores (g) papillose, 20-22 µm.

Distribution: Australia (W.A., S.A., N.T.), endemic. Apparently rather rare (1, 4, 14, 21).

Pottia latzii Catcheside sp. nov.

Species *P.scabrifoliae* Bartram similis, sed folia margine plana, cellulis supernis crassis parvis (6-8 µm diametro versus 10-12 µm), sporis magnis, 23-27 µm diametro, dense et minute papillosis.

Type: Australia, Northern Territory, Mount Giles, on soil, coll. P.N. Latz No.6604d, 19.ix.1976.

Fig. 52

Autoecious. Small, in dense tufts, green. Stem short 2-3 mm tall. Upper leaves (a, b) moderately twisted when dry, patent when moist, reaching 1·6 mm long by 0·5 mm wide, oblong, tapering to an acute apex, apiculate with the excurrent costa; margins plane, papillose (c); costa strong; upper cells (c) small, 6-8 μm across, irregularly hexagonal to rounded, thickly walled, papillose; basal cells (d) irregularly rectangular, smooth, hyaline, with thick walls towards the costa, but much longer and thinner walled in about four marginal rows. Seta about 4 mm long, brown; capsule (e) erect, oval, 1 mm long without the operculum; operculum conical rostrate, slightly oblique, about 0·5 mm long; no peristome; spores (f) 23-27 μm diameter, densely and finely papillose.

Distribution: Australia (N.T.) endemic, rare.

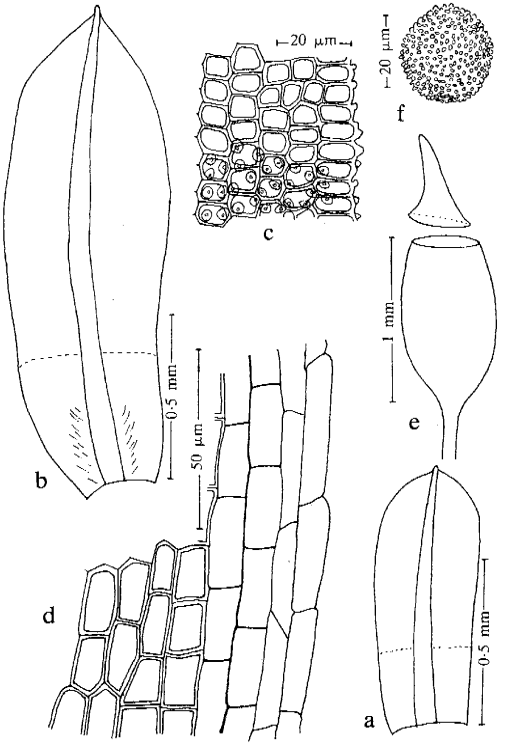


Fig. 52. *Pottia latzii*

Pottia brevicaulis (Tayl.) C.Müll. 1849, *Syn.* **1**:556.

Basionym: *Gymnostomum brevicaule* Tayl. 1829, *London J. Bot.*, **5**:42.

Type: Western Australia, Swan River, coll. J. Drummond.

Fig. 53

Very small plants (a), scarcely 1 mm tall without the fruit. Leaves (b) short, reaching 0·7 mm long by nearly 0·4 mm wide, usually blunt but sometimes acute; margin recurved except at apex. Costa strong, expanded towards the apex, ceasing in the apex or very shortly excurrent, the adaxial cells of the costa protuberant and highly papillose, abaxial side of costa less conspicuously papillose. Mid and upper laminal cells (c) hexagonal, 11-12 μm wide, densely papillose; margins (d) entire but papillose; lower laminal cells oblong, larger, smooth. Seta fairly long, capsule oval, about 0·7 mm long without the operculum; operculum with a rather long narrow oblique beak; spores 25-28 μm diameter, papillose.

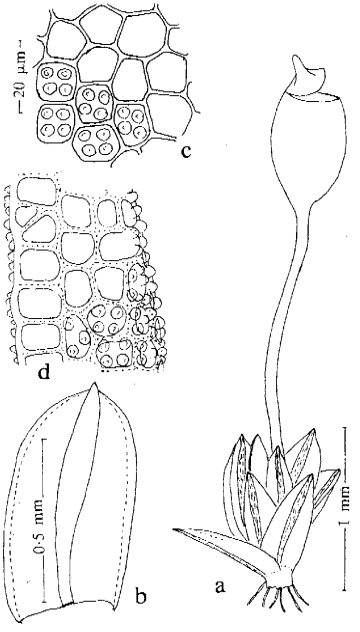


Fig. 53. *Pottia brevicaulis*

Distribution: Australia (W.A., S.A., Vic., N.S.W.) endemic. Apparently rare, ephemeral in semi desert (14, 17).

Pottia truncata (Hedw.) B.S.G. 1843, *Bryol. Eur.* **2**:37.

Basionym: *Gymnostomum truncatum* Hedw. 1801, *Spec. Musc.* p.30.

Type: Germany.

Pottia truncatula (With.) Bus. 1858, *Musci Neerl. Exs.* no. 67 *nom. illeg.*

Fig. 54

Autoecious. Gregarious in loose tufts or patches on bare soil and banks, dull green. Stem 0·5-1 cm, highly, slightly branched. Leaves in five rows, spreading, soft, twisted when dry, lower ones short, oblong-spathulate, upper (a) longer, oblong, shortly and slightly acute; margin plane, slightly irregular (b) towards apex with the projecting transverse cell walls, not papillate; costa excurrent in a short point; upper cells (b) rather large, hexagonal, thin-walled, smooth. Seta short, slender; capsule shortly oval or turbinate, truncate when empty, wide-mouthed and almost hemispherical, wall thin, pale brown, exannulate; lid flat, with a very oblique, more or less longly rostrate beak (c) or conical (d); calyptra smooth; no peristome; spores (e) large, 24-30 μm diameter, minutely punctulate.

Distribution: Europe, Asia, North Africa, N. and S.America, Australia (S.A., Vic., Tas., A.C.T.), New Zealand. Fairly common in South Australia (5, 6, 8) in gardens and urban habitats, probably not native.

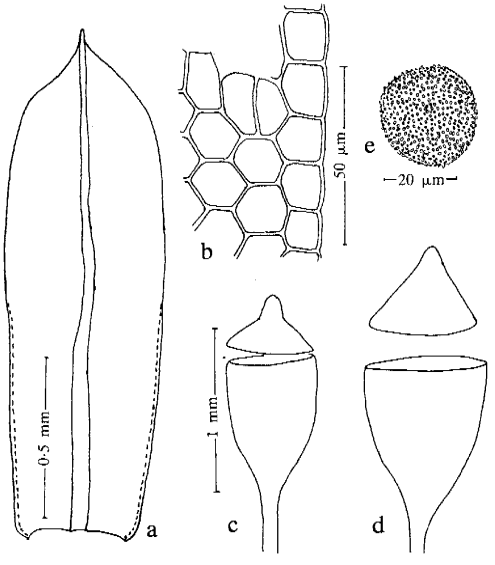


Fig. 54. *Pottia truncata*

Pottia drummondii (Wils.) Willis 1954, *Vict. Nat.* **70**:70.

Basionym: *Phascum drummondii* Wils. 1848, *London J. Bot.*, **7**:26.

Type: Western Australia, Swan River, coll. J. Drummond.

Figs. 47b, 55

Very small plants, like minute bulbs. Plants (a) without the fruit, 1-1·5 mm tall, bearing a few erect or somewhat spreading leaves. Leaves (b,c) barely reaching 1 mm long, very broad, obtuse, concave to convolute, sometimes cucullate at the apex, incurved and somewhat twisted when dry; upper cells (d) 17-25 μm wide, papillose or smooth, irregularly polygonal, somewhat smaller and quadrate at the margin (e); costa ceasing in or below the apex. Seta 1·5-2 mm long, pale reddish brown; capsule ovate to pyriform, with a long oblique

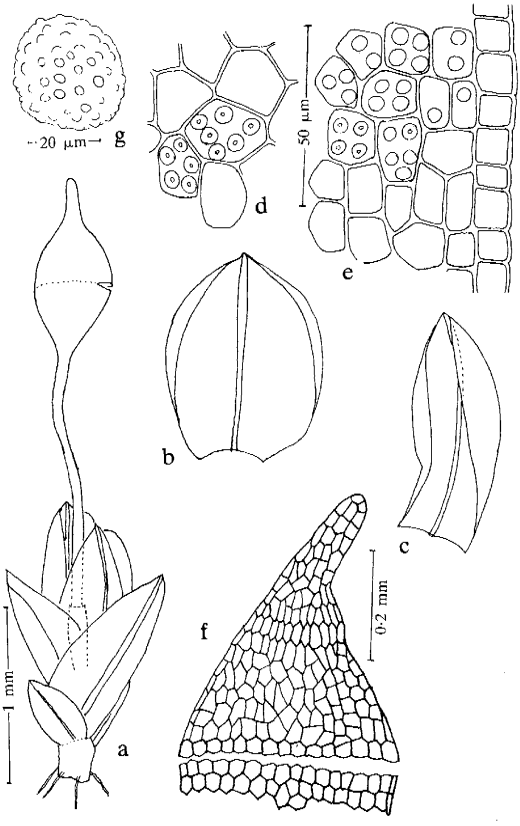


Fig. 55. *Pottia drummondii*

beak, reddish brown when ripe, with no differentiation of any zone of dehiscence; exothecial cells (f) uniform, the capsule opening along its equator between undifferentiated rows of exothecial cells; calyptra oblique, covering nearly the whole capsule. Spores (g) pale, filled with oil globules, 30-35 μm diameter, nearly smooth or with a few small warts (fig. 47b).

var. **obscura** Willis 1954, *Vict. Nat.* **70**:171.

Type: Victoria, Sandy desert, Dimboola Shire on ground, coll. F.M. Reader, 1 Aug. 1897; in Herb. MEL as *"Phascum molle"* C.M. *ined.*

Leaves more acute, costa reaching apex, cells rather obscure, spores larger, 30-40 μm diameter, slightly warted.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., ?Qld) endemic, unless the New Zealand *P.maritima* (R.Brown ter.) Broth. belongs to this species. Fairly common in South Australia (1, 4, 5, 17) on clay pans and salt marshes, both coastal and inland. Fig. 55 more nearly represents var. *obscura* Willis, which seems to be commoner.

PHASCOPSIS Stone 1980, *J.Bryol.* **11**:17-31.

A monotypic genus of cleistocarpous mosses resembling *Phascum* but differing in the large campanulate calyptra, sometimes split on one side, and the presence of about three rows of differentiated cells at the base of the beak of the capsule (fig. 58j).

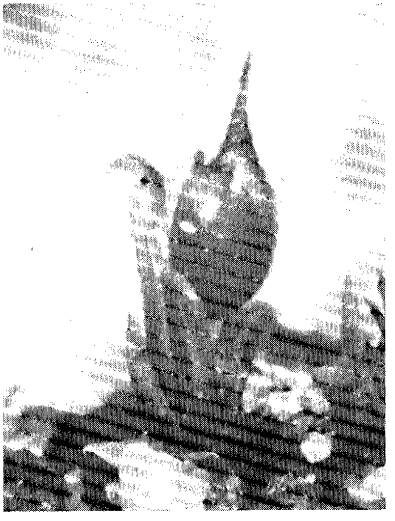


Fig. 56. *Phascopsis rubicunda* (Meningie, S.A.) (Photo A. G. Stone) x c.30.

Phascopsis rubicunda Stone 1980, *J.Bryol.* **11**:17.

Type: Victoria, Dimboola, Pink Lake.

Figs. 56, 57, 58

Small plants in dense patches on saline soil. Deep bronze green, stems (a) to 4 mm tall, sometimes branched. Leaves crowded, erecto-patent when moist, larger upwards, the lower ones oblong to elliptical (b), the upper ones (c) oblong, tapered rapidly to an acute apex, carinate, somewhat twisted when dry; costa brown, very thick, excurrent in a short blunt to acute point (d); margin (d, f) entire, plane, papillose; lower laminal cells (e) lax, hyaline, rectangular or polygonal; middle and upper (f) laminal cells hexagonal, walls firm, papillose.

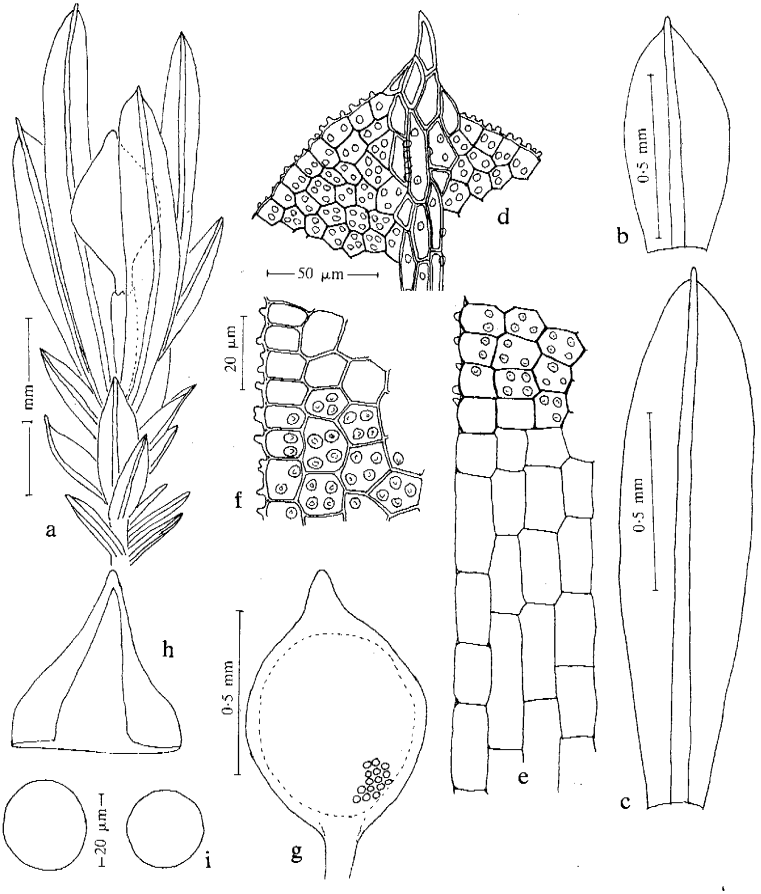


Fig. 57. *Phascopsis rubicunda*

Capsule on a short straight seta, the vaginula crenate on the margin, capsule immersed to emergent, overtopped by long perichaetial leaves, globose with a short to long apiculus; calyptra campanulate, easily split up one side, base crenate; spores smooth, yellow, 20-24 μm diameter.

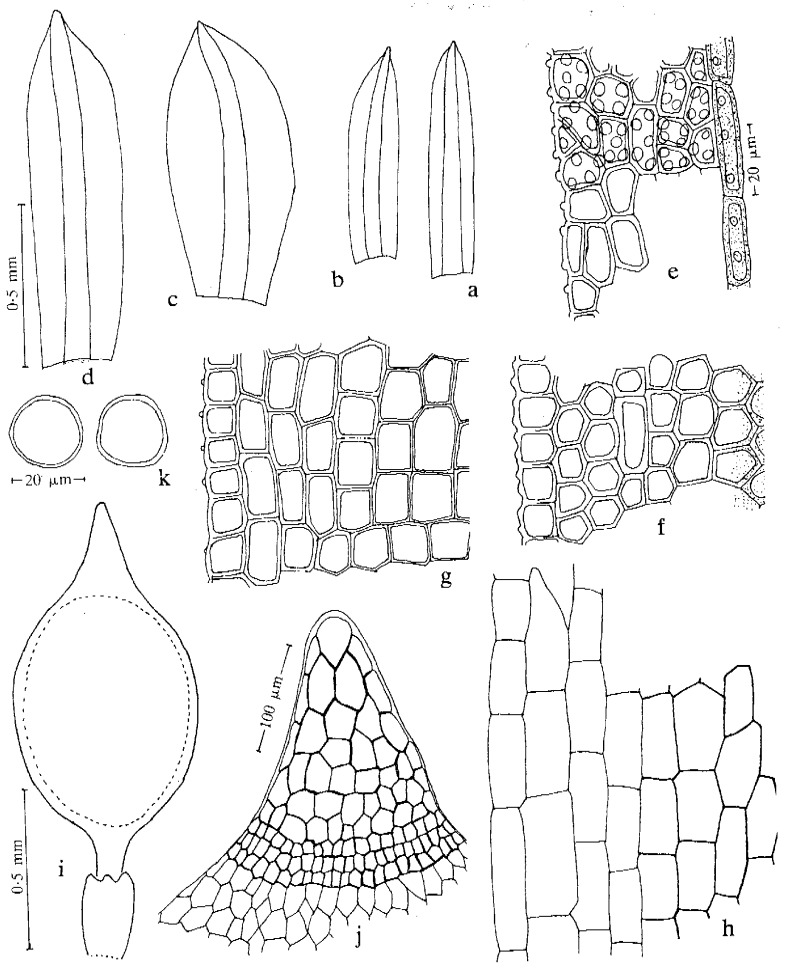


Fig. 58. *Phascopsis rubicunda*

Distribution: Australia (W.A., S.A., Vic.), on salt marshes and the shores of salt lakes (5), apparently rare or overlooked. Endemic. The South Australian plant (fig. 58) differs somewhat from the Victorian one (fig. 57). The leaves (a-c) are narrower, with a thicker costa and narrower lamina, the upper cells (e abaxial, f adaxial view) have thicker walls, as do the cells of the middle lamina (g), but the lower cells (h) are similar, the capsule (i) is broadly ellipsoid, the perichaetial leaves shorter (d), the spores smooth (k). Too few specimens have been seen to judge whether these differences are significant.

PHASCUM Hedw. 1801, *Spec. Musc.* p.19.

Lectotype: *P.cuspidatum* Hedw. cf. Grout 1939, *Moss Fl. N.Amer.* **1**:195.

Small plants; stem without a central strand. Leaves ovate to narrowly lanceolate, acute, entire; costa excurrent, in section with two large median cells, two large ventral cells and a dorsal stereid band; basal laminal cells rectangular, upper cells quadrate, hexagonal or rhomboidal, papillose. Seta short, straight or curved; capsule immersed or emergent, erect or pendulous, cleistocarpous, ovoid or subglobose with a distinct blunt apiculus; upper exothecial cells undifferentiated (fig. 59h); columella present; calyptra cucullate, small.

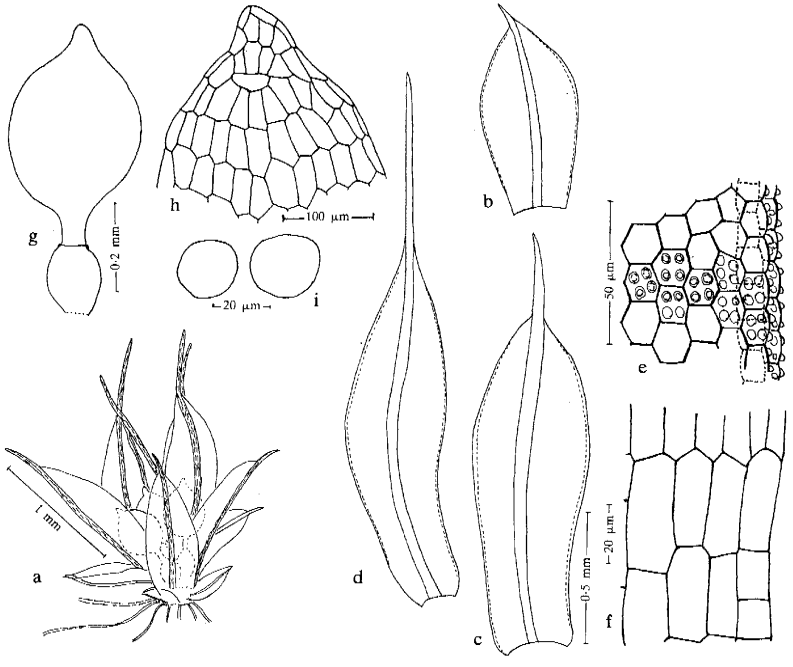


Fig. 59. *Phascum tasmanicum*

Phascum tasmanicum Dixon et Rodway 1923, *Pap. Proc. R.Soc.Tas.* for **1922**:25.

Type: Tasmania.

Plants (a) small, about 2 mm tall, growing on soil. Lower leaves (b) spreading, ovate-elliptical, acute, somewhat conduplicate; costa strong, red, excurrent; upper leaves (c) longer, oblong, tapering to an acute apex, with costa more excurrent in a straight arista, passing into the perichaetial leaves (c); margin recurved except at apex and base. Adaxial cells of costa rectangular, 2 to 5 times as long as wide, narrower and with pointed ends in and towards the arista; abaxial cells of costa elongated , 8-10 times as long as wide. Middle and upper cells of lamina quadrate or hexagonal (e), 12-14 μm across, cell walls firm and yellowish, papillose, papillae conical, usually about four on each surface of a cell, cells a little larger towards the costa; lower cells (f) larger, rectangular or polygonal, smooth, larger towards the costa. Capsules usually several on a plant (a); capsule (g) broadly elliptical, about 0·4 x 0·3 mm, apiculate, brown and shiny when mature; vaginula with an entire margin; spores thin walled, 20-25 μm diameter, pale, smooth.

Distribution: Australia (S.A., Vic., Tas.) endemic. Rare (14, 15). Scott and Stone (1976,p.178) state that the type, examined at the British Museum, appears referable to *Acaulon crassinervium* C.Müll. However, the plant described above is different and may need a new name.

ACAULON C.Müll. 1847, *Bot. Zeit.* 5:99.

Lectotype: *A.muticum* (Hedw.) C.Müll. *cf* Limpr. 1885, *Laubm. Deutschl.* 1:178.

Basionym: *Phascum muticum* Hedw. 1801, *Spec. Musc.* p.23.

Small bulbous ephemeral plants, 1-2 mm tall, growing in patches or scattered among other small mosses on soil. Stem short, without a central strand, bearing a few erect, overlapping leaves, the upper, passing into perichaetial leaves, much larger than the lower. Leaves broad, ovate, concave, pointed; costa usually thin, percurrent or excurrent, costa bearing lamellae in subgenus *Alaticosta;* upper leaves convolute, enclosing the capsule. Seta very short, foot short and thick, vaginula rounded and obovate. Capsule immersed, globular, with a minute obtuse apiculus, cleistocarpous, the exothecial cells near the apex (fig. 64j; fig. 65g) quite undifferentiated; calyptra very small, conical, entire or irregularly torn at the base. Paroecious or dioecious, with minute male plants among the rhizoids of the female plants.

There are two subgenera:

ACAULON: *A.integrifolium, A.triquetrum, A.robustum, A.eremicola, A.crassinervium.*

ALATICOSTA: *A.chrysacanthum, A.leucochaete.*

A.integrifolium and *A.crassinervium* are commonest. The species often grow mixed together or in small adjacent patches.

Key to South Australian species:

1. Leaf margin plane or incurved; leaf as wide as long or wider, cells smooth . 2
   Leaf margin recurved, at least in part; leaf longer than wide, most upper cells papillose 6
2. Leaves with two to three irregular, inconspicuous longitudinal lamellae on adaxial side of costa, leaf apex aristate 3
   Leaves without lamellae; leaf apex mucronate or aristate 4
3. Plants reddish golden, with a golden point to the leaf
   A.chrysacanthum, p.142
   Plants paler, with a longer, flexuous, hyaline point to the leaf
   A.leucochaete, p.144
4. Leaves strongly keeled, the plants appearing triangular from above, usually reddish gold; margin near apex denticulate, with double teeth
   A.triquetrum, p.137
   Leaves rounded on abaxial surface, the plants appearing rounded or oval from above, usually green to light brown; margin near apex entire or with simple teeth 5
5. Upper cells of leaf rhomboid hexagonal, 50-60 μm long by 20-24 μm wide; margin obscurely denticulate above, with a few large teeth
   A.eremicola, p.139
   Upper cells of leaf irregularly hexagonal, isodiametric, 12-15 μm across; margin of leaf entire . . . . . *A.integrifolium*, p.136
6. Plants bulbiform; leaves broad, concave; capsules one on a plant 7
   Plants with patent leaves; leaves oblong, the costa excurrent in a long straight arista . . . . . *Phascum tasmanicum*, p.135
7. Costa excurrent in a long, often hyaline, arista . . . . . *A.robustum*, p.138
   Costa excurrent in a short, often recurved, arista . . . *A.crassinervium*, p.140

Acaulon integrifolium C.Müll. 1855, *Bot. Zeit.* **13**:745.

Type: Victoria, Yarra River, coll. F. v. Mueller.

A.apiculatum (Hook.f.et Wils.) Jaeg. 1869, *Musc. Cleist.* p.20.

Basionym: *Phascum apiculatum* Hook.f.et Wils. 1854, *Fl.Nov.Zel.* **2**:58.

Type: New Zealand.

Fig. 60.

Small, gregarious, bulbiform plants (a, b, c), oval in profile, growing on bare earth in the open, 1-2 mm high, pale green when young, pale brown when old. Leaves (d) closely imbricated, the two uppermost much the largest and enclosing the capsule, broadly ovate-rotund, very concave, acute or shortly acuminate, tips reflexed when moist, margins plane, entire. Costa ceasing below apex to just excurrent in a mucro. Upper cells (e) 12-15 μm across, irregularly shaped from subquadrate to rhomboid, smooth, incrassate; lower cells (f) rectangular, hyaline, thinly walled. Capsule immersed, orange-brown, globose, erect on a very short seta, cleistocarpous. Calyptra (g) very small. Spores 18-38 μm diameter, finely papillose.

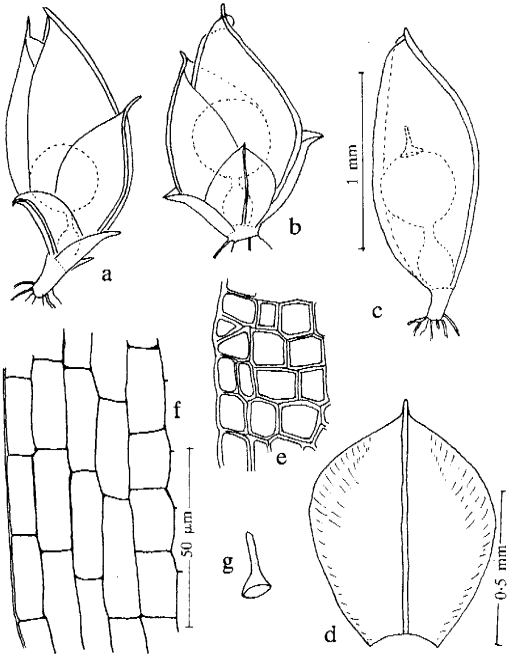


Fig. 60. *Acaulon integrifolium*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., ?Qld), New Zealand.

Relatively common (4, 6, 11), on undisturbed soil near Adelaide.

Acaulon triquetrum (Spruce) C.Müll. 1847, *Bot. Zeit.* **5**:100.

Basionym: *Phascum triquetrum* Spruce 1845, *London J. Bot.*, **4**:189.

Type: Europe, near Strassburg.

Fig. 61.

Plants (a) small, to about 1·5mm tall, green to brownish. Lower leaves (b) oval, concave, the uppermost leaves (c), usually three, larger and strongly keeled so that the plant appears triangular from above; leaves acute, margin plane or narrowly recurved; costa excurrent in a recurved apiculus; upper laminal cells (d) hexagonal to irregularly polygonal, 12-16 µm wide, narrower at the margin where the outer wall is very thick and shows paired blunt teeth opposite to the periclinal walls; lower laminal cells larger, shortly rectangular.

Seta (e) arcuate, thin and fragile; capsule (e) inclined or horizontal, globose, with a small blunt apiculus; spores about 30 μm diameter, finely papillose.

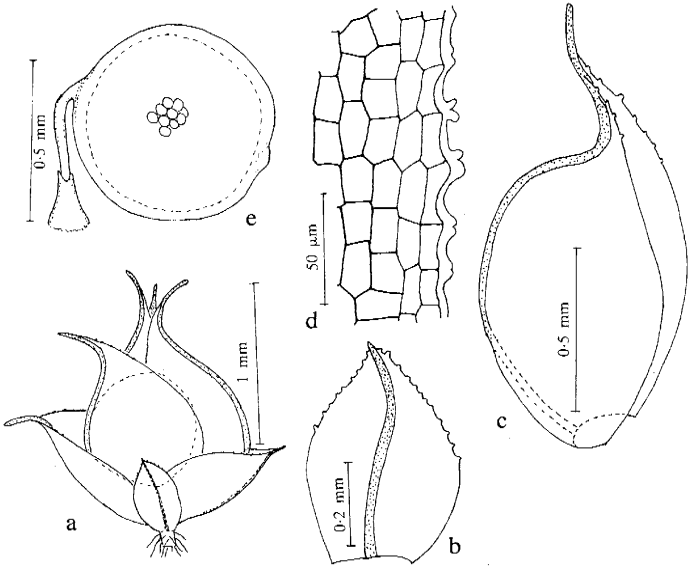


Fig. 61. *Acaulon triquetrum*

Distribution: Europe, N.Africa, N.America, Australia (W.A., S.A., Vic., N.S.W., N.T.). Infrequent in South Australia (4, 15, 17), chiefly in Flinders Ranges and arid zone, usually as scattered plants.

Acaulon robustum Broth. *ex* Roth 1913, *Hedwigia* **53**:94.

Type: Australia.

Fig. 62

Plants (a) relatively large, about 3 mm tall, fairly deep green in colour, often clustered due to branching of the stem. Leaves (b) broadly ovate, acute, somewhat keeled and slightly twisted when dry; perichaetial leaves (c) cucullate; margin recurved from just below apex, usually slightly dentate above; costa strong, excurrent in a straight arista, which may be hyaline; upper cells (d), irregularly hexagonal, 12-16 μm across, walls firm, smooth or somewhat papillose. Capsule when ripe sometimes exposed by spreading of leaves; calyptra small, conical, split at base; spores 25-30 μm diameter.

Distribution: Australia (S.A., Vic., N.S.W., N.T.) endemic. Rare (4, 12, 14, 15).

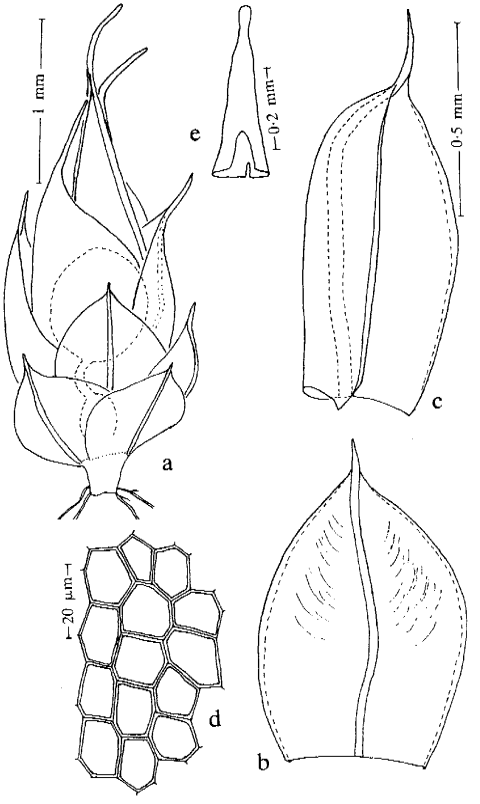


Fig. 62. *Acaulon robustum*

Acaulon eremicola Stone 1979, *J.Bryol.* **10**:467-74.

Type: Northern Territory, Mount Olga Gorge near waterhole. I.G. Stone 5134, 13.vi.1977.

Figs. 47d, 63

Plants relatively large, 2-3 mm tall, soft, pale brown. Leaves ovate elliptical, acute to acuminate, somewhat keeled when dry; perichaetial leaves larger, conduplicate; costa running into the acuminate apex, which often droops, and excurrent; laminal cells (a) very long, rhomboid-hexagonal above and incrassate, tending to irregularly rectangular below (b) with thinner walls; upper lamina cells 50-60 µm long, or even 70 µm or more in the perichaetial leaves, by

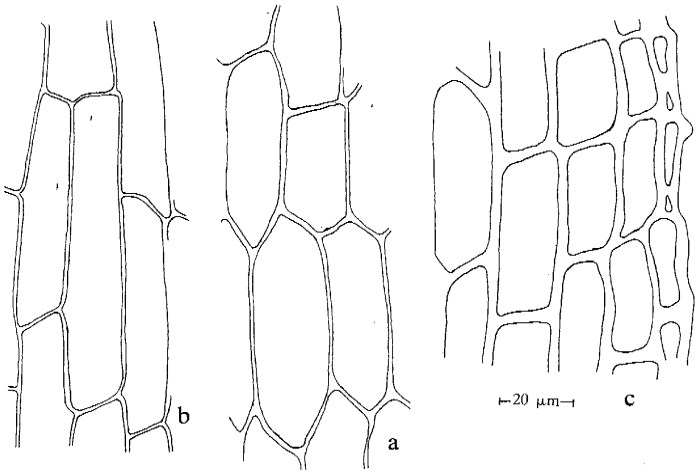


Fig. 63. *Acaulon eremicola*

20-24 μm wide; margin (c) obscurely denticulate above, with an occasional large tooth on the perichaetial leaves. Spores 28-40 μm diameter (fig. 47d).

Distribution: Australia (S.A., N.T.) endemic. Rare, only known from desert mountains (21).

Acaulon crassinervium C.Müll. 1902, *Hedwigia* **41**:119.

Type: Australia, New South Wales.

Fig. 64

Plants (a) small, to 2 mm high, dark green when young, reddish brown when mature. Leaves (b, c) ovate-lanceolate, longer than wide, acute to acuminate; margin more or less entire, recurved (c) from apex more than half way down leaf; costa strong, reddish brown, sometimes papillose adaxially, excurrent in an arista that is often recurved and sometimes hyaline at the tip; perichaetial leaves (d) similar, larger, somewhat conduplicate; upper and marginal cells of lamina irregularly hexagonal, 12-18 μm across, papillose on one or both surfaces; lower cells more or less oblong, larger, smooth. Upper marginal (h) and inner (g) cells of perichaetial leaves larger. Capsule exposed at maturity, subglobose (i) with a small blunt apiculus; calyptra (k) small, campanulate; spores 35-40 μm diameter.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., ?Qld) endemic. Rather uncommon (11, 14).

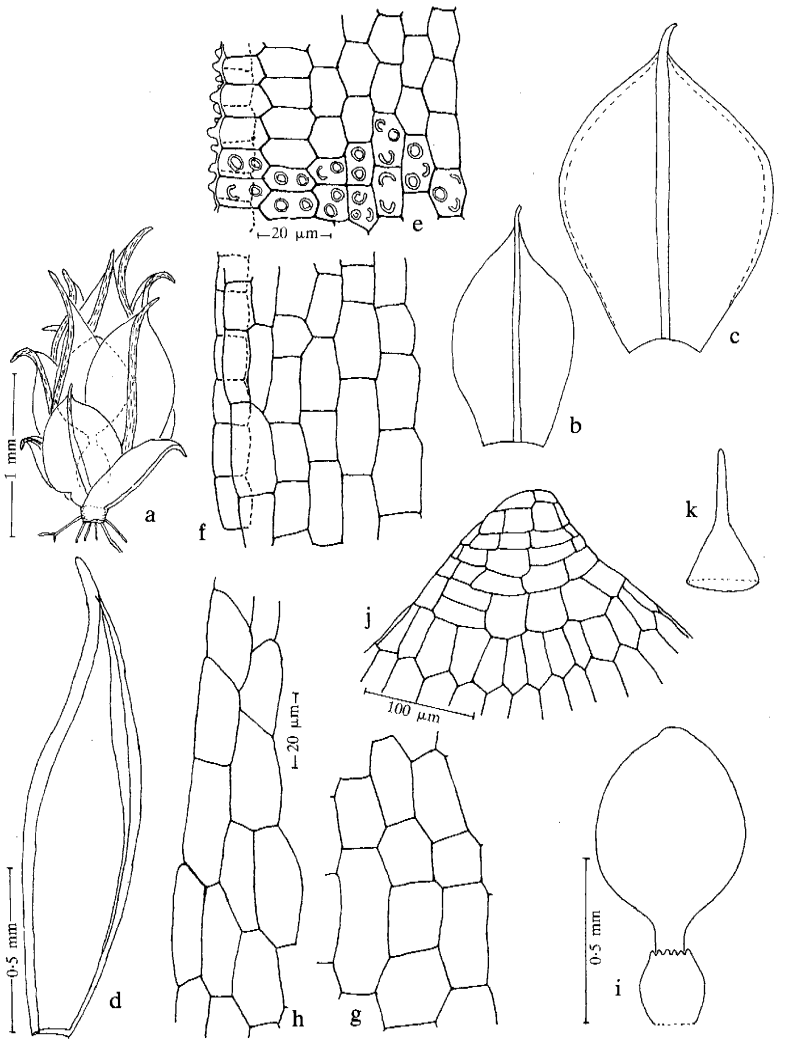


Fig. 64. *Acaulon crassinervium*

Subgenus ALATICOSTA Stone 1976, *J.Bryol.* **9**:213.

Costa bearing two, rarely three, lamellae on the middle to upper parts of the adaxial side; in cross section with one large group of stereid cells abaxially, usually a small central group of thinly walled cells which collapse (Begleiteren or companion cells) and two large chlorophyllose cells adaxially; the lamellae extend from the two adaxial cells and are 2-9 cells high, the crest often uneven.

Acaulon chrysacanthum Stone 1976, *J.Bryol.* **9**:213.

Type: Victoria, Murray Valley Highway, near Boundary Bend, on bare red sandy soil in mallee scrub. I.G. Stone 1385, 15 June 1969, in herb. MEL.

Fig. 65

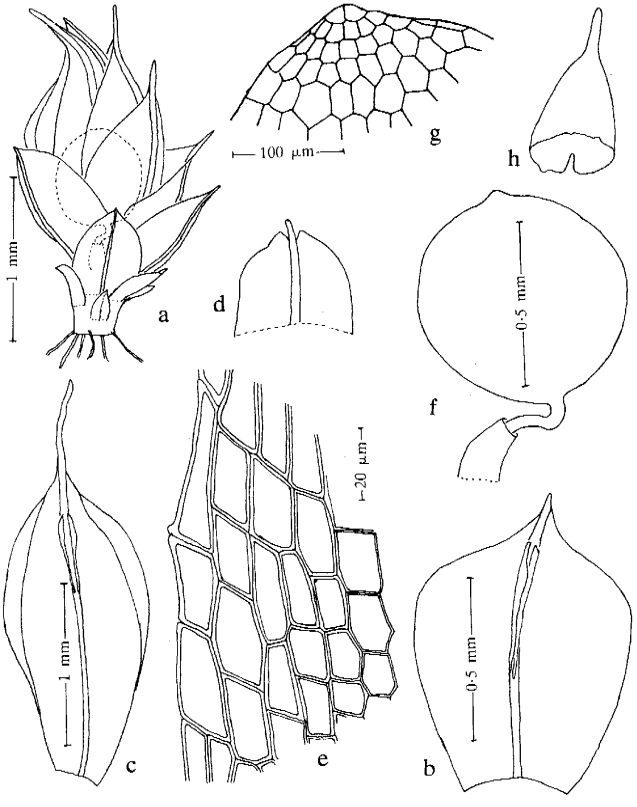


Fig. 65. *Acaulon chrysacanthum*

Plants (a) to about 2 mm tall, shining reddish gold, bulbiform. Leaves (b) 9 to 12 in number, incurved, broadly ovate to oblong-ovate, as wide as or wider than long, deeply concave, acute, sometimes emarginate the inner and perichaetial (c) to 1·5 mm or more long, convolute, the lowermost very small; margin entire below, plane or sometimes slightly incurved, towards the apex (e) entire or irregular crenate or denticulate; costa reddish gold, excurrent in the upper

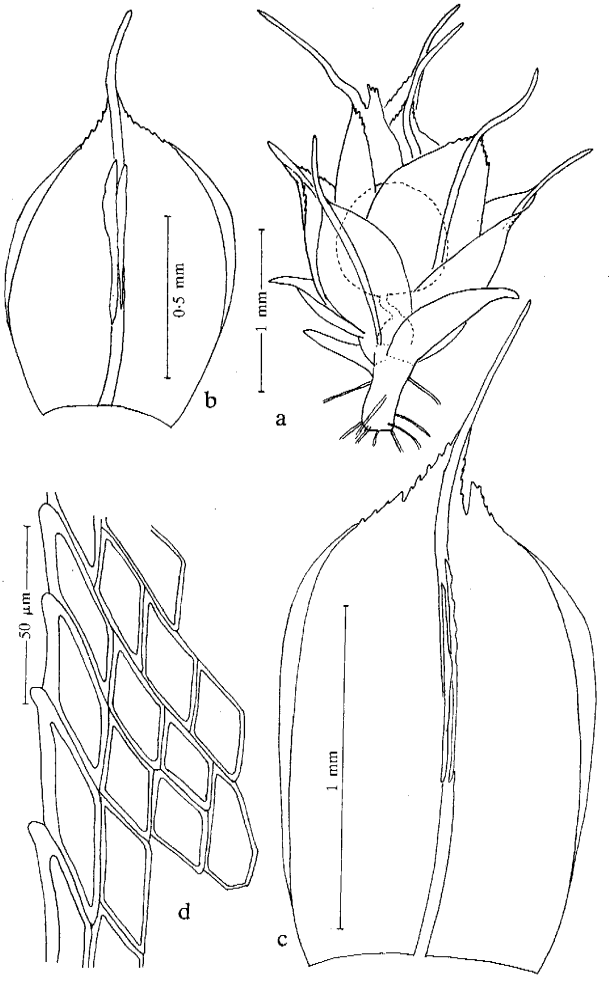


Fig. 66. *Acaulon leucochaete*

leaves as a strong, generally straight, arista, smooth or slightly rough. Lamellae two, sometimes a third sprouting from one of them, arising in the median to upper part of the costa from two rows of green cells on its adaxial side. Laminal cells (e) smooth, the upper and middle rhombic to shortly rectangular, the walls thin to rather thick; basal cells hyaline, oblong-hexagonal to rectangular, walls thin. Capsule shining reddish gold, globose, 0·6-0·8 mm diameter, with a minute apiculus; seta bent; spores brown, 30-35 μm diameter, papillose, operculum (h) conical. Paroecious; antheridia in the axils of leaves below the two inner perichaetial leaves.

Distribution: Australia (S.A., Vic., N.S.W.) endemic. Rare (17) on soil in mallee scrub.

Acaulon leucochaete Stone 1976, *J.Bryol.* **9**:217.

Type: Victoria, Boundary Bend, I.G. Stone 1548B, 19 July 1969, in herb. MEL.

Fig. 66

Similar to *A.chrysacanthum* but paler and often less glossy, somewhat smaller (a). Leaves (b) broadly ovate, concave; costa excurrent as a long hyaline flexuous hair narrower, longer and rougher, reaching a half the length of the lamina of the perichaetial leaves (c), a few teeth on the abaxial side. Upper margin of the leaf irregularly dentate (c), the apical cells often hyaline and very thickly walled. Margin of middle to upper part of leaf (d) denticulate, the laminal cells rhomboid. Capsule less shiny, smaller, about 0·6 mm diameter; spores dull yellow, 23-25(-30) μm diameter, papillae much smaller, so the spores appear nearly smooth.

Distribution: Australia (W.A., S.A., Vic., N.S.W.) endemic. On soil in mallee scrub, apparently commoner (14, 15, 17) than *A.chrysacanthum.*

CALYPTOPOGON (Mitt.) Broth. 1902, *Nat. Pfl.* **1**(3):419.

Streptopogon section *Calyptopogon* Mitt. 1879, *Phil. Trans. R. Soc. London* **168**:33.

A monotypic genus with the characters of the species.

Calyptopogon mnioides (Schwaegr.) Broth. 1902, *Nat. Pfl.* **1**(3):419.

Basionym: *Barbula mnioides* Schwaegr. 1842, *Spec. Musc.* Suppl.**4**:plate 310B.

Type: South America, Andes Quitenses, coll. Jameson.

Fig. 67, 68

Plants fairly robust, in tufts on the bark of trees or on twigs and small branches. Stems 1-4 cm tall, yellowish green, darker brown and tomentose below. Leaves (a) 3-4 mm long, laxly imbricate, erecto-patent when moist, twisted and crisped when dry, oblong-lanceolate, shortly acuminate, concave and keeled above, margins undulate, plane and entire; costa strong, prominent abaxially, excurrent in a cuspidate point, sometimes serrulate at the apex. Upper laminal cells (b) small, about 10 μm diameter, isodiametric, irregularly

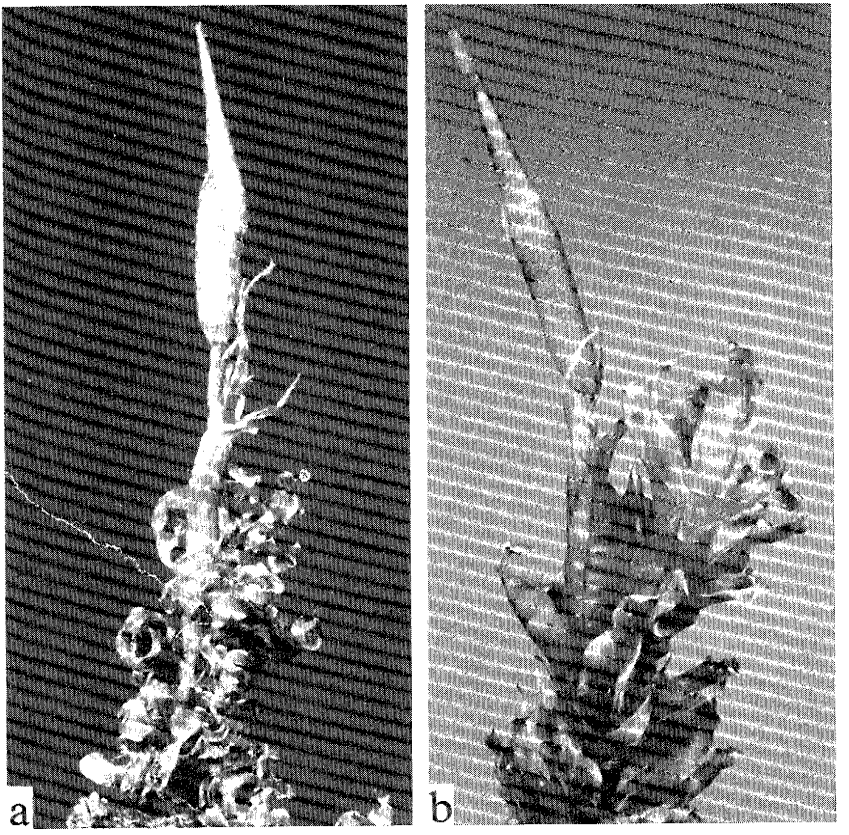


Fig. 67. *Calyptopogon mnioides* (a) dry, (b) moist (Photo A. G. Stone) x12.

polygonal, rounded at angles, somewhat incrassate, papillose, changing abruptly to linear or rectangular, hyaline, thinly walled cells at the base (c); marginal cells in lower part of leaf (d) forming a hyaline or yellow border of elongated, incrassate cells, passing upward (e) into narrower, intramarginal cells, with a row of small quadrate cells outside. Upper adaxial side of costa bearing multicellular gemmae (f). Perichaetial leaves very long and sheathing, often exceeding the fruit, finely tapered, not bordered and with much larger cells; seta short, 3-4 mm long, erect. Capsule erect, oblong cylindrical, 2-2·5 mm long, yellowish, mouth red, turning brown later. Peristome reddish or brown, a basal cylinder bearing 32 filaments twisted to the left, filaments densely

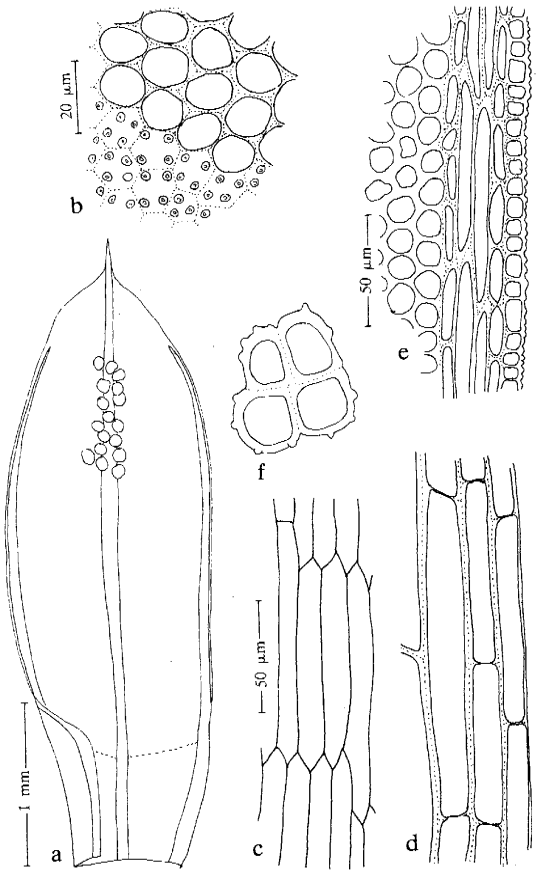


Fig. 68. *Calyptopogon mnioides*

papillose and striolate transversely. Operculum long, narrowly conical, erect, as long as capsule. Calyptra long, mitriform, deeply lobed at the base. Spores 16-32 µm diameter.

Distribution: S.America, Australia (S.A., Tas., Vic., N.S.W.), New Zealand. Rare in South Australia (6), on *Exocarpus* in Mt Lofty Ranges.

DESMATODON Bridel 1819, *Mant. Musc.* p.86.

Lectotype: *D.latifolius* (Hedw.) Brid. *cf* Venturi 1868, *Comm. F.Fl.Gea Venezia* **1**(3):123.

Small plants growing in mats or turfs. Leaves incurved or contorted when dry, oblong-lanceolate or subspathulate, broadly acute to obtuse, entire. Costa

excurrent, sometimes as an arista, or ceasing below the apex, more or less widened and swollen above, but not bearing distinct appendages, though the cells project individually (fig. 70d) to give a granular appearance on the adaxial surface; in section with an abaxial group of stereid cells. Upper cells of leaf small, papillose; basal cells larger, elongated, smooth. Perichaetial leaves scarcely different from vegetative leaves. Seta elongate. Capsule erect and symmetrical, oblong or cylindrical. Operculum beaked. Peristome of 16 short teeth, each divided nearly to the base to make 32 segments which are erect or oblique, straight or slightly twisted. Calyptra cucullate.

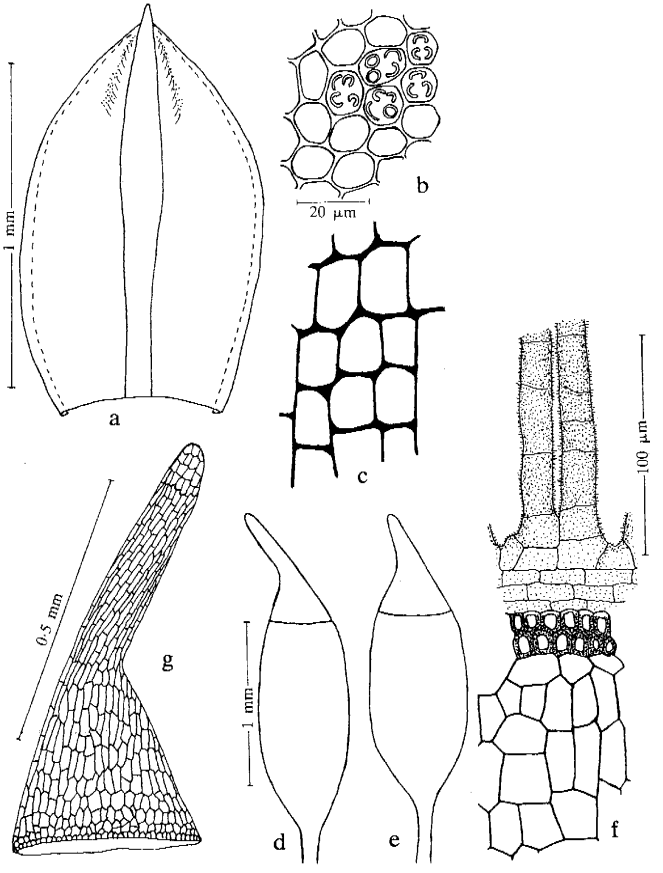


Fig. 69. *Desmatodon convolutus*

Key to South Australian species:

1. Leaves short (reaching 1·2 mm) and broad, about 1·5 times as long as wide; capsule with thinly walled exothecial cells, those of the operculum in straight longitudinal rows; no annulus ..... *D.convolutus*, p.148

   Leaves longer (reaching 3 mm) and narrow, about 2·5 to 4 times as long as wide; capsule with thickly walled exothecial cells, those of the operculum in spiral rows; a persistent annulus of small cells present *D.recurvatus*, p.148

Desmatodon convolutus (Brid.) Grout 1939, *Moss Fl. N. Amer.* **1**:224.

Basionym: *Trichostomum convolutum* Brid. 1806, *Spec. Musc.* **1**:232.

Type: Europe. Fig. 69

Densely gregarious on clay soils or on calcareous rocks and soils, yellow green to green. Stems 2 mm tall, simple or branched. Leaves (a) 0·8-1·2 x 0·7-0·8 mm, imbricate and more or less twisted when dry, spreading when moist, densely crowded, broadly oblong to oval-oblong or subspathulate, concave, subacute or sometimes more tapered; margins revolute usually throughout, entire. Costa strong, much thicker and a little wider in the upper part of the leaf and usually granular in this upper part from protruding, papillose cells, excurrent in a mucro. Upper laminal cells (b) subquadrate or polygonal, rounded at the angles, obscure with dense minute papillae; lower cells (c) more elongate, rectangular, hyaline, the corners thickened, the marginal cells shorter and narrower. Seta 0·5 to 1 cm long, reddish but often yellow above; capsule (d, e) 1-1·5 mm long, narrowly oblong to elliptical, brown; walls of exothecial cells (f) thin except for about two rows at the mouth of the theca, surface smooth, cells clear; no annulus; peristome teeth (f) short, 0·4 mm long, inserted on a short basal membrane, brown or reddish, papillose, oblique or slightly twisted, especially when moist; operculum (d, e) with an oblique beak about half the length of the theca, composed (g) of thinly walled cells disposed in nearly straight longitudinal rows; spores 16-20 μm diameter, very finely papillate. Autoecious.

Distribution: Northern Hemisphere, Australia (W.A., S.A., Vic., N.S.W., A.C.T., N.T.), New Zealand, South Africa, Chile. Very common in South Australia, on soil and rocks, especially in arid and semi-arid areas (1, 4-6, 14, 15, 17, 18, 21). Somewhat variable, especially with diminutive plants with a short operculum that may be specifically distinct.

Desmatodon recurvatus (Hook.) Mitt. *in* F. v. Mueller 1881, *Fragm. Phyt. Austr. Suppl.* **11**:114.

Basionym: *Tortula recurvata* Hook. 1819, *Musci Exot.* **2**:plate 130.

Type: South Africa, Cape of Good Hope.

Desmatodon reflexidens (Hamp.) Jaeg. 1873, *Ber.S.Gall.Naturw.Ges. 1871-2*:403.

Basionym: *Trichostomum reflexidens* Hamp. 1860, *Linnaea* **30**:625.

Type: Victoria.

Fig. 70; Plate 6A

Similar to *D.convolutus*, but generally larger and darker green; stems to 3 mm tall. Leaves (a, b) longer and somewhat narrower, 1·5-3 × 0·6-0·7 mm, oblong to oblong lanceolate, acute to acuminate, less concave, margin (e) revolute

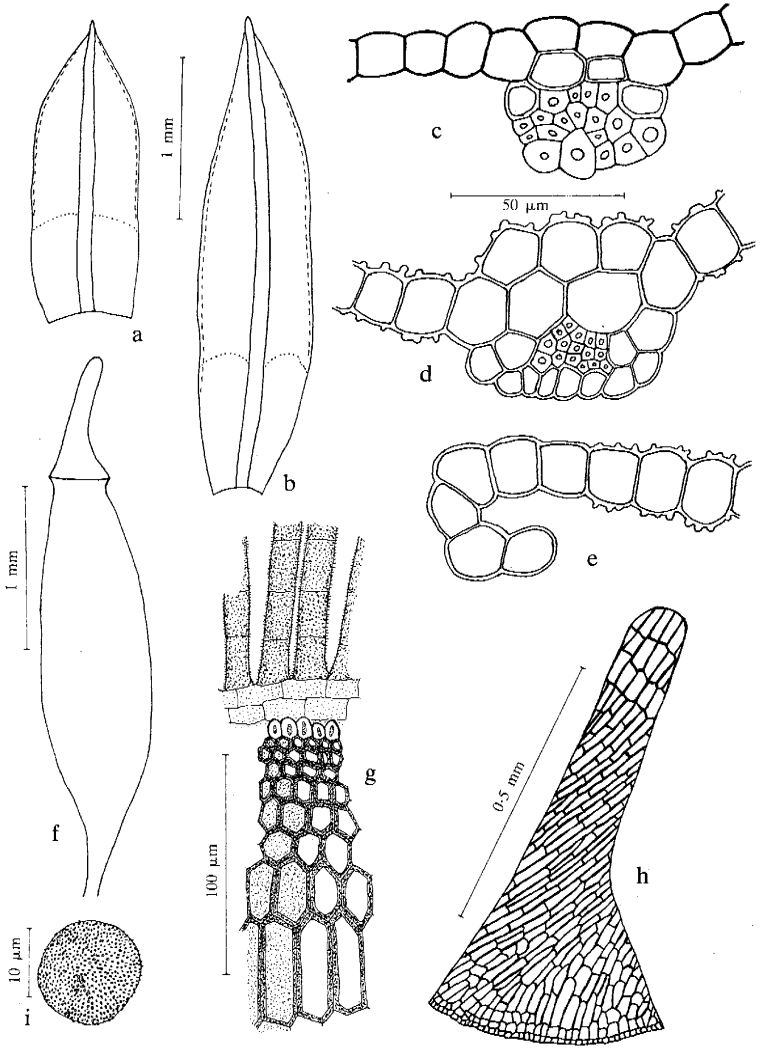


Fig. 70. *Desmatodon recurvatus*

above; costa rather narrower and less swollen and granular in the upper part (d), excurrent in a mucro, papillose above (d), smooth below (c); laminal cells similar, those in 4-6 rows near the margin not papillose. Seta taller, brown, 1-2 cm; capsule (f) longer, 1·7-2·4 mm long, dark brown; walls of exothecial cells (g) very thick, the surface often minutely punctulate; annulus present (g), persistent; operculum relatively shorter, about one third of the length of the capsule (f), composed of thickly walled cells (h), disposed spirally; spores 13-16 μm, very finely papillose.

Distribution: South Africa, Australia (S.A., Vic.). Uncommon in South Australia (1, 6, 8, 11, 12) on soil on banks in moister habitats, e.g. gorges, than those occupied by *D.convolutus*. This species has commonly been regarded as synonymous with *D.convolutus*. However, the plants are quite distinct and have different distributions and ecological preferences.

CROSSIDIUM Jur. 1882, *Laubmossfl. Oest. Ungarn.* p.127 *nom. cons.*

Type species: *C.squamigerum* (Vic.) Jur.

Calciphilous plants growing in dense greyish green or olive turfs. Stem in cross section differentiated into a central strand of small cells with thin walls and a cortex of large cells. Leaves obovate-lingulate to ovate or deltoid, deeply concave above; the apex usually piliferous or mucronate, rounded obtuse; margin revolute entire. Upper and median cells hexagonal to quadrate, walls thin or thick, papillose or not; basal cells rectangular to quadrate, walls thin, smooth. Costa excurrent as a whitish hair in most species, but in others ceasing below the apex; in cross section with a group of thinly walled cells between the abaxial stereids and the adaxial row of guide cells, of which there are two to several in one layer, thinly walled, but thicker with age. Photosynthetic filaments borne on upper part of costa; filaments branched, 1 to 12 cells tall, cell walls thin, quadrate to subspherical, the apical one distinct and usually with mamillate projections. Dioecious or autoecious. Perichaetial leaves scarcely differentiated, but wider and longer than vegetative leaves. Perigonium bud-like, the leaves progressively reduced. Seta long; capsule erect, cylindrical; operculum conical to rostrate; peristome of 32 finely papillose teeth on a short basal membrane.

Monograph: C. Delgadillo M. 1975.

Key to South Australian species:

1. Leaves with a short to long hair point, formed by the excurrent costa; upper laminal cells smooth or nearly so; apical cell of filament short ..... *C.geheebii*, p.150

   Costa not excurrent, leaves blunt to cucullate; upper laminal cells densely papillose; apical cell of filament large ..... *C.davidai*, p.152

Crossidium geheebii (Broth.) Broth. 1902, *Nat. Pfl.* **1**(3):426.

Basionym: *Tortula geheebii* Broth. 1900, *Oefv. Finsk. Vet. Soc.Foerh.* **42**:98.

Type: New Zealand, coll. Reader, in Herb. MEL under no. 7.

Fig. 71

Plants somewhat hoary; leaves (a, b) widely ovate to ovate-oblong, obtuse, concave, margins reflexed, entire; costa wide, in section with 3-4 layers of stereid cells, excurrent in a long, to 0·3 mm, hyaline, smooth arista; filaments (c, d) 4-9 cells tall, the apical cell rather squat, with 1-4 mamillae; upper laminal cells rounded hexagonal (e), subquadrate at the margin (f), to about 15 μm diameter, pellucid and smooth, rarely with a few small papillae; the lower laminal cells (g) longer, shortly rectangular. Dioecious or autoecious; seta 0·5-1 cm long; capsule (h) about 1-2 mm long, erect, narrowly elliptical, peristome twisted spirally to the left, annulus of 2-3 rows of small cells; operculum conical-rostrate, slightly bent, about ⅔ length of theca; spores small, 12-15 μm, very finely papillose.

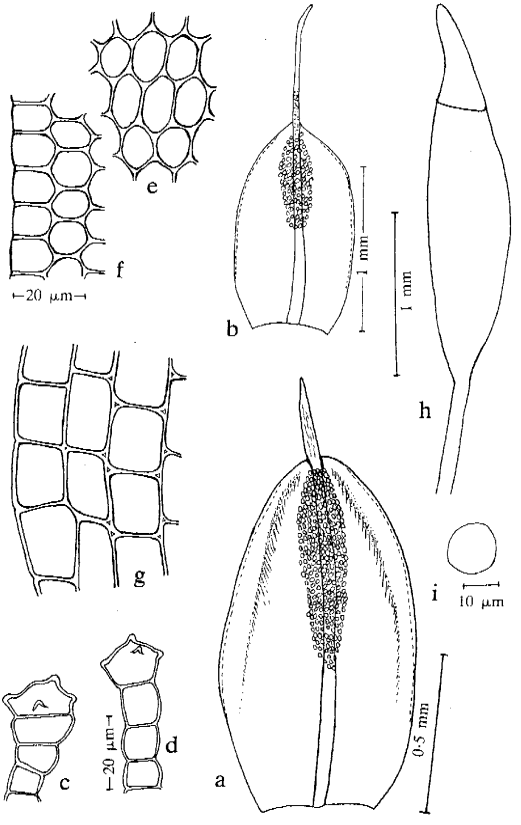


Fig. 71. *Crossidium geheebii*

Distribution: Australia (W.A., S.A., Vic., N.S.W., N.T.), New Zealand. Fairly common in South Australia (5, 15, 17-19), often mixed with other small earth mosses such as *Desmatodon convolutus,* in arid and semi-arid areas.

Crossidium davidai Catcheside sp.nov.

Species *C.rosei* Williams similis folio sine arista, sed folia lingulato-obovata concava apice obtuso cucullatoque, costa sub apice evanida; cellulae supernae parietibus tenuibus papillosis; fila costata cellula globosa papillosa terminans; peristomium valde productum.

Named for my son, collector of the type, who signs himself "David A".

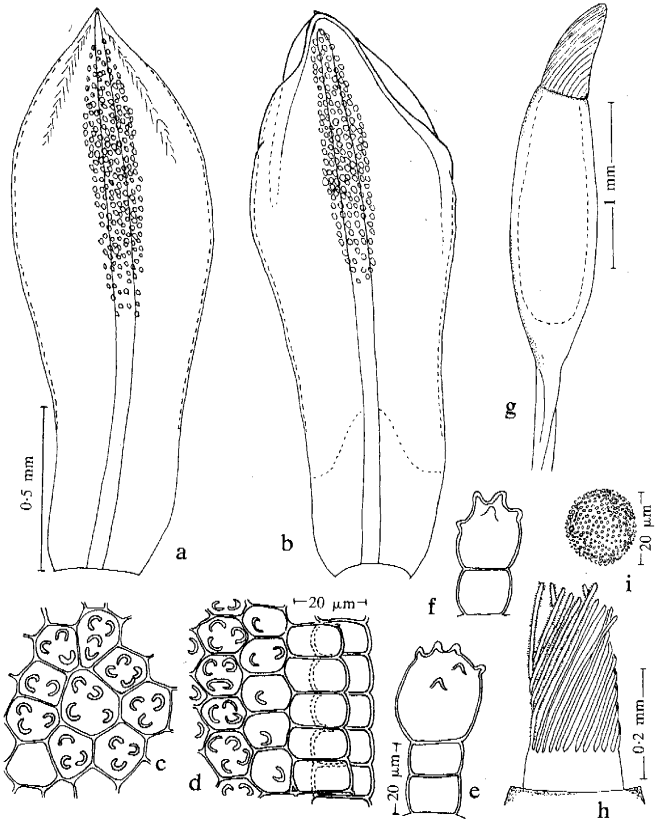


Fig. 72. *Crossidium davidai*

Type: South Australia, Gairdner division, 95 km south of Woomera by Port Augusta Road, on soil in scrub, coll. D.E.A. Catcheside, Sept. 1971. In Herb. D.G. Catcheside.

Fig. 72; Plate 7C

Plants green when moist, deep olive-brown when dry. Leaves (a, b) lingulate-obovate, to 1·5-1·9 mm long by 0·5-0·65mm wide, widest above the middle, concave above, with the apex blunt and cucullate or with a small mucro; margin entire, narrowly recurved from apex to near the base; base not sheathing nor decurrent; upper laminal cells (c) with fairly thin walls, hexagonal or polygonal, 12-16 μm diameter, each with several crescentic papillae on both sides, the cells in two marginal rows (d) smooth and transversely rectangular; lower laminal cells much larger, smooth, rectangular, short and narrow near the margin; costa ceasing in or just below apex; filaments (e, f) 1 to 4 cells high, the cells 9-12 μm long, the terminal cell longer almost globose or ovoid, 20-25 μm diameter, with 4 to 6 mamillae. Seta 5-8 mm long, pale brown; capsule (g) reddish brown, slenderly ellipsoid, 2-2.3 mm long, nearly 0·5 mm wide; operculum conical, slightly bent, blunt; peristome (h) about 400 μm high, with a basal membrane about 80 μm high, bearing 32 teeth, twisted to the right and covered with fine acute papillae; spores (i) 18-22 μm diameter, minutely papillose.

Distribution: Australia (S.A.) endemic. Widely distributed in the interior of South Australia (14, 16, 18, 19, 21). Readily confused with *Desmatodon convolutus*.

ALOINA Kindberg 1882, *Bih. K. Svensk. Vet. Ak. Handl.* **6**(19):22 *nom. cons.*

Barbula sect. *Aloina* C.Mu¨ll. 1849 *Syn.* **1**:596 *nom.illeg.*

Lectotype: *A.aloides* (Schultz.)Kindb.

In dense, greyish green to bronze green turfs on calcareous soil. Stem short, usually unbranched, in cross section with no central strand or only a poorly formed one, inner cells small with thin walls. Leaves with an auriculate sheathing base, fleshy, concave, with broadly incurved margins and a blunt cucullate or open apex. Costa very wide and flat, sometimes forming a cusp and, in some species in the upper leaves, excurrent as a hyaline arista; the adaxial surface and adjoining cells of the lamina covered with multicellular, usually branched, chlorophyllous filaments; filaments of 3-9 nearly spherical cells, the terminal one spherical to conical and thickened apically; in cross section usually with several rows of stereid cells abaxially covered by one or more layers of large cells, usually with thin walls and extending laterally to the lamina, which is partly two-layered. Upper and median laminal cells subquadrate, usually wider transversely, with thick walls; lower cells thinly walled, pellucid, rectangular and elongated. Seta long, usually twisted to the left below and to the right above; capsule erect, cylindrical or ovoid oblong; peristome teeth 32, borne on a basal cylinder, papillose, spirally twisted to the left; operculum narrowly conical, about a third of the length of the capsule; calyptra cucullate, smooth.

Monograph: C.Delgadillo M. 1975.

Key to South Australian species:

1. Leaves acute, with a long hyaline arista, often flexuous towards the tip *A.sullivaniana,* p.155
   Leaves obtuse, without an arista 2
2. Leaf base with a differentiated margin of about two rows of hyaline, elongated, thinly walled cells* . . . . . *A.rigida,* p.157
   Leaf base with marginal cells shortly rectangular not hyaline, nearly as large as adjacent cells and with firm walls . . . . . *A.ambigua,* p.155

Note* Care must be taken to examine an intact leaf without the delicate hyaline cells having been eroded or torn away.

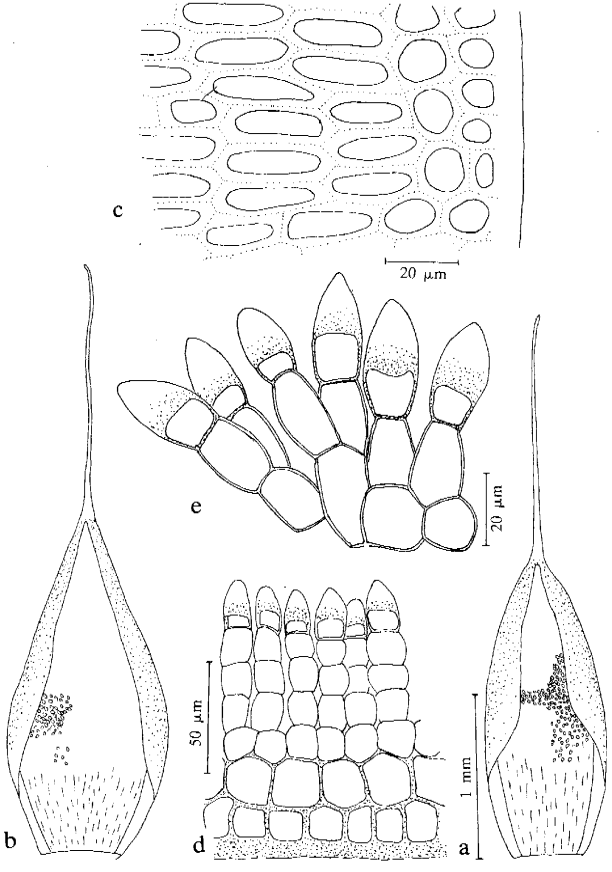


Fig. 73. *Aloina sullivaniana*

Aloina sullivaniana (C.Müll.) Broth. 1902, *Nat. Pfl.* **1***(3)*:428.

Basionym: *Barbula sullivaniana* C.Müll. 1898, *Hedwigia* **37**:130.

Type: Australia, Victoria, Moyston, coll. Sullivan no. 535.

Fig. 73

Leaves (a, b) about 2 mm long, imbricated and incurved when dry, long, spreading when moist, widely elliptical with a short sheathing base, apex cucullate and subacute; leaf abruptly narrowed above sheathing base and then broadening above; costa excurrent as a cusp in lower leaves, excurrent as a long, smooth hyaline arista in upper leaves, costa very broad throughout, apparently without stereid cells (d), of large rectangular cells below, abaxial cells above subquadrate to transversely elongated; upper lamina cells (c) about 15 μm across, very incrassate, narrowly transversely elliptical, but nearly quadrate towards the margin; lower cells larger, subquadrate, pellucid, with thinner walls, sometimes thickened at the angles; lower marginal cells somewhat elongated transversely; terminal cell of photosynthetic filaments (e) conical, very thickened and coloured. Seta long, to 1·4 cm, flexuous; capsule long, 3-3·5 mm, erect, cylindrical, widened at base, brown; operculum narrowly conical, suberect, about a third of the length of the capsule.

Distribution: Australia (W.A., S.A., Vic., N.S.W.), New Zealand. Fairly common (5, 14) in arid and semi-arid regions on soil, often with *Crossidium geheebii* which is resembles. This differs in the shorter capsule and the leaf which has a reflexed margin, a clearly defined costa and cells which are pellucid.

Delgadillo (1973) regards *A.sullivaniana* as merely a robust form of *A. bifrons* (De Not) Delgadillo, which he also records from the Mediterranean region, N.America and S.Africa.

Aloina ambigua (B.S.G.) Limpr. 1888, *Laubm. Deutschl.* **1**:638.

Basionym: *Barbula ambigua* B.S.G. 1842, *Bryol. Eur.* **2**:76.

Type: Europe.

Fig. 74

Leaves (a, b) lingulate, 1-3 × 0·3-0·7 mm, incurved and cucullate at the apex and usually appearing obtuse, but is slighty pointed when flattened out, spreading, slightly curled when dry; margin entire; upper cells quadrate or rectangular and transversely elongated, thickly walled with rounded corners; basal cells (c) rectangular, marginal hardly different, a little smaller, walls firm; costa ceasing at or below apex; filaments short, 3-6 cells high, branched, terminal cell nearly spherical to elongately ovoid. Dioecious. Seta red, paler above, 6-12 mm long; capsule erect, elongate-cylindrical, dark brown; operculum elongate; annulus narrow, persistent; calyptra hardly covering more than the operculum; peristome teeth only moderately twisted when dry, borne separately on a distinct basal membrane projecting above the mouth of the theca (d); spores 14-16 μm.

Distribution: Europe, N.Africa, N.America, Australia (S.A., Vic.).

Fairly common in S.Australia (1, 2, 6, 8) on calcareous soil at roadsides and on the banks of cuttings. Probably an introduced species, in view of its occurrence on disturbed soils. *A. aloides* (Schultz) Kindb., a species of Europe and N.Africa, to which *A.ambigua* is closely related, may occur. It differs in having a peristome with a very short, scarcely evident, basal membrane, with the peristome teeth paired at their bases and strongly twisted when dry and in the larger spores, 18-22 μm. They are often treated as varieties of the one species, *A.aloides*.

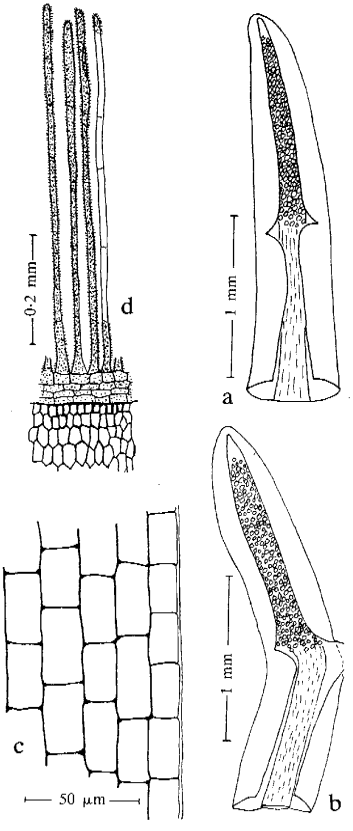


Fig. 74. *Aloina ambigua*

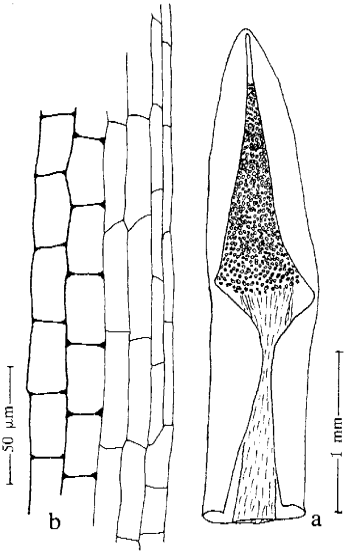


Fig. 75. *Aloina rigida*

Aloina rigida (Hedw.) Limpr. 1888, *Laubm. Deutschl.* **1**:637.

Basionym: *Barbula rigida* Hedw. 1801, *Spec. Musc.* p.115.

Type: Europe.

Fig. 75

Leaves (a) lingulate, lower ones 0·5 × 0·3 mm, upper ones to 2·5 × 0·8 mm, apex cucullate, margin entire or irregularly denticulate above; blade as long as or longer than the sheathing base; sheathing base (b) with a marginal zone of long, hyaline, thinly walled cells, the inner cells rectangular with firmer walls; upper cells of lamina transversely elongated, with thick walls and the angles rounded; costa ending at or below the apex; filaments branched, 3-9 cells high, the terminal cell conical to nearly spherical. Dioecious; seta red, twisted to right above and slightly to left below, 6-15 mm; capsule red, ovoid-cylindrical or more or less elliptical; annulus large, revoluble, in 1-3 rows; peristome long strongly twisted, yellowish, with the basal membrane showing above the mouth of the theca; operculum conical to subulate, rostrate, erect or inclined; spores finely papillose, 12-20 μm diameter; calyptra long, covering capsule to well below operculum.

Distribution: Europe, Asia, N.and S.America, Australia (S.A.).
In South Australia (5) occasional on calcareous soil, in dry disturbed habitats, such as road sides. Probably introduced.

PTERYGONEURUM Jur. 1882, *Laubm. Oest. Ungarn.* p.95 *nom.cons.*

Lectotype: *P.cavifolium* Jur. = *P.ovatum* (Hedw.) Dix.

Autoecious. Leaves concave, ovate or obovate, margin plane or narrowly recurved; costa somewhat wider above, bearing 2-4 chlorophyllose lamellae on the adaxial side of the upper half, often excurrent as a hyaline arista; cells rhomboidal, papillose above. Seta short or long, straight; capsule more or less erect, symmetrical, ovoid to cylindrical; operculum rostrate, no peristome, or poorly developed.

Key to South Australian species:

1. Costa excurrent in a long hyaline arista ..... *P.ovatum*, p.157
   Costa percurrent or ceasing below the apex of the leaf.... *P.kemsleyi*, p.158

Pterygoneurum ovatum (Hedw.) Dixon 1934, *Rev. Bryol. Lich.* **6**:96.

Basionym: *Gymnostomum ovatum* Hedw. 1801, *Spec. Musc.* p.31.

Type: Europe.

Tortula pusilla (Hedw.) Mitt. 1869, *J.Linn. Soc. Bot.* **12**:165.

Fig. 76

Plants short, 1-2 mm tall; stem thick, with an extensive rhizoidal system. Leaves (a) to about 1 mm long without the arista, concave, broadly obovate, the apex obtuse or even cucullate. Margin more or less entire, somewhat inflexed above and sometimes covering the upper part of the lamellae. Costa narrow, usually golden, generally excurrent in a strong, nearly smooth, hyaline, curved arista. Upper laminal cells (b) pellucid, roughly hexagonal, 10-18 μm wide in

broadest part of the leaf, smaller above, walls fairly thick, papillose; lower cells (c) larger, shortly rectangular, with thin walls with corners thickened. Lamellae two to four, to eight cells high, chlorophyllose, sometimes with short filaments. Seta 2-2·5 mm straight or flexuous; capsule (d) erect, shortly cylindrical; operculum lowly conical with a long, usually oblique, beak, the cells in straight rows; calyptra subulate, split on one side, covering most of capsule. No peristome; spores 40-50 μm diameter, but much smaller, about 30 μm, in some specimens, dark brown, densely granular.

Distribution: Europe, W.Asia, N.Africa, N.America, Australia (W.A., S.A., Vic., N.S.W.). In South Australia on soil in semi-arid areas (20). Australian material shows considerable variation and more than one species may be included in the above description.

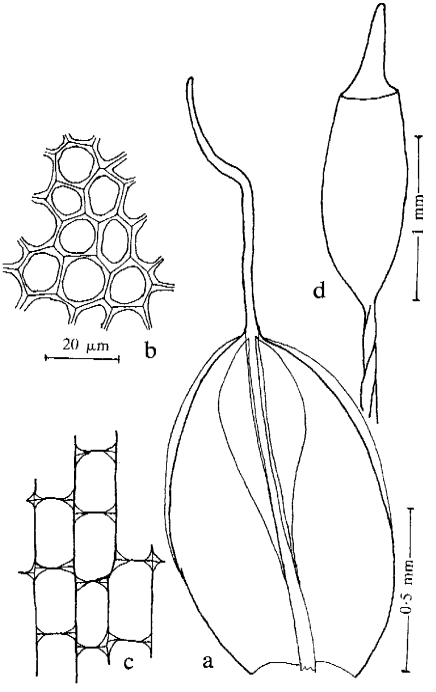


Fig. 76. *Pterygoneurum ovatum*

Pterygoneurum kemsleyi Willis 1954, *Victorian Nat.* **71**:8-10.

Type: Western Australia, Feysville, 15 miles S.E. of Kalgoorlie, on bare red loam, leg. D.S. Kemsley, 8 Sept. 1951.

Small gregarious plants on bare red loam. Stems short, 1-2 mm tall. Leaves suberect and concave when moist, imbricated and strongly incurved when dry, 1-1·5 mm long by 0·5 mm wide, obovate to narrowly oblong or somewhat panduriform, apex subcucullate, obtuse or mucronate, often denticulate at the extreme apex, sometimes a little plicate, paler near the base, margin plane, entire; perichaetial leaves similar. Costa strong, about 80 μm wide, percurrent or ceasing below the apex, bearing two lamellae and sometimes a third narrower one between them, on the adaxial surface, lamellae 4-5 cells high, bearing copious short protonemal filaments near apex, giving a greener fuzzy appearance. Cells pellucid, subquadrate above, 15 μm wide; lax hyaline and rectangular below, 30-35 μm long. Seta slender, about 6 mm long, reddish. Capsule erect, ovoid or subcylindrical, about 1 mm long without the operculum, smooth; no peristome; operculum not seen; calyptra narrowly cylindrical, about 2 mm long, smooth; spores 25-40 μm nearly smooth, contents obscurely granular.

Distribution: Australia (W.A., S.A.) endemic. Rare in semi-arid to arid environments (20).

TORTULA Hedw. 1801, *Spec. Musc.* p.122 *nom.cons.*

Lectotype: *T.subulata* Hedw.

Plants small to robust, generally in tufts. Leaves lingulate or spathulate, obtuse, with plane, reflexed or revolute margins, which are entire and often bordered with differentiated cells. Costa stout, usually excurrent in a cusp or arista, which is hyaline or coloured. Upper cells of leaf rounded, obscure, papillose, chlorophyllose; median cells quadrate and pellucid; lower cells rectangular and hyaline. Seta long; capsule erect, symmetrical, usually cylindrical. Peristome of 32 filiform, papillose teeth, usually spirally twisted and always united at base to form a cylinder which is tall or short. Operculum conical, with a beak. Calyptra cucullate. Spores small.

Key to South Australian species:

1. Minute plants growing on soil; costa not excurrent, but greatly swollen in upper, deciduous leaves ..... *T.oleaginosa,* p.167
   Moderately large to robust plants; costa excurrent in an arista, not swollen in upper leaves 2
2. Either spherical gemmae on leaves or with clusters of miniature leaves; leaf margin plane 3
   No gemmae nor miniature leaves; leaf margin revolute 4
3. Gemmae spherical on adaxial surface of costa; abaxial side of costa mamillose; upper laminal cells large about 20 μm across, pellucid, mamillose ..... *T.papillosa,* p.161
   With clusters of miniature leaves at apex of shoot and in leaf axils; abaxial side of costa smooth; upper laminal cells small, about 12 μm, papillose *T.pagorum,* p.163
4. Tall and robust; leaves to 4 or 5 mm long without arista; arista denticulate, reddish at base, hyaline above ..... *T.princeps,* p.165
   Short and small; leaves 1-2 mm long without arista; arista smooth, hyaline ..... *T.muralis,* p.160

Tortula muralis Hedw. 1801, *Spec. Musc.* p.123.
Type: Europe.

Fig. 77

Typically growing in small dense cushions, sometimes in extended patches on rocks or walls, short, 5-15 mm high, dull, glaucous green or a brighter green, hoary from excurrent, hyaline costae. Leaves *(a)* patent, when dry twisted and curled, oblong or elongate lingulate, 1-2 (−3) mm long, obtuse; margin revolute throughout, not thickened, slightly yellowish; costa yellowish, excurrent in a long hyaline smooth hair, usually at least half the length of the leaf; basal laminal cells hyaline, smooth, rectangular and linear, becoming much smaller above *(b)* passing abruptly to papillose cells, irregularly hexagonal and green above *(c)*, papillose on both sides; usually one or two marginal rows more strongly thickened and less papillose. Monoecious. Seta straight, 1-2 cm long, yellow at first, becoming dark purplish red with age; capsule *(d)* erect, cylindrical, reddish brown, becoming very dark; operculum rostellate, about one third length of theca, crenate at margin, its cell rows wound spirally in several complete turns; annulus of 2-3 rows, revoluble; cells of exothecium elongate rectangular, shorter towards the mouth; peristome teeth on a short basal membrane, the teeth twisted spirally 2-3 times; spores usually 7-9 μm yellow, smooth.

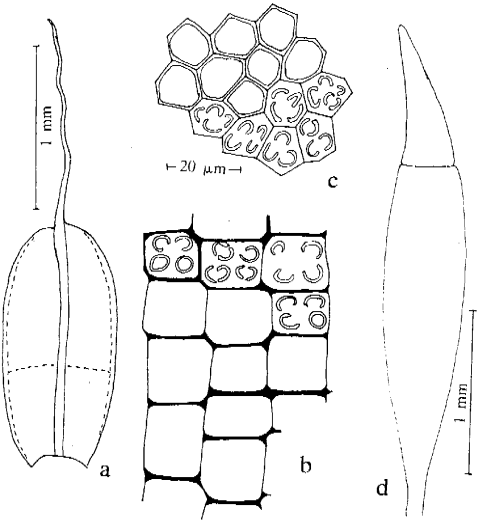


Fig. 77. *Tortula muralis*

Distribution: Europe, Asia, N.America, Australia (W.A., S.A., Vic, Tas, N.S.W., ACT, Qld). Common in South Australia (6-8, 10) on walls, roofs and rocks, in abundant fruit; rather variable, but the segregates described are unreliable in their characters.

Tortula papillosa Wils. *in* Spruc. 1845, *London J. Bot.* **4**:193

Type: England.

Figs. 78, 79a

Plants small, tufted on rough bark of trees and shrubs, dark green or greenish brown. Stems usually 7-8 mm tall, rarely more, and very slightly twisted when dry, spreading when moist, broadly oblong-spathulate or obovate-spathulate, very concave, with margins somewhat involute above, rounded at the apex, subacute or obtuse, entire. Costa stout, excurrent in a short or long hyaline

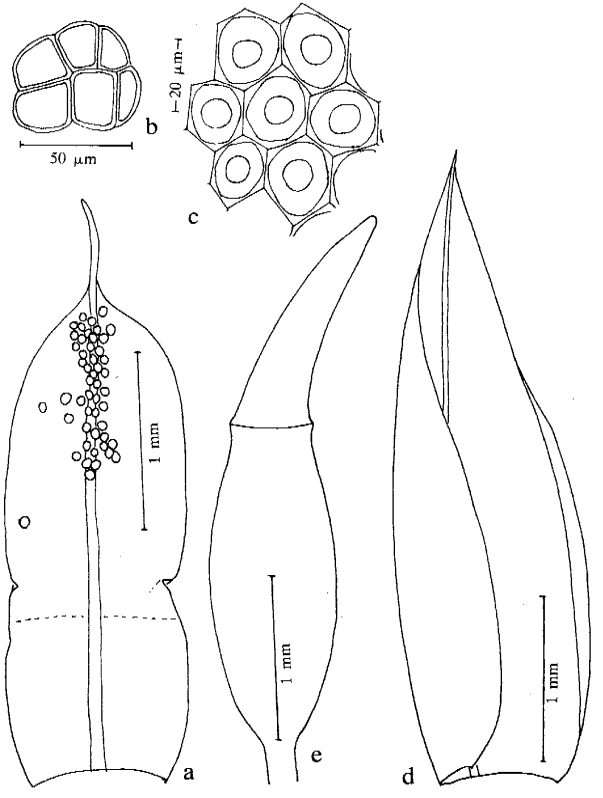


Fig. 78. *Tortula papillosa*

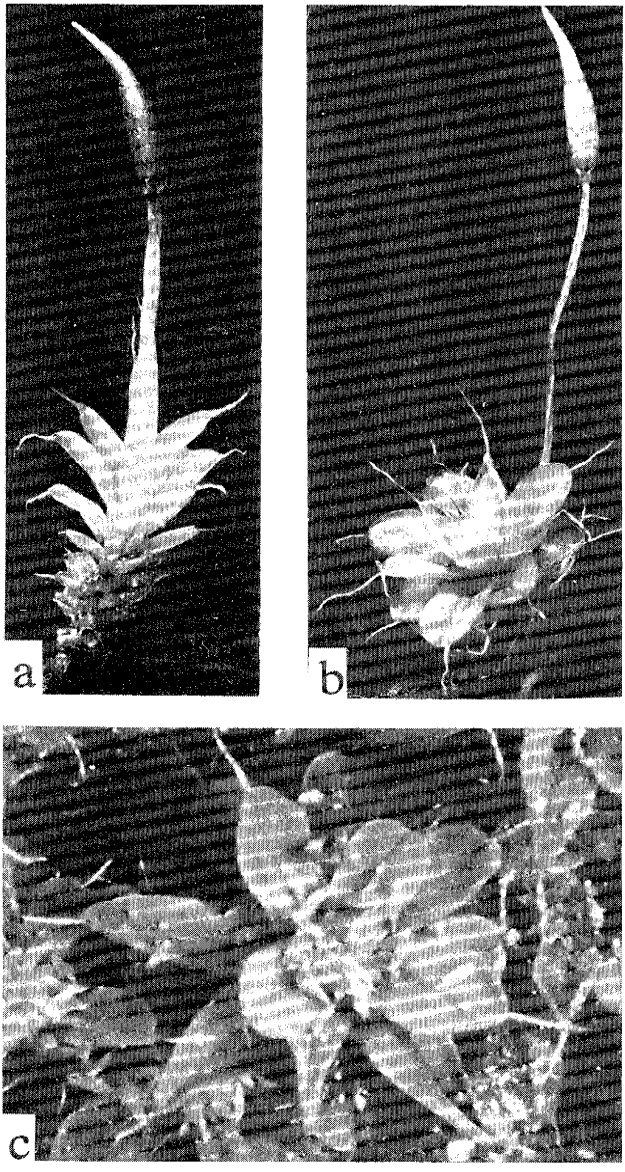


Fig. 79. a. *Tortula papillosa* (After Stone, 1971) x8; b. *Tortula pagorum* (After Stone, 1971) x8; c. *Tortula pagorum* (After Stone, 1971) x12

arista, somewhat mamillose at the back or smooth, with gemmae borne on the adaxial surface towards the apex; gemmae (b) multicellular, broadly oval or rotund. Laminal cells (c) very large, 20 μm or more across, pellucid chlorophyllose, broadly oval or hexagonal or subrotund, usually with thickened angles, variably mamillose on the dorsal surface in the upper part; basal cells oblong, not markedly hyaline, scarcely different at the margin. Perichaetial leaves (d) very long and sheathing, clearly showing at the base of the seta, acute, the cells throughout elongate-oblong, hyaline and smooth. Seta short, about 5 mm long, yellow, twisted to right. Capsule (e) 2-2·5 mm long, cylindrical; basal peristome tube whitish, about 0·5 mm high, the teeth about twice this length, red, papillose, inclined only, not twisted. Operculum half or more the length of the capsule. Calyptra cucullate. Spores about 16 μm diameter.

Distribution: widespread in Northern Hemisphere, South America, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, South Africa. Apparently sterile everywhere except in Australia, where it fruits freely. Common (1, 6-9, 12, 14); on introduced trees in urban areas; on shrubs and trees, such as *Acacia* spp, which have a rough and stable bark. It is usually accompanied by *T.pagorum* which is somewhat less robust and apparently less common than *T.papillosa*. Brotherus described *T.baileyi* from Adelaide having the vegetative and sporophyte characters of *T.papillosa* with, in addition, the propagula of *T.pagorum*. It is evident that *T.baileyi* is based on a mixture, many of the plants so named from N.S.W. and Lord Howe Island being in fact purely *T.pagorum* (Catcheside, 1967).

Tortula pagorum (Milde) De Not. 1869, *Epil. Atti Univ. Genova* **1**:542

Basionym: *Barbula pagorum* Milde 1862, *Bot. Zeit.* **20**:469.

Type: Switzerland.

Figs. 79b and c; 80

Plants densely caespitose in small to extensive mats or cushions on trees or shrubs, clear green becoming darker when dry, often with a reddish tinge. Stems up to 10 mm high, but usually less than 5 mm, radiculose at base, central strand present but somewhat indefinite. Leaves (a, b) mostly in a terminal rosette, the lowermost very small, incurved and closely appressed when dry, not crisped, but often slightly twisted, erect to spreading when moist, obovate, lingulate or panduriform, concave above 2·0-2·5 mm long (excluding the arista), about 1 mm wide, apex rounded, truncate or rarely retuse. Leaf margin (f) plane, not bordered, strongly papillose above. Costa pale red, thick, smooth on the back, excurrent as a smooth or rarely somewhat roughened arista, up to 1 mm long, very conspicuous in dry plants; in cross section showing two median guide cells, two adaxial cells of nearly equal size, and a large abaxial stereid group; basal leaf cells (c, d) hyaline, with yellow walls, the cross walls often thickened, rectangularly hexagonal towards the costa (c), shorter toward the margins (d); cells of the upper three quarters of the leaf (e, f) much more densely chlorophyllose, roundish quadrate to hexagonal, isodiametric, about 12 μm in diameter, papillose with numerous high, crescent-shaped or circular papillae.

Vegetative reproduction through lanceolate to elliptic and ovate ecostate, leaf-like propagula (g) 200-250 μm x 80-100 μm, the cells (h) densely papillose or verrucose, with a smooth or faintly papillose hyaline apical spine (h), produced at the apex of stem and in the axils of the upper leaves.

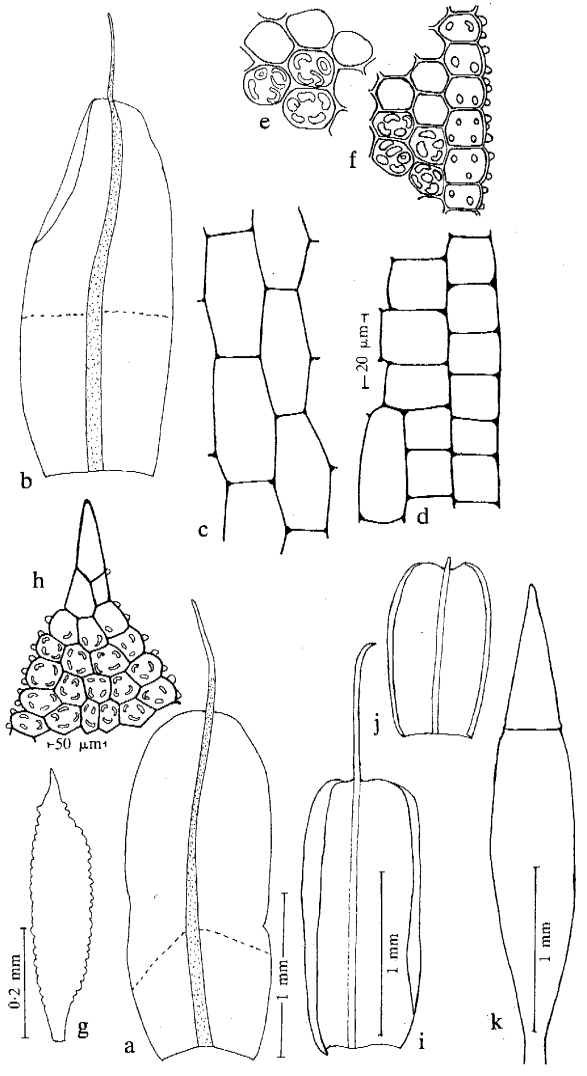


Fig. 80. *Tortula pagorum*

Dioecious. Perichaetial leaves (i, j) sheathing, shorter than foliage leaves, often retuse at the apex, the innermost (j) with a very short arista. Seta 5-9 mm; capsule (k) cylindrical, theca 2-2·5 m long, operculum narrowly conical, 1-1·5 mm long; tesselated tube of peristome pale, the teeth pale orange or pinkish; spores 8-10 μm, greenish brown, slightly papillose; calyptra cucullate. Male plants somewhat shorter, perigonium terminal, the innermost perigonial leaves about as wide as long, round at apex, apiculate, costa ceasing at apex, cells less papillose.

Distribution: Europe, N.America, Australia (S.A., Vic., N.S.W.), New Zealand.

Occasional on urban trees, with *T.papillosa,* sometimes on walls, and in semi-arid areas on shrubs (6-9, 12, 21). Fruit known only in Australia (Stone 1971).

Tortula princeps De Not. 1838, *Mem. R. Acc. Sc. Torino* **40**:288.

Type: Sardinia.

Figs. 81, 82; Plate 5A

Usually robust plants in rather dense cushions or tufts, on rocks, walls, sand dunes, etc. rarely on trees; green above, bright ruddy brown below. Rather variable; stems up to 3 cm high, branched, lightly matted together in the lower parts with brown tomentum. Leaves (a, j) crowded, when dry appressed and more or less spirally twisted, spreading when moist, but hardly if at all recurved; very large, broadly oblong elliptic, acute (a) or obtuse (j), carinate, up to 4-5 mm long by 1·5 mm wide; margin revolute from base to above the middle, often nearly to the apex, plane and crenulately papillose towards the apex. Costa stout, reddish brown, denticulate on the back, excurrent in a long, hyaline, denticulate arista, often reddish at the base. Inner basal cells (l) rectangular, thinly walled, hyaline or brownish, shorter and more coloured towards the margins; upper cells (b, k, the latter drawn at three foci) hexagonal, densely covered with crescentic or lobed papillae on both sides, obscure, 12-18 μm diameter, one row at margin often slightly distinct, compressed and transversely elliptical, rather more opaque. Perichaetial leaves (c) shorter, costa shortly apiculate. Seta 1-3 cm long, reddish; capsule (d) erect or slightly curved, narrowly cylindrical, to 6 mm. long; operculum long conic, about half as long as theca, its cell rows twisted several times; exothecial cells (e) thickened towards the surface, as seen in T.S.; annulus (f) of 1-3 rows, persistent, basal tube of peristome (g) long, pale reddish, becoming white when old, obliquely tessellate, papillose teeth (h) spirally twisted about two full turns; spores (i) 10-15 μm diameter, yellowish green, finely papillose.

Distribution: Europe, Asia, Western N. America, S. America, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Common in South Australia (1-6, 9, 10, 12, 14, 15, 17, 20), chiefly on sandy soils (fig. 81), on dunes, in mallee and dry sclerophyll forest, sometimes on rock (fig. 82) and occasionally on trees.

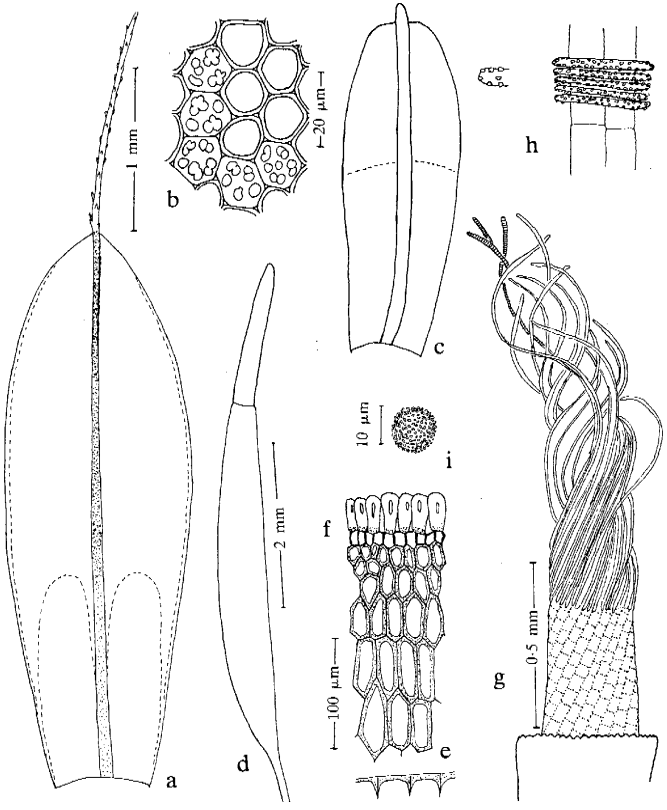


Fig. 81. *Tortula princeps*

Very variable, the Australian plants differing from the European ones in not being interruptedly comose and in some having the margin revolute nearly to the apex instead of half to two-thirds of the way up. In this respect, the Australian plants approach the northern *T.ruralis* (Hedw.) Gaertn. which, however, has squarrosely reflexed leaves and smaller cells.

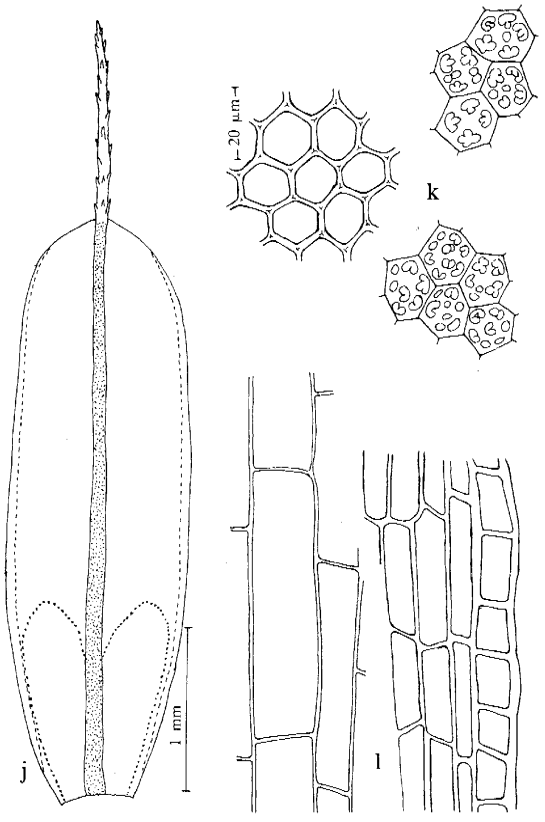


Fig. 82. *Tortula princeps*

Tortula oleaginosa Stone 1978, *J. Bryol.* **10**:117-24.

Type: Victoria, Murray Valley Highway, near Boundary Bend, on red crusted sandy loam in mallee scrub. I. G. Stone 1552, 19 July 1969, in Herb. MEL.

Figs. 83, 84

Minute plants on soil, probably perennial, not more than 1 mm tall, fleshy stems bearing several whorls of leaves, the uppermost being fleshy and deciduous; rhizoids colourless. Lower leaves (a) yellowish green, 0·3-0·5 mm long, wide, obovate or spathulate, with or without an apiculus, concave cucullate; margin plane, entire, crenulate towards apex, especially from

projecting irregular papillae; costa percurrent or ceasing below apex, in section with 1-few central cells, two large adaxial cells and 3-4 thicker abaxial cells, papillose on both surfaces in upper half, the adaxial cells larger than laminal cells as seen in surface view (c) and projecting; laminal cells quadrate to shortly oblong, incrassate, outer wall of marginal cells (b) thicker, 10-20 μm wide above, larger towards costa, walls thinner towards the base of the leaf. Upper leaves form deciduous propagula (d), with the costa greatly widened and

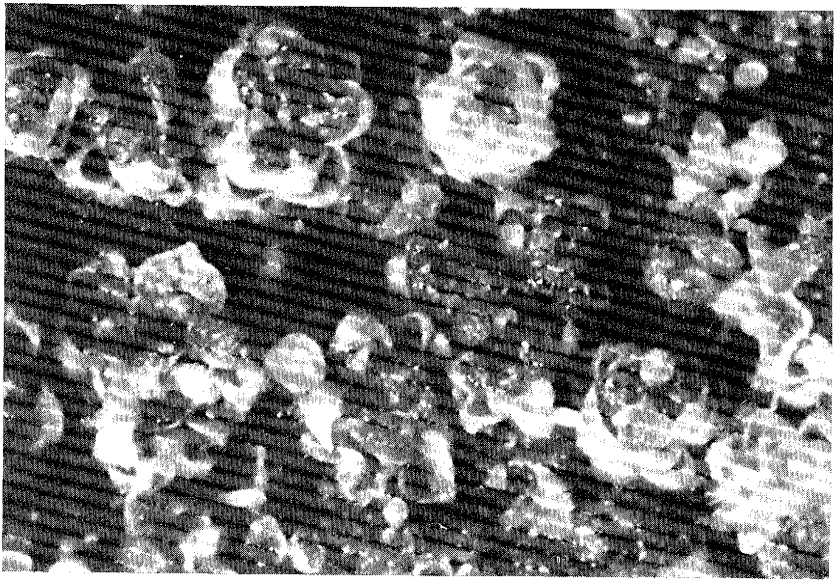


Fig. 83. *Tortula oleaginosa* (After Stone, 1979) x37·5.

swollen abaxially, consisting in section of a mass of thinly walled cells, with a layer of thickly walled, papillose cells adaxially and abaxially, the abaxial cells narrowly transversely rectangular; lamina much reduced where the costa is swollen (d, e); lower part of leaf narrower, delicate with a zone (f) of isodiametric cells, each with 2-4 chloroplasts, the costa thin and weak and vanishing at the base of the leaf; propagula detaching by irregular breakage at the leaf base. Probably dioecious; archegonia axillary; antheridia and sporophytes not seen.

Distribution: Australia (W.A., S.A., Vic., N.S.W.) endemic. Not uncommon (17, 20) in semi-arid to arid salt bush and mallee country on the soil crust with other small mosses, lichens and algae, along the southern margin of the arid Eremaean floristic province (Burbidge, 1960). In the absence of sporophytes the assignment to *Tortula* is uncertain. There are resemblances to *Desmatodon convolutus* and other Pottiaceae.

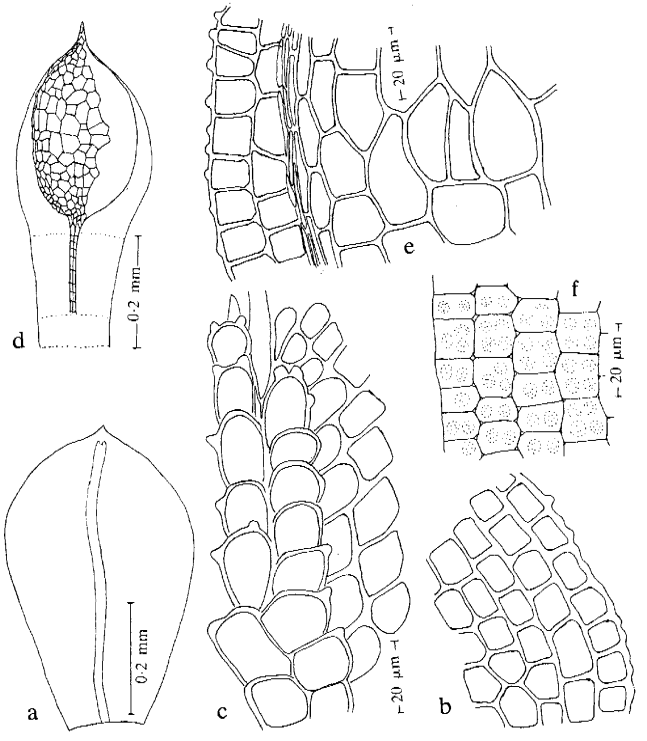


Fig. 84. *Tortula oleaginosa*

Tribe BARBULEAE Herz. 1926, *Geogr. der Moose* p.98.

The tendency in classification now is to divide the large genus *Barbula* into a number of smaller genera. Otherwise the divisions may be treated as subgenera and sections. The following key attempts to distinguish the three genera that occur in South Australia and a fourth which may be found; the sections of *Barbula* are also differentiated. The axillary hairs are found by dissecting the young growing tips of shoots.

1. Margins of leaf plane 2
   Margins of leaf revolute or of two layers of cells above 3
2. Base of leaf sheathing, the juxtacostal cells usually yellow and with a row of papillae; perichaetial leaves convolute and elongated; costa percurrent or excurrent ..... *Barbula* section *Streblotrichum: B.calycina,* p.185
   Base of leaf not sheathing, the basal cells all smooth and hyaline; apex of leaf hyaline, formed of a few large cells, the terminal one acute
   (Bryoerythrophyllum binnsii, p.171)

3. Basal cells of leaf elongated, lax and hyaline; cell walls thin 4
   Basal cells of leaf scarcely elongated except close to the costa; cell walls thick 6
4. Upper leaf margins with the cells in two layers; no adaxial stereid band in costa; peristome teeth nearly straight. *Trichostomopsis australasiae,* p.170
   Upper leaf margins with the cells in one layer; adaxial stereid band present in costa; peristome teeth spirally twisted 5
5. Costa ending in or below obtuse to acute apex; upper laminal cells pellucid, smooth or slightly papillose
   Barbula section *Hydrogonium; (B.ehrenbergii,* p.180)
   Costa excurrent; upper laminal cells obscured with dense papillae
   Barbula section *Helicopogon; B.crinita, B.luteola,* p.181
6. Axillary hairs with brown, slender basal cells; laminal cells well defined in surface view; cells of abaxial surface of costa quadrate to shortly oblong..... *Didymodon,* p.172
   Axillary hairs hyaline throughout; laminal cells obscure in surface view due to dense papillae; cells of abaxial surface of costa linear oblong
   Barbula, p.176

TRICHOSTOMOPSIS Card. 1909, *Rev. Bryol.* **36**:73.

Barbula section *Asteriscium* C. Müll. 1872, *Linnaea* **42**:312.

Type species: *T.crispifolia* Card.

Plants small, caespitose with short erect stems. Leaves crowded, usually incurved or crisped when dry, spreading when moist from a somewhat clasping base, entire, lanceolate to oblong, acute to attenuate, channelled; margins slightly reflexed, cells in two layers in one or more rows in upper part; costa percurrent, in section with only an abaxial stereid band; basal leaf cells usually very lax and hyaline; upper leaf cells rounded or quadrate, papillose or mamillose or smooth. Dioecious. Seta terminal, elongate; capsules oval to cylindrical, erect; peristome teeth divided nearly to the base into two filiform papillose forks which are erect to slightly twisted; operculum conically rostrate with spirally twisted cells. Genus monographed by Robinson (1970).

Trichostomopsis australasiae (Hook. & Grev.) H. Robinson 1970, *Phytologia* **20**:187.

Basionym: *Tortula australasiae* Hook. & Grev. 1824, *Edin.J.Sci.* **1**:301.

Type: New Holland, King George's Sound, coll. Menzies 1791.

Fig. 85

Stems up to 1 cm high. Leaves (a) incurved to contorted when dry, spreading when moist, 1·5-2·5 mm long, oblong to narrowly lanceolate from an oblong base, shortly to longly acute, channelled to the tip; cells of upper leaf (b) lamina subquadrate often with somewhat thickened corners with several papillae per cell, the papillae sometimes C-shaped, cells mostly 9-12 μm wide, many slightly shorter than wide; inner basal cells very lax, up to 60 μm long and 20 μm wide, with 2-3 rows of only slightly narrower marginal cells; costa percurrent; cells of

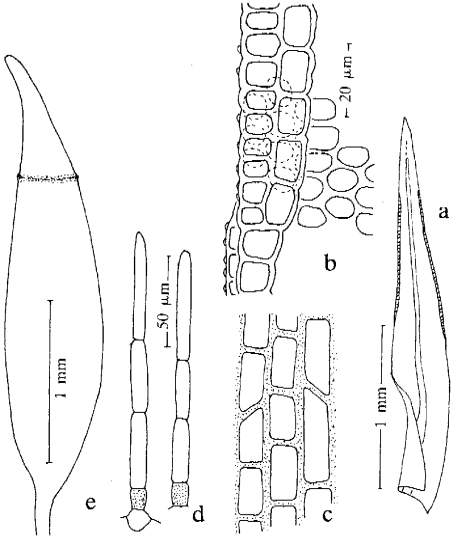


Fig. 85. *Trichostomopsis australasiae*

upper surface of costa distinctly papillose, in section as large as or larger than guide cells. Axillary hairs about four cells long, about 140-160 µm high, the basal cell short and brown. Seta 7-10 mm long, straight, reddish when mature; capsule oblong-ellipsoid, about 2 mm long, with a curved rostrate operculum.

Distribution: North, Central and South America, S.Africa, Australia (W.A., S.A., Vic., Tas., N.S.W.), New Zealand.

Common (1, 6, 8, 12, 14, 15, 17), on soil, in lawns and on calcareous soil in moist habitats.

BRYOERYTHROPHYLLUM Chen 1941, Hedwigia 80:4.

Bryoerythrophyllum binnsii (R.Br.ter.) Wijk et Marg. 1959, Taxon 8:71

Basionym: *Trichostomum binnsii* R.Br.ter. 1897, *Trans.N.Z.Inst.* **29**:486.

Type: New Zealand.

Plants to 1 cm tall in dull reddish brown turfs on earthy banks. Leaves lingulate, obtuse with a very acute hyaline tip of a few cells; costa prominent papillose, channelled; margins plane; cells small, 9 µm across, quadrate, covered with dense papillae; basal cells long and wide, hyaline towards the costa, marginal narrow and green.

Distribution: New Zealand, Australia (Vic., Tas.).

DIDYMODON Hedw. 1801, *Spec. Musc.* p.104.

Type species: *D.rigidulus* Hedw.

Similar to *Barbula*, but lamina cells well defined in surface view, rounded to rounded quadrate or rhomboidal, walls thick, smooth or papillose with large, low blunt papillae; basal cells somewhat larger, oblong, pale green to pale brown. Costa percurrent to excurrent; in section with the adaxial stereid band weak or nearly absent; cells of adaxial and abaxial surfaces of costa in surface view rounded-quadrate or shortly oblong. Axillary hairs with brown slender basal cells and three or four thick, hyaline upper cells. Peristome teeth erect or somewhat twisted to the left. Small rhizoid tubers present in some species. Plants yellowish green to bronze above, dark brown below, in dense turfs on soil.

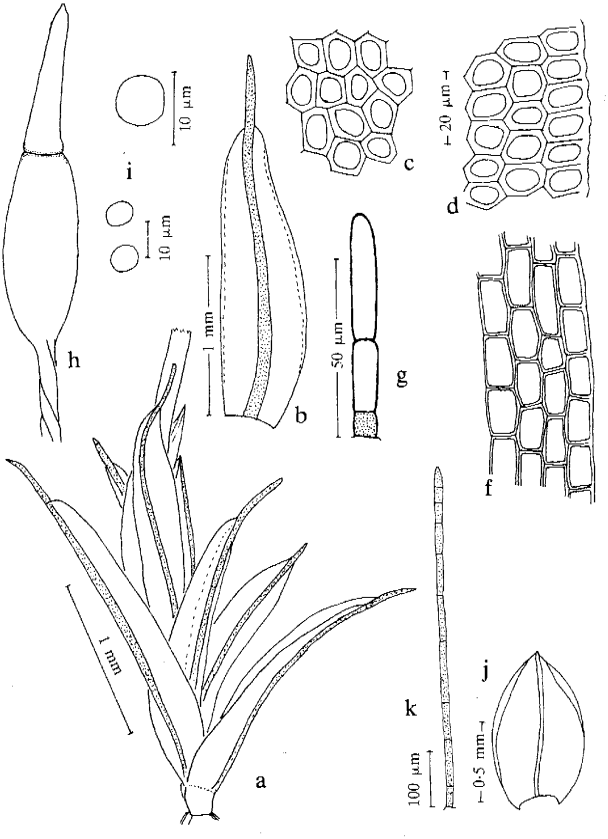


Fig. 86. *Didymodon torquatus*

The genus is taxonomically difficult in Australia, where it is very common in arid and semi-arid areas. It is uncertain whether there is one widely distributed very variable species, *D.torquatus*, or several. The following key summarises how the three presumed species apparently differ.

1. Leaves curled and flexuous when dry, not twisted around the stem; basal cells pellucid and hyaline, except close to margin . . . *D.luehmanni*, p.175
   Leaves twisted helically around the stem when dry; basal cells not hyaline or only subhyaline near the costa 2
2. Leaves rather broadly lanceolate; basal laminal cells more or less quadrate or rectangular . . . . . *D.torquatus*, p.174
   Leaves more narrowly tapering, linear lanceolate; basal laminal cells somewhat elongated and hyaline, especially near the costa *D.subtorquatus*, p.174

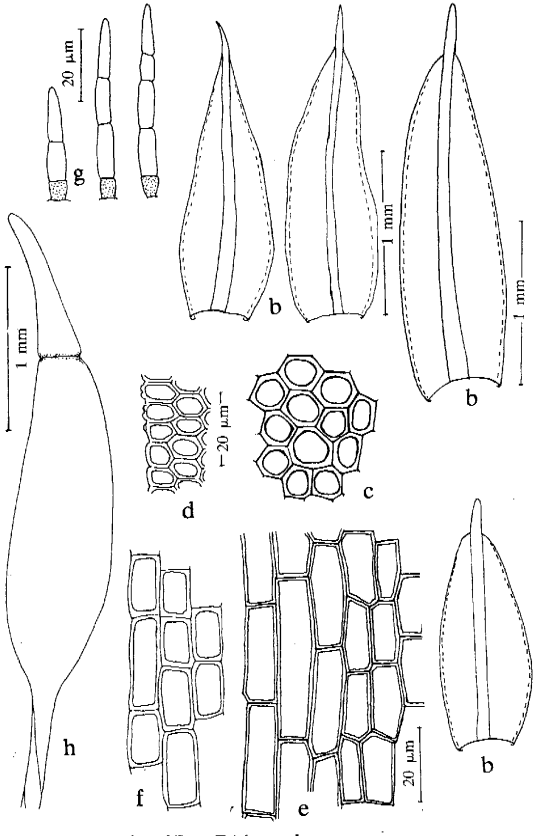


Fig. 87. *Didymodon torquatus*

Didymodon torquatus (Tayl.) comb.nov.

Basionym: *Barbula torquata* Tayl. 1846, *London J. Bot.*, 50.

Type: Western Australia, Swan River, coll. J. Drummond.

Fig. 86, 87

Stems (a) 0·5-1(-2) cm tall. Leaves (b) 1-2·5 mm long, spirally twisted around the stem when dry, with the leaf tips projecting in lax plants, rather broadly lanceolate, acuminate, concave with margins entire and usually closely recurved; costa strong, yellow percurrent or shortly excurrent; upper cells (c) 8 μm diameter, subquadrate, incrassate, papillose but not densely so, sometimes smaller at the margin (d); papillae bluntly conical or obscure; lower cells somewhat longer but little altered except at base (e) where they are shortly rectangular, relatively shorter at the margin (f) and firm-walled, but not hyaline; axillary hairs (g) short, stout or slender. Perichaetial leaves not differentiated; seta 1-1·75 cm, slender, reddish; theca 1·75-2·5 mm long, erect, the capsule (h) narrowly cylindrical to oval, straight or slightly curved; peristome long, strongly twisted to the left, of 16 brown teeth, set on a low basal membrane and each divided into two papillose filaments; operculum at least half length of theca, bluntly conically rostrate, slightly curved, with cells curving to the right; calyptra cucullate; spores (i) 8-10 μm; dioecious. Perigonium gemmiform, terminating short branches; the perigonial leaves (j) broadly ovate, convolute, concave; the paraphyses (k) slender, very long, coloured.

Distribution: Australia (W.A., S.A., Vic., N.S.W., Tas., A.C.T., N.T.), New Zealand, S.America. Very common (1, 2, 4-10, 14, 15, 17-20) in semi arid to arid areas, in mallee and sclerophyll scrub, on soil. Figs. 86 (from Murray Lands) and 87 (from Kangaroo Island) illustrate some of the complex variation.

Didymodon subtorquatus (C.Müll. et Hamp) comb.nov.

Basionym: *Barbula subtorquata* C.Müll. et Hamp. 1855, *Linnaea* **26**:492

Type: South Australia, Mount Gambier, coll. F.von Mueller; Plate III in F.von Mueller (1864) *Analytical Drawings of Australian Mosses.*

Fig. 88

In looser tufts than *D.torquatus,* usually taller. Leaves (a) 2-3 mm long, narrowly lanceolate, tapering gradually to a very acuminate apex (b); margin weakly revolute, papillose (e); costa strong, percurrent to excurrent; upper cells (c, d, e) very small, roundish quadrate, smooth or obscurely papillose, incrassate, uniform throughout, lower cells (f) somewhat elongated and subhyaline especially near the base in an area adjacent to costa; longitudinally plicate above. Seta slender 2-3 cm, red. Axillary hairs (g) 80-100 μm tall, usually with four hyaline cells and one brown basal cell. Capsule narrowly cylindrical, 2 mm long; operculum obliquely conical, half the length of the capsule; peristome with a short base, tightly twisted.

Distribution: Australia (W.A., S.A., Vic., Tas.,) endemic. Rare in South Australia (1, 5, 6), apparently the extreme in robustness of *D.torquatus,* occurring in moister areas.

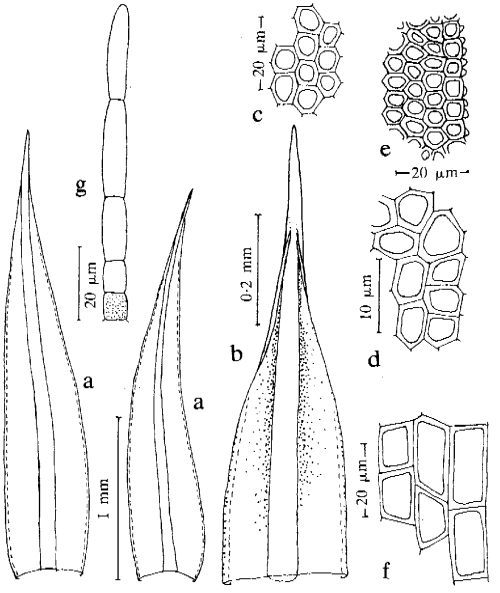


Fig. 88. *Didymodon subtorquatus*

Didymodon luehmanni (Broth. et Geh.). comb. nov.

Basionym: *Barbula luehmanni* Broth. et Geh. 1895, *Oefv. Finsk. Vet. Soc. Foerh.* **37**:158.

Type: Victoria, Loutit Bay, coll. Luehmann.

Fig. 89

Leaves (a, b) lanceolate, acuminate, flexuous when dry, strict and patent when moist, carinately concave; margin entire, revolute almost to apex; costa thick, 75 µm wide at base, reddish, excurrent in a short, rigid, smooth acute hair, basal cells (c) rectangular, pellucid, smooth; upper cells (d, e) roundish quadrate, 7·5-15 µm papillose. Axillary hairs (f) 80-100 µm tall, with 3 or 4 hyaline cells. Perichaetial leaves clasping from a long vaginant base shortly lanceolate acuminate, margin plane, costa slender; seta 1 cm tall, flexuous, slender, pale red, apex yellow; theca erect, small, asymmetric, oblong, chestnut, shiny; annulus narrow, persistent, peristome tube 75 µm high, greyish hyaline, densely papillose, bearing orange, papillose teeth once twisted; operculum with a curved beak, shorter than theca, obtuse.

Distribution: Australia (S.A., Vic.) endemic. Rare in South Australia (5, 9, 17).

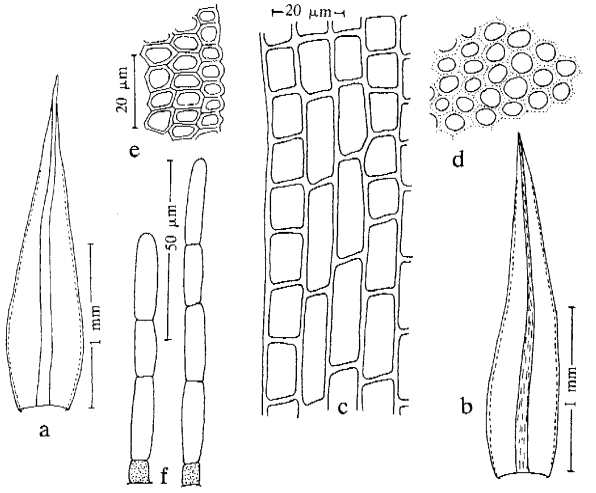


Fig. 89. *Didymodon luehmanni*

Similar to *Barbula vinealis* Brid., but that has shorter, more nearly quadrate, basal cells.

BARBULA Hedw. 1801, *Spec. Musc.* p.115.

Lectotype: *B.unguiculata* Hedw. *fid.* Steere *in* Grout 1938, *Moss Fl. N.Amer.* 1:175.

Usually dioecious. Stem brown, with a central strand. Leaves ligulate to spathulate; margin narrowly recurved below and plane above, or recurved or plane throughout, usually entire. Upper laminal cells quadrate to shortly oblong, densely papillose and obscure in surface view or smooth and well defined; basal cells more or less enlarged, oblong, smooth, nearly hyaline, forming an inverted V shaped area. Costa percurrent, excurrent or ceasing below apex; in section with adaxial and abaxial stereid bands, the adaxial one usually well developed; cells of abaxial surface in surface view oblong to linear oblong, with walls thick and smooth or papillose. Axillary hairs of 4-15 cells, hyaline throughout or with two to five basal coloured cells. Perichaetial leaves usually somewhat longer than stem leaves, acute to acuminate, rarely ligulate and obtuse. Capsule cylindrical on a long seta; operculum rostrate. Peristome teeth 32, twisted to left, usually at least once, finely papillose, borne on a short membranous cylinder; annulus in 1-3 rows, deciduous; calyptra cucullate. Some species bear rhizoid tubers, either pear-shaped or elliptical in leaf axils, or spherical on subterranean rhizoids (not observed in Australian species).

Key to South Australian species:

1. Margin of leaf plane or only slightly recurved; leaves flaccid or undulate . . 2
   Margin of leaf strongly recurved; leaves rather stiff 3
2. Costa shortly excurrent; upper cells papillose; base of leaf sheathing, with elongated cells except at margin, the cells adjacent to the costa usually golden and bearing one or rarely two rows of papillae . . *B.calycina*, p.185
   Costa ceasing in or below the obtuse to acute apex; upper cells smooth or nearly so; basal cells elongated, hyaline smooth; plants semiaquatic (*B.ehrenbergii*, p.180)
3. Upper laminal cells bearing about 2 to 4 simple, dome-shaped papillae on each cell 4
   Upper laminal cells bearing several compound, branched papillae on each cell 5
4. Leaves oblong lanceolate to narrowly lingulate, tapering rather abruptly to an obtuse apex . . . . . *B.unguiculata*, p.178
   Leaves lanceolate to nearly deltoid, tapering gradually from below middle of leaf to an acuminate apex . . . . . *B.hornschuchiana*, p.178
5. Leaves lanceolate, tapering to a subacute apex from below the middle of the leaf; costa longly excurrent, covered on whole upper adaxially side by quadrate cells, with compound papillae . . . . . *B.crinita*, p.181
   Leaves lingulate, tapering abruptly to a blunt apex; costa shortly excurrent, a narrow channel in the upper adaxial side occupied by elongated cells bearing a few simple papillae . . . . . *B.luteola*, p.182

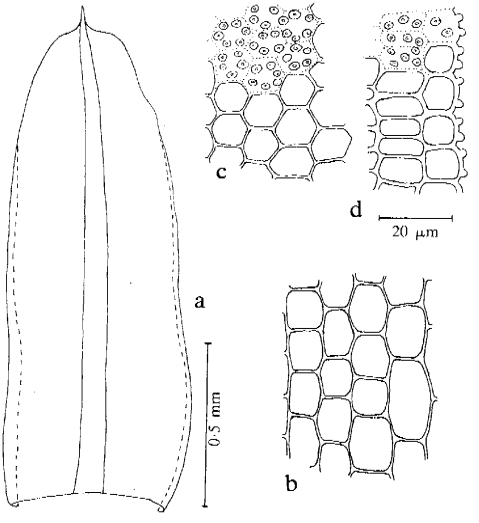


Fig. 90. *Barbula unguiculata*

Barbula unguiculata Hedw. 1801, *Spec. Musc.* p.118.

Type: Europe.

Fig. 90

Dioecious. Stems short, usually 5-15 mm, stems orange, not tomentose; bright green above, reddish brown below. Leaves (a) patent when moist, twisted and incurved when dry, lingulate to lingulate-lanceolate, the apex obtuse or rounded, apiculate, the margin recurved except near the apex, crenulate from papillae; costa stout, green to light brown, shortly excurrent, adaxial cells elongate; basal lamina cells (b) rectangular, shorter towards the margin; upper cells (c) 10-14 μm roughly hexagonal, rectangular to quadrate at margin (d) incrassate, papillose, the papillae simple and hemispherical. Perichaetial leaves somewhat larger with a sheathing base; seta deep reddish brown; capsule erect, narrowly ellipsoid, straight; operculum longly rostrate; peristome strongly twisted; spores 10-14 μm.

Distribution: throughout Northern Hemisphere, southern S. America, Australia (S.A., Vic., Tas.). Uncommon (8) on soil in Adelaide, probably introduced.

Barbula hornschuchiana Schultz 1822, *Flora* **5**(Syll):35.

Type: Europe.

Barbula subspiralis Hampe 1864, in F.von Mueller, *Analytical drawings of Australian Mosses,* Plate II.

Type: Australia felix, coll. F.von Mueller no. 78, 1855.

Desmatodon adustus Mitt. 1856, *Kew J. Bot.* **8**:258.

Type: Victoria, Gippsland, coll. F. von Mueller no. 78, 1855.

Fig. 91

Dioecious. Plants small in dense flat turfs on soil, olive-green to brownish green when dry, green when moist; stems (a) 0·5-1 cm tall, slender, innovating from below perichaetia. Leaves (b, c) borne spirally on the stem, more densely towards the top, curled when dry and twisted around stem, spreading to reflexed when moist; narrowly triangular, strongly revolute from base to apex; costa very stout, somewhat thicker above and prominent abaxially (d), excurrent in a short arista. Upper laminal cells (e) quadrate to hexagonal, about 10-14 μm across, somewhat incrassate, pellucid, papillose on adaxial surface in an area extending two thirds or more down from the apex and out towards the reflexed margin, which is also papillose; adaxially the cells are smooth at the base and in a zone extending towards the upper part of the leaf; abaxially, the cells and costa are papillose in corresponding zones; papillae dome shaped, generally four to each cell; lower cells of leaf (f) somewhat larger than those above, quadrate, but rectangular in a small patch adjacent to costa, smooth, somewhat incrassate; axillary hairs (g) of 5-6 cells, all hyaline, but one or two basal cells may contain chloroplasts. Perichaetial leaves (i) larger than foliage leaves, somewhat cymbiform, margin not reflexed; some leaves (h) below the perichaetial leaves intermediate, with the upper regions of the margins reflexed; capsule (j) slender

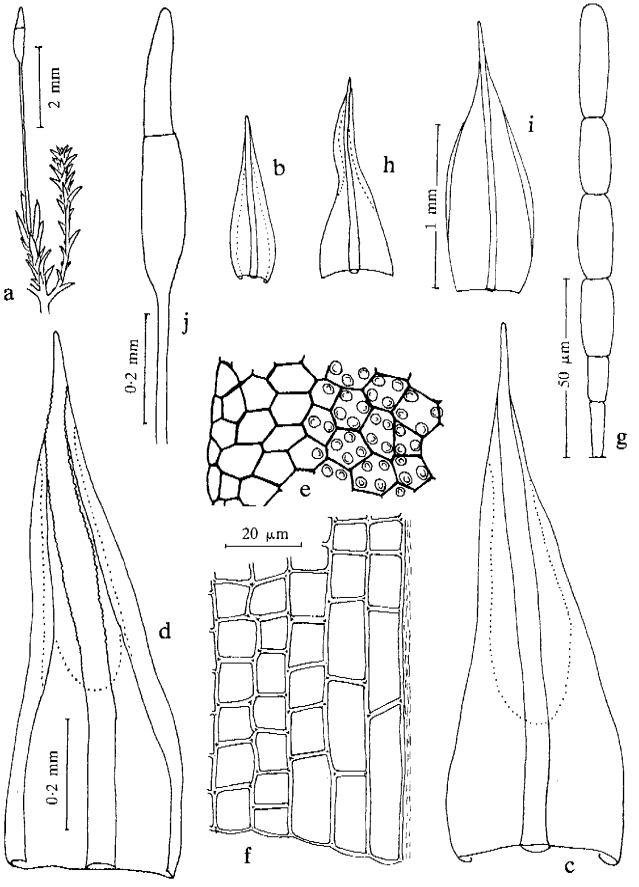


Fig. 91. *Barbula hornschuchiana*

0·8-1·5 cm long, cylindrical on a slender reddish brown seta, about 6 mm long; operculum conically rostrate, oblique, very long; calyptra long, narrowly conical.

Distribution: Europe, S. W. Asia, N. Africa, S. Africa, Australia (W.A., S.A., Vic., Tas.). On otherwise bare soil on verges of roads in Adelaide, also in the Flinders Ranges and semi-arid areas (1, 2, 5, 8, 10, 13, 14, 17); uncertain whether native or introduced, or both.

The S. Australian material is exactly like specimens from Britain. The assignment of *Barbula subspiralis* Hampe and *Desmatodon adustus* Mitt. to the same species is based in part on the fact that specimens in herb. BM show they are founded on parts of the same collection by F.von Mueller. What passes for *D.adustus* cannot be distinguished from *B.hornschuchiana,* of which Plate II of Mueller's drawings is a fair, if superficial, representation.

Barbula ehrenbergii (Lor.) Fleisch. 1901, *Musci Arch. Indic.* ser.**4**:no.161

Basionym: *Trichostomum ehrenbergii* Lor. 1868, *Abh. Akad. Wiss. Berlin* 1867:25.

Type: Mesopotamia.

Fig. 92.

Plants of medium size, dull yellowish to brownish green, in dense tufts, often incrusted with a calcareous deposit; stems 1-5 cms long, usually simply or irregularly branched; leaves (a) flaccid, somewhat crisped when dry, erect spreading when moist, 2-3 mm long, oblong lanceolate to ligulate; costa ending

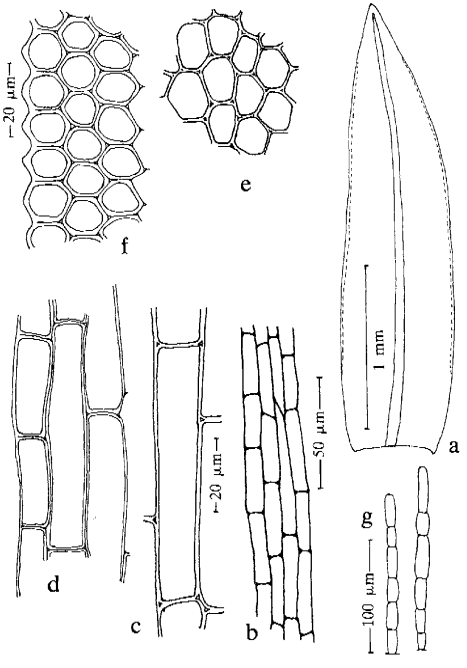


Fig. 92. *Barbula ehrenbergii*

in or just below the obtuse to subacute apex; margin plane to very slightly recurved; basal cells (b-d) thinly walled, elongate, enlarged, pellucid, upper cells (e, f) isodiametric, polygonal, smaller, slightly papillose or smooth, thin walled. Axillary hairs (g) hyaline. Clavate gemmae sometimes present. Fruit unknown.

Distribution: Europe, S.W. Asia, East Indies, N.Africa, N.America, Australia (W.A.). Plants grow in dense tufts on limestone or calcareous soil, often in running water.

Barbula crinita Schultz 1823, *Nov. Acad. Leop. Car.* **11**(1):226.

Type: S.Africa.

Barbula pilifera (Hook.) Brid. 1826, *Bryol. Univ.* **1**:572 *hom.illeg.*

Basionym: *Tortula pilifera* Hook. 1818, *Musci Exot.* **1**:plate 12.

Type: S.Africa.

Barbula pseudopilifera C.Müll. et Hampe 1853, *Linnaea* **26**:493.

Type: Tasmania.

Figs. 93

Usually robust plants, yellow tinged with green or brown. Stems 1·5-10 cm high, simple or dichotomously branched. Leaves (a) 3-4·5 mm long, twisted and sometimes crisped when dry, erecto-patent or spreading when moist, crowded towards the apex of the stem, rigid, lingulate lanceolate from a short, appressed widened base, slightly reflexed, subacute, variably concave, sometimes concave-carinate; margins recurved, entire, minutely crenulate with projecting papillae; costa stout yellow, prominent abaxially (b), excurrent in a yellowish arista which is robust, straight, hyaline-tipped, usually smooth but occasionally slightly denticulate, reaching one third or more of the length of the leaf; adaxial cells (c) quadrate; abaxial cells (d) elongate. Upper cells (e, f) 9-10 (-15) μm across, isodiametric, broadly hexagonal or oval or subrotund, densely papillose but not obscure, with walls thin or firm; papillae (g) compound, branched; cells increasing in length lower down the lamina, ultimately longly rectangular or linear at the base of the leaf, pellucid, smooth, yellowish, firm-walled and with several rows at the margin subquadrate or shortly rectangular and chlorophyllose. Axillary hairs (h) hyaline, very long. Perichaetial leaves long, exserted, pale membranous, longly acuminate and piliferous. Seta about 1-2 cm long, reddish or pale; theca rather large, narrowly cylindrical, slightly curved, 2·5-3 mm long; operculum rostrate, very long, up to 2 mm; calyptra long, cucullate. Perigonia minute, gemmiform, with four antheridia and numerous jointed paraphyses.

Distribution: Central and S.Africa, southern S.America, Australia (W.A., S.A., Vic., Tas., N.S.W., ACT.), New Zealand. Very common (1, 2, 5, 6, 8-12, 14, 15, 17, 18, 20), in semi-arid areas, especially on sandy soil, in mallee and sclerophyll scrub.

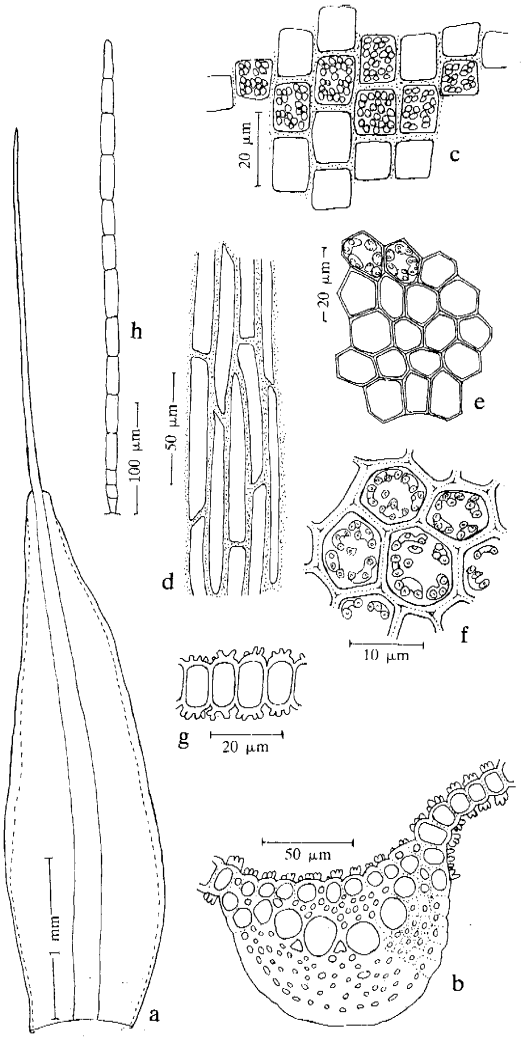


Fig. 93. *Barbula crinita*

Barbula luteola (Mitt.) Par. 1894, *Ind. Bryol.* p.82.
Basionym: *Tortula luteola* Mitt. 1856, *Kew J. Bot.* **8**:258.
Type: Australia.

Barbula pungens (Hook. f. et Wils.) Jaeg. 1880, *Ber. S. Gall. Naturw. Ges* **1877-78**:408.

Basionym: *Tortula pungens* Hook. f. et Wils. 1859, *Fl.Tasm.* **2**:175. *nom. illeg. incl. spec. prior. (T.luteola* Mitt. 1856). Type: Australia.

Fig. 94

Similar to *B.crinita* Schultz, with which it has been combined, but it is dark green, in loose, softer tufts in moist habitats, such as gorges. Leaves (a) spreading when moist, 2-3 mm long, oblong lingulate, flexuose, narrowed abruptly above to an obtuse or round apex, with a slightly acuminate centre, margin revolute in lower three quarters of leaf; costa channelled, shortly

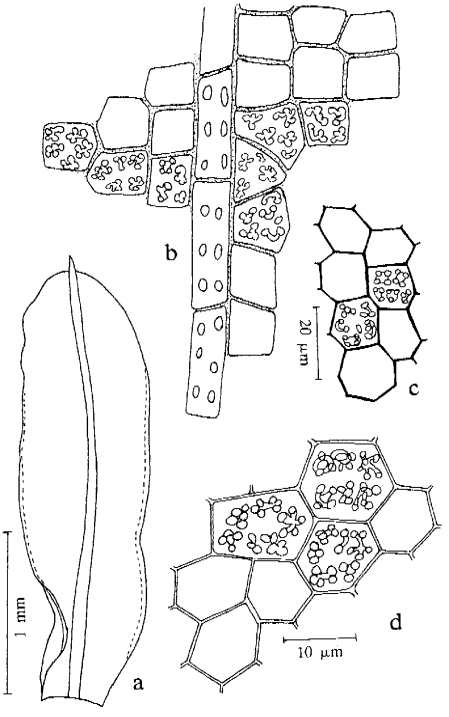


Fig. 94. *Barbula luteola*

excurrent as a stiff point; middle cells on adaxial side of upper part of costa (b) elongated and bearing a few simple papillae, the lateral cells quadrate and with denser compound papillae. Upper laminal cells (c, d) irregularly hexagonal, 10-14 µm across, walls thin, bearing compound branched papillae; basal cells elongate, rectangular. Perichaetial leaves loose, often not distinct. Seta pale,

1-2 cm; capsule fusiform, 2 mm long; operculum subulate, equal in length to theca; peristome teeth long, slender, red, twisting irregularly.

Distribution: Australia (S.A., Vic., Tas.), endemic? Rare in South Australia (1, 6) in moist places in gorges and depressions.

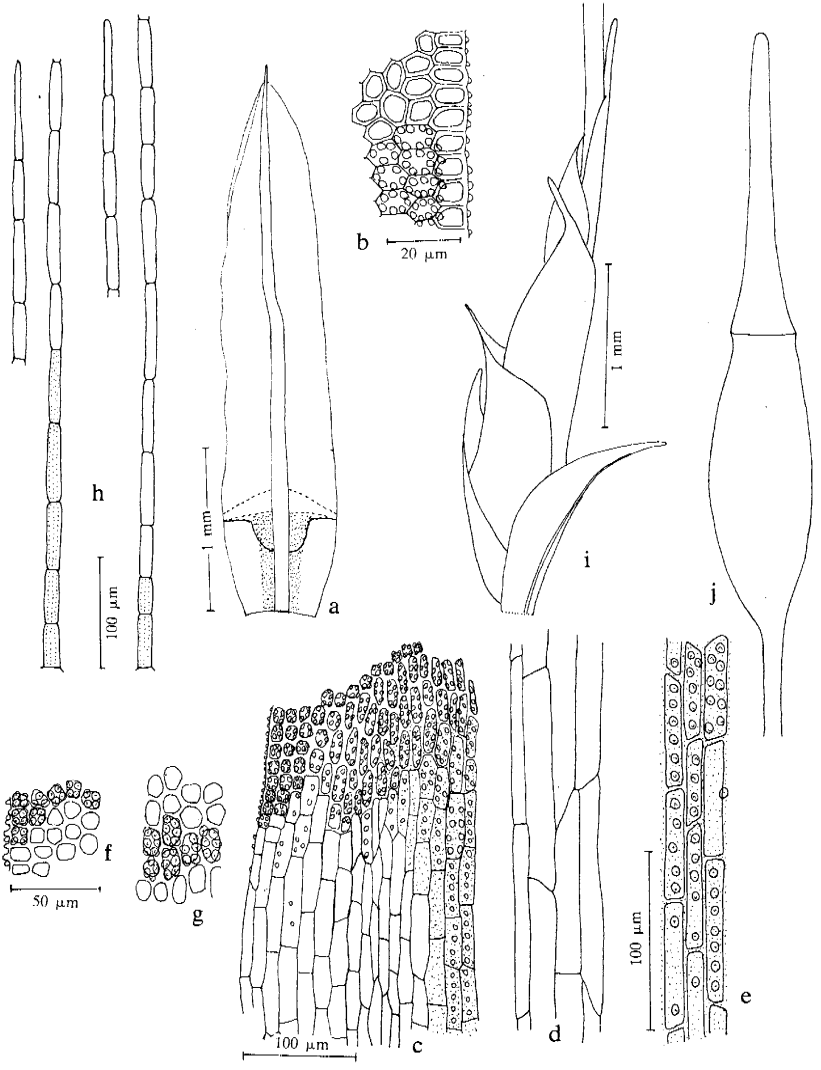


Fig. 95. *Barbula calycina*

Barbula calycina Schwaegr. 1823, *Spec. Musc.* Suppl. **2**(1):63.

Type: New Holland, coll. La Billardière.

Tortella calycina (Schwaegr.) Dix. 1923, *Bull. N.Z.Inst.* **3**(3):124.

Fig. 95, Plate 5B.

In tufts on earth or rock, usually on open ground, green or yellow-brown above, dark brown below; stems 0·5-3 cm tall, simple or branched, the taller plants densely tomentose. Leaves (a) 2-3 mm long, appressed and contorted, sometimes spirally, when dry, with incurved apices, erecto-patent when moist; widely oblong-lanceolate, acuminate, involute, with variably undulate, entire plane margins; costa stout, 100-120 μm wide below, finely papillose, excurrent in a longer or shorter mucro. Upper cells (b) 8-10 μm isodiametric, dense and obscure, with several papillae on each surface of each cell; passing below to longer cells within than at margin (c, f, g) then to lower cells (c) which are elongated, hyaline and smooth (d), with several rows of cells adjacent to costa (e) golden in colour and seriately papillose. Axillary hairs (h) very long, 0·7 to 0·8 mm long, with two to five basal, long, brownish cells and 8-12 long hyaline cells. Perichaetial leaves (i) longly sheathing, conspicuous, cylindrical; seta very long, 1-3·5 cm, slender, often flexuose, light reddish brown below, yellow above; capsule (j) 1·25-2 mm long, narrowly elliptic or fusiform, brown, erect or inclined, straight or slightly curved; peristome teeth inserted on a short basal membrane, bearing 32 papillose, brown filaments, spirally twisted one-and-a-half to twice around; operculum with a long fine beak at least as long as capsule; spores 8-10 μm.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, Chile. Common in South Australia (1-10, 12, 14, 17) on soil in moist to semiarid areas, on dunes, in mallee and sclerophyll forest, in open areas and on heath.

In recent treatments, the species has usually been assigned to the genus *Tortella*, but it lacks the V-shaped basal area of hyaline cells, ascending up the margin; *Tortella* also has the axillary hairs hyaline throughout, of 10-20 cells. Until the plant has been thoroughly examined, it is preferable to leave it in *Barbula*. It is quite variable, the basal cells adjacent to the costa sometimes lacking either the papillae or the colour or both. The status of *B.subcalycina* C.Müll. (1868, Linnaea **35**:617) is uncertain.

Tribe PLEUROWEISIEAE (Limpr.) Chen 1941, *Hedwigia* **80**:55.

GYMNOSTOMUM Nees et Hornsch. 1823, *Bryol. Germ.* **1**:153 *nom. cons.*

Lectotype: *G.calcareum* Nees et Hornsch.

Calciphilous plants in dense tufts. Leaves ligulate or linear, more or less keeled with plane and entire margins. Costa strong, ceasing below the apex. Upper cells small, rounded quadrate, papillose; lower cells rectangular with yellow walls. Perichaetial leaves somewhat sheathing at the base; seta long; capsule erect, oval, oblong or cylindrical; no peristome; annulus persistent, of one row of small cells; operculum longly rostrate, oblique; calyptra narrowly cucullate, covering half of the capsule. Dioecious.

Gymnostomum calcareum Nees & Hornsch. 1823, *Bryol. Germ.* 1:153
Type: Europe

Fig. 96

Small plants in dense, vividly green mats on damp limestone or sandstone rock or on calcareous soil. Stems slender, 0·3-2 cm tall, simple or fastigiate, densely matted, bright green above, brown below. Leaves (a) 0·7-1 mm at apex of stem, shorter below, usually crowded, crisped when dry, but not neatly curled, erecto-patent or spreading when moist, narrowly lingulate, ligulate or linear; apex variable, rounded, obtuse, acute or apiculate; margins plane, entire, often rough with papillae; costa fairly strong, 30-50 μm wide near base, ceasing below the apex, sometimes papillose above on both sides; in section with a patch of stereids abaxially only. All cells with rather thick walls; basal cells (b) rectangular, to about 40 μm long, about four times as long as wide, smooth, yellowish; upper cells (c) small, 4-6 (-8) μm, subquadrate, papillose on both surfaces. Axillary hairs (d) short, with one basal coloured cell and one to three

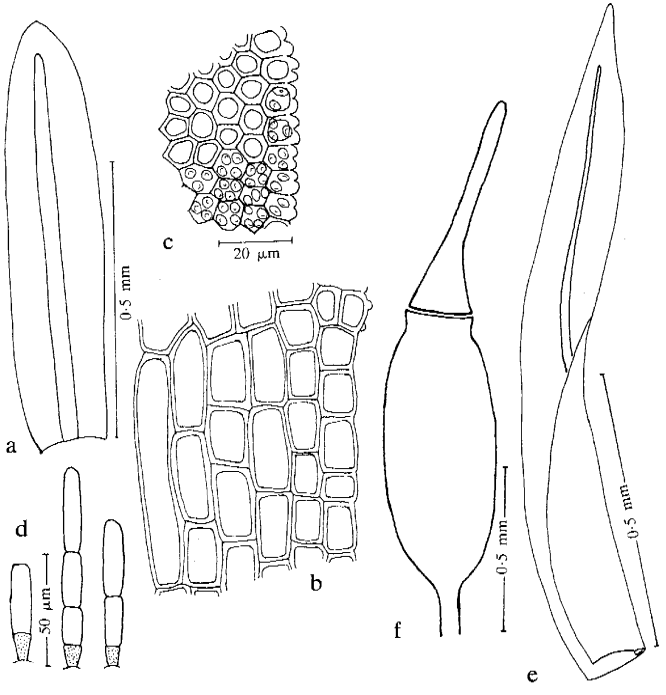


Fig. 96. *Gymnostomum calcareum*

hyaline cells. Perichaetial leaves (e) larger, sheathing basally; seta to about 5 mm long, erect, pale yellow; capsule (f) 0·65 to 1 mm long, elliptical oblong or cylindrical, usually orange-yellow with a reddish mouth; operculum longly rostrate, oblique; spores 9-11 μm, smooth.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T. Qld, N.T.), New Zealand, S.America, S.Africa, N.Hemisphere. Common on basic substrates (1, 6, 10, 17).

Zander (1977) reduced *G.calcareum* to synonymy with *G.aeruginosum* Sm. (1804, *Fl.Brit.* **3:** 1163; type British). The latter is larger with the leaves neatly curled when dry, the costa wider, 60-110 μm wide near the base, with adaxial and abaxial stereids in section and the upper laminal cells larger, usually 10-14 μm across. Zander regards them as connected by transitions; the South Australian plants fit *G.calcareum.*

Tribe LEPTODONTIEAE Herz. 1926, *Geogr. der Moose* p.101.

Leaves borne in three rows, somewhat twisted around the stem.

1. Cells each with several low papillae ..... *Leptodontium paradoxum,* p.187
   Cells each with one large central spinous or branched papilla
   Triquetrella papillata, p.190

LEPTODONTIUM (C.Müll) Hamp. *ex.* Lindb. 1864, *Oefv. K. Vet. Ak. Foerh.* **21**:227.

Trichostomum section *Leptodontium* C.Müll. 1849, Syn. **1**:577.

Type: *L.squarrosum* (Hook.) Hamp. *in* Lindb. 1864 *loc.cit.* =*L.viticulosoides* (P.Beauv.) Wijk and Marg.

Slender to robust plants in loose, yellowish green tufts. Leaves when dry appressed and twisted or curled, when moist usually squarrose, concave, carinate, lanceolate or lanceolate-lingulate from an elliptical or ovate base, margins reflexed below and irregularly toothed above; costa percurrent or ceasing below the apex; cells rectangular, hyaline or yellow at the base, rounded above and in the middle, densely papillose on both surfaces. Perichaetial leaves sheathing; capsule cylindrical; peristome inserted below the rim, with a pre-peristome in some species; teeth smooth or finely papillose, split variably into two filiform segments, sometimes joined above; operculum long, beaked or conical.

Leptodontium paradoxum Stone et Scott 1980, *J.Bryol.* in press

Type: Victoria

Fig. 97

Robust, 1·5-4 cm tall, in loose tufts on soil yellowish green or glaucous green above brown below; outer cells of stem small, thickly walled. Leaves (a) 2-3 mm long, squarrose when moist, loosely appressed and twisted when dry; lanceolate-acuminate from a wide, ovate base, arched, tightly folded above about the costa, margins slightly undulate, recurved in the lower half; base

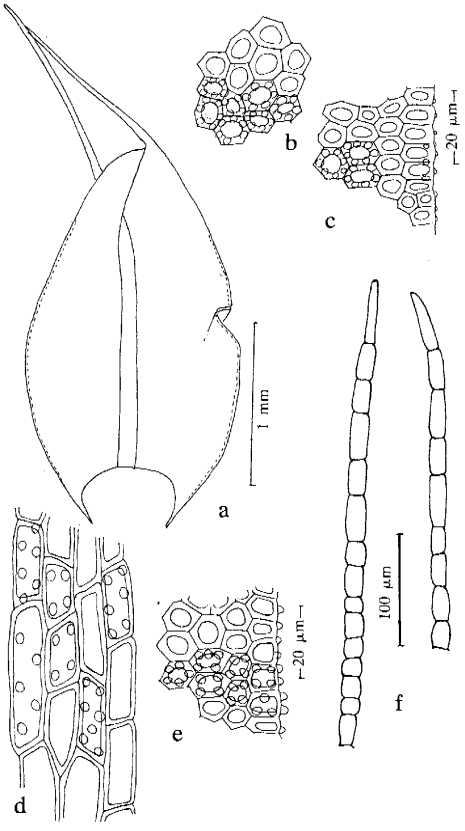


Fig. 97. *Leptodontium paradoxum*

longly decurrent on the stem; costa stout, yellowish, percurrent or excurrent, the cells on the adaxial side more elongated and less papillose than the cells of the lamina. Upper cells (b, c) about 6-7 µm across, hexagonal, very incrassate with rounded cavities, densely papillose, but not obscure, papillae dome shaped; cells becoming longer in a rather small area towards the costa at the leaf base, where they are rectangular (d) and bear rows of papillae; the marginal cells near the base (e) are like the upper cells scarcely larger and papillose except for one or two rows at the extreme base; cells of decurrent base narrowly rectangular, smooth. Axillary hairs (f) hyaline throughout, of 9-15 rather short cells. Fruit unknown.

Distribution: Australia (W.A., S.A., Vic., N.S.W.), endemic. Not uncommon (5, 7), on dry soils, often with *Barbula crinita*, with which it may be confused if the aristae are short. It has also been confused with *Barbula subtorquata*. It has

been known as *L.interruptum* (Mitt.) Broth., recorded from S.Africa and New Zealand, but that species does not have decurrent leaves, the leaf apex is denticulate, the leaves are more undulate, the outer cells of the stem are enlarged and collapsing with age, and the papillae on the basal cells larger and often truncate.

TRIQUETRELLA C.Müll. 1897, *Oesterr. Bot. Zeitschr.* **47**:421

Type species: *T.tristicha* C.Müll.

Slender plants, with filiform stems in loose coherent tufts on soil or rock; stems irregularly branched. Leaves in three rows, appressed when dry, squarrose when moist, concave, carinate, ovate-lanceolate, acuminate, entire, margins recurved in lower part of leaf; costa ceasing below apex, papillose; cells

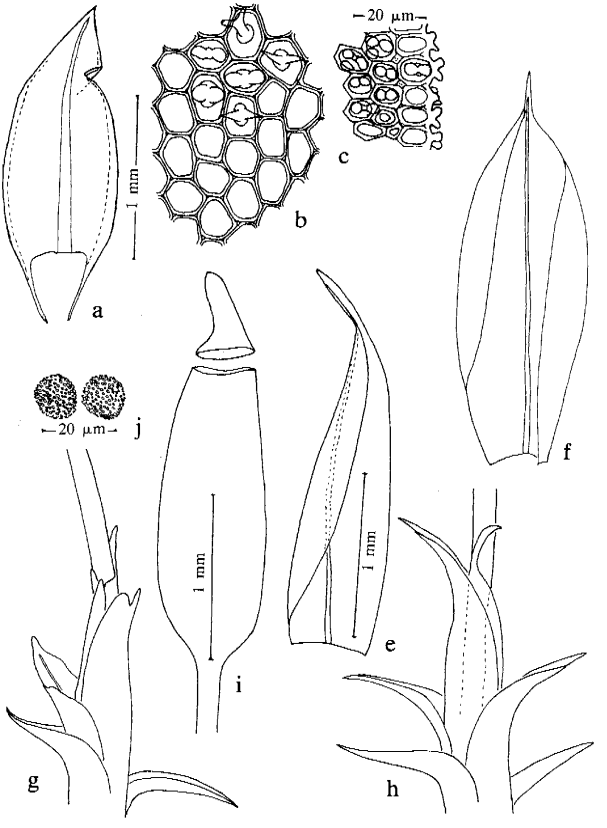


Fig. 98. *Triquetrella papillata*

rounded, green, densely papillose on both surfaces. Perichaetial leaves sheathing; seta yellow, flexuose; peristome inserted below the rim of the capsule, sometimes with a preperistome; teeth 16, short, hyaline, weakly jointed, sometimes slightly split; operculum conically rostrate.

Triquetrella papillata (Hook. f. & Wils.) Broth. 1902, *Nat. Pfl.* **1**(3):399.

Basionym: *Didymodun papillatus* Hook. f. et Wils. 1844, *London J. Bot.*, **3**:544.

Type: Terra Van Diemen

Figs. 98, 99; Plate 6B

In loose mats on earth or rock, often among grass and on old dunes; yellow-green above, brownish below. Stems 2-4 cm tall, filiform, rigid, brittle when dry, irregularly branched, flexuose. Leaves (a) 1-2 mm long, borne in three rows, erect, closely appressed when dry, widely spreading to squarrose when moist, widely ovate-lanceolate or ovate-cordate from a longly decurrent base, carinate, acute to acuminate, margins entire and somewhat revolute in lower half; costa strong, failing below apex or percurrent, papillose above; cells (b) 10-14 μm, hexagonal, incrassate, rounded, densely papillose on both surfaces, papillae tall and spinous or branched and clubbed, one or rarely two per cell; marginal cells (c) smaller. Axillary hairs (d) hyaline, of 6 to 8 cells. Perichaetial leaves (e, f) sheathing, larger, with a broader and longer base quickly narrowed

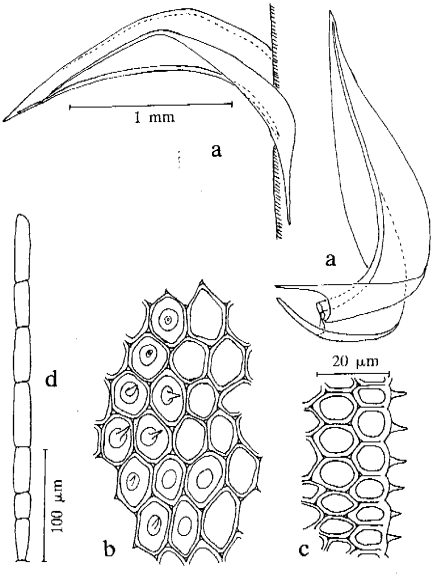


Fig. 99. *Triquetrella papillata*

to a short (g) or long (h) reflexed or straight subula. Seta 1-1·25 cm long, slender, yellow; capsule (i) about 1·5-2 mm long, erect, narrowly cylindrical, light brown; peristome teeth 16, inserted under the rim, hyaline, short, blunt, obscurely and obliquely striolate and cracked irregularly, weakly articulate; operculum with a short and rather blunt curved beak, about a quarter to one third of the length of the capsule; spores (j) 10-18 μm.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Common in South Australia (1, 2, 4-12, 14, 15, 17, 18), but rarely in fruit. Rather variable ranging from forms with short leaves and predominantly branched papillae (fig. 98) to those with longer more acuminate leaves and predominantly or exclusively unbranched spinous papillae (fig. 99). However, there seems to be a continuous series. C.Müller has described a number of "species", but none seem to be at all distinctive.

Subfamily TRICHOSTOMOIDEAE (B. S. G.)Limpr. 1888, *Laubm. Deutschl.* **1**:819.

Key to Genera:

1. Enlarged hyaline cells forming a distinct V-shaped area at the base of the leaf, sharply demarcated from the upper smaller chlorophyllose cells and ascending up the margin 2
   Enlarged hyaline cells not forming a distinct V-shaped area and not sharply demarcated 3
2. Leaves lanceolate or linear lanceolate from a broad base; plants small, annual, cleistocarpous; papillae crescentic ..... *Tetrapterum*, p.191
   Leaves linear lanceolate, not contracted from a broad base; plants large, perennial, stegocarpous; papillae hemispherical ..... *Tortella*, p.200
3. Autoecious, small plants; axillary hairs of 3-5 cells; leaf margin plane or involute ..... *Weissia*, p.193
   Dioecious; plants larger; axillary hairs of 8-15 cells; leaf margin plane *Trichostomum*, p.199

TETRAPTERUM Hamp. *ex* Jaeg. 1869, *Ber.S.Gall.Naturw Ges.* **1868-9**:85.

Type species: *T.australe* Hampe=*T.cylindricum* (Tayl.) Jaeg.

Autoecious. Small mosses growing in dense patches on soil. Leaves coiled or spirally twisted together when dry, spreading when moist; lanceolate or linear-lanceolate to lingulate from a broad base, flat and with an entire margin; costa percurrent; upper cells small, roundish quadrate, both sides of each cell with several C-shaped to ring-shaped papillae; lower cells elongated, rectangular, thinly walled, hyaline and sharply demarcated from the chorophyllose cells. Capsule cleistocarpous, erect, longly ellipsoidal to cylindrical, ridged at the base or with longitudinal ridges, winged in some species; no operculum differentiated; calyptra cucullate.

Andrews (1945) regards *T.tetragonum* (Hook.) Andrews from South Africa as the type and sole member of the genus, assigning our species to *Astomum*.

Tetrapterum cylindricum (Tayl.) Jaeg. 1869, *Ber. S.Gall.Naturw. Ges.* **1868-9**:86.

Basionym: *Phascum cylindricum* Tayl. 1846, *London J. Bot.*, **5**:42

Type: Western Australia, Swan River, coll. J. Drummond.

Fig. 100

Stems short, 1-2 mm tall, the whole plant (a) not exceeding 5 mm. Leaves (b, c, d) lanceolate, the upper ones (d) to 1·5 mm long, erect or erecto-patent when moist, the lower ones small and spreading; concave, the hyaline base wide, narrowing rapidly to the lingulate, green, upper part; leaves, when dry, folded along costa, incurved and twisted spirally around the stem; costa strong, golden, papillose on both surfaces above, shortly excurrent. Basal cells shortly rectangular, pellucid, 8-10 μm wide and mostly two or three times as long as

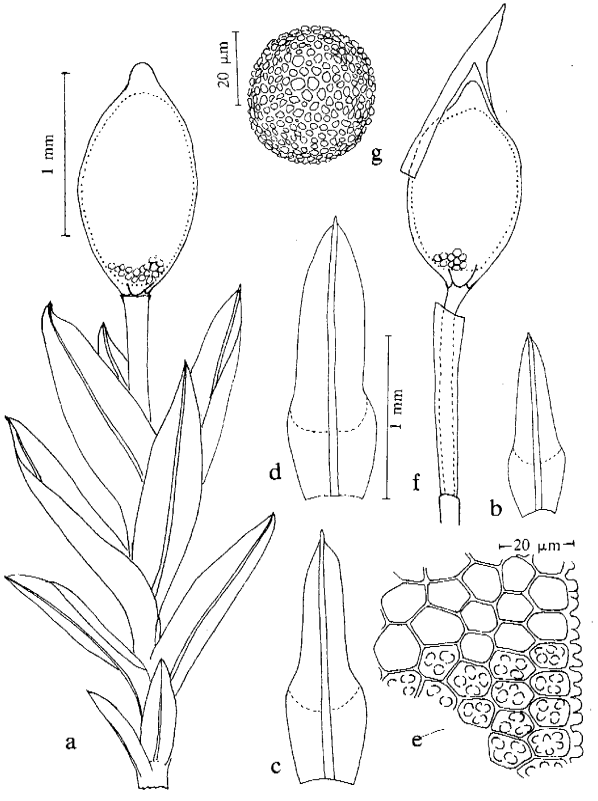
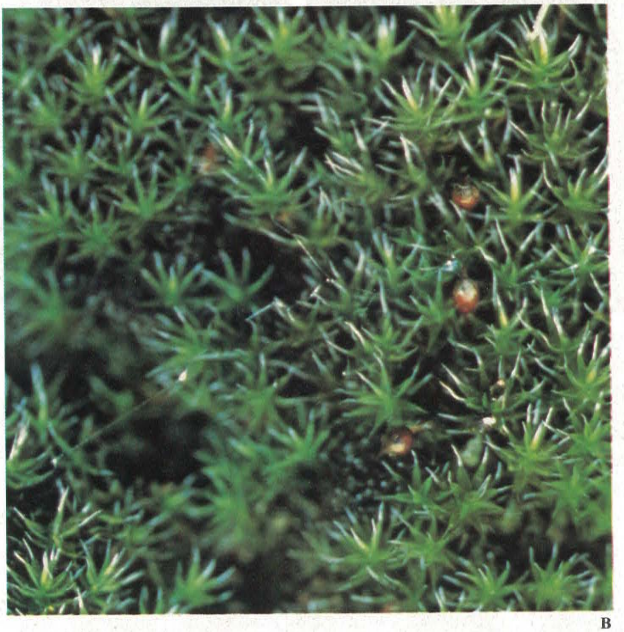


Fig. 100. *Tetrapterum cylindricum*

Plate 1. A, *Polytrichum juniperinum* x3; B, *Dawsonia longiseta* x3; C, *Polytrichum juniperinum* male.

A



B

Plate 2. A, *Grimmia pulvinata* x3; B, *Grimmia laevigata* x3.

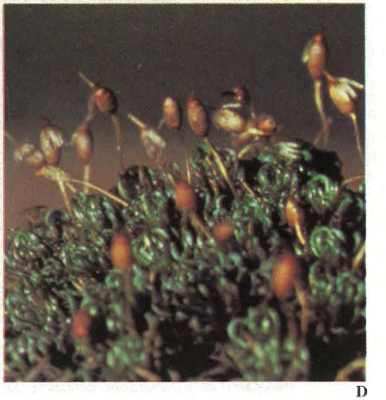
Plate 3. A, *Ditrichum cylindricarpum* x4; B, *Dicranoloma diaphanoneurum* x4; C, *Dicnemoloma pallidum* moist x4; D, *Dicnemoloma pallidum* dry x4.

Plate 4. A, *Campylopus introflexus* dry x4; B, *Campylopus introflexus* moist x4; C, *Campylopus clavatus* dry x4; D, *Campylopus clavatus* moist x4.

A

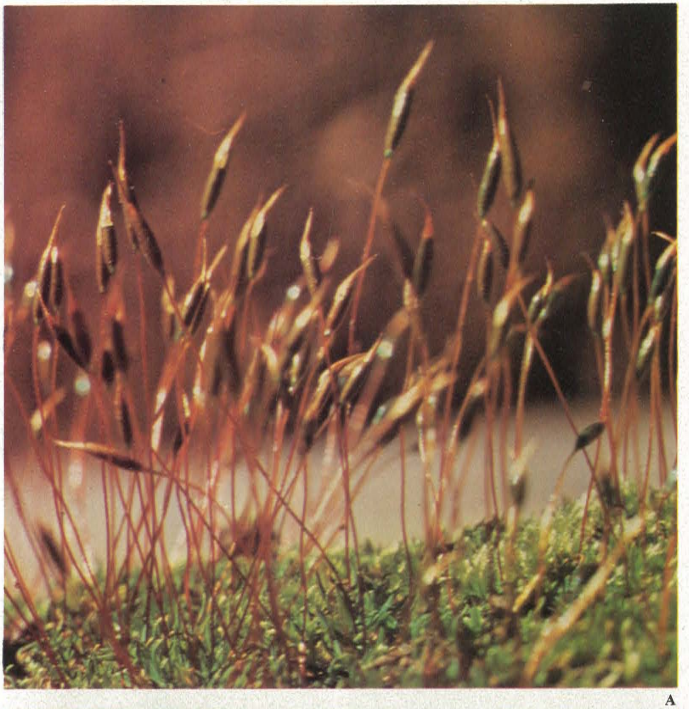
B

C



D

Plate 5. A, *Tortula princeps* x3; B, *Barbula calycina* x3; C, *Encalypta vulgaris* x4; D, *Ptychomitrium australe* x4.

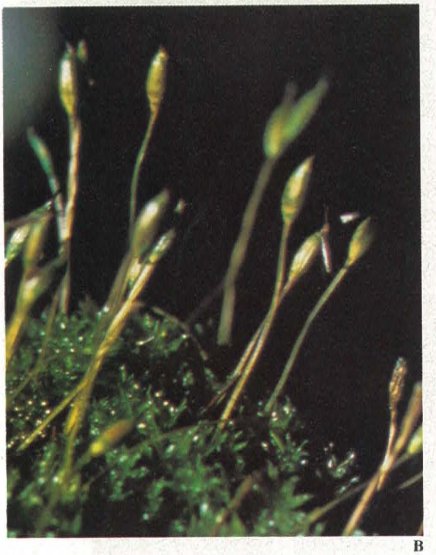


A

B

Plate 6. A, *Desmatodon recurvatus* x4; B, *Triquetrella papillata* x4.

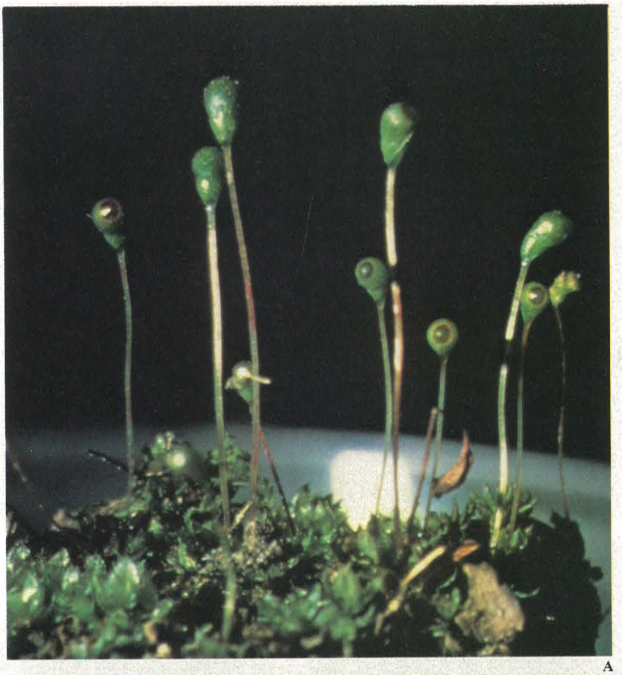
A



B

C

Plate 7. A, *Macromitrium tenue* x4; B, *Zygodon hookeri* x4; C, *Crossidium davidai* x4.



A

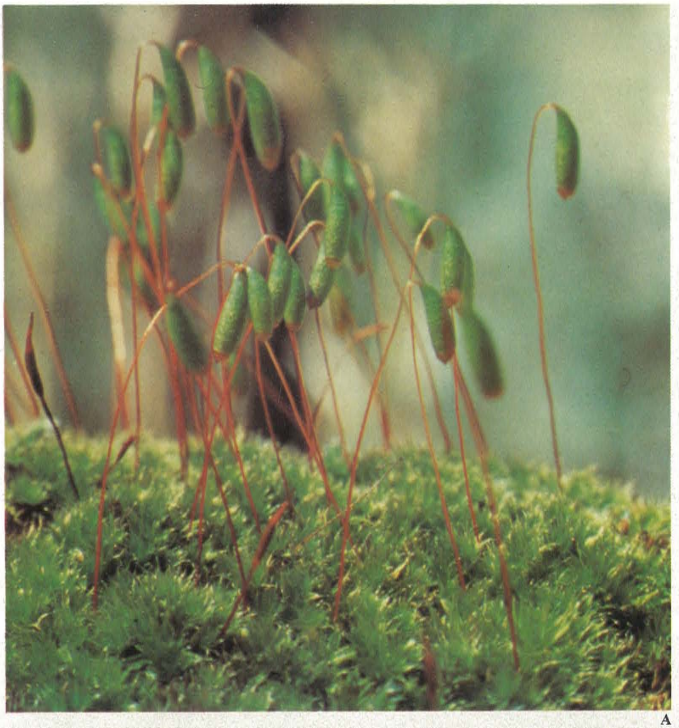
B

Plate 8. A, *Funaria glabra* x4; B, *Funaria hygrometrica* x4.

A

B

Plate 9. A, *Mielichhoferia bryoides* x4; B, *Bryum argenteum* x4.



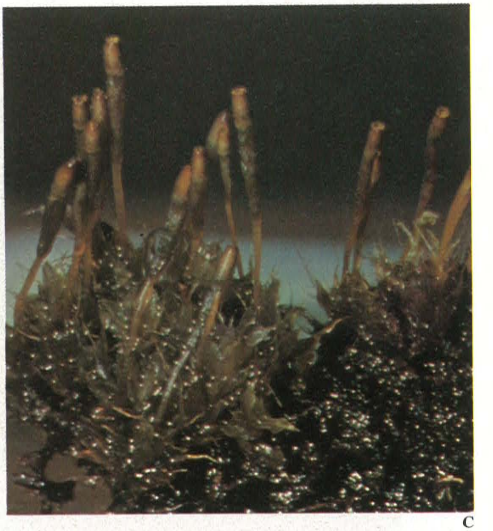
A

B

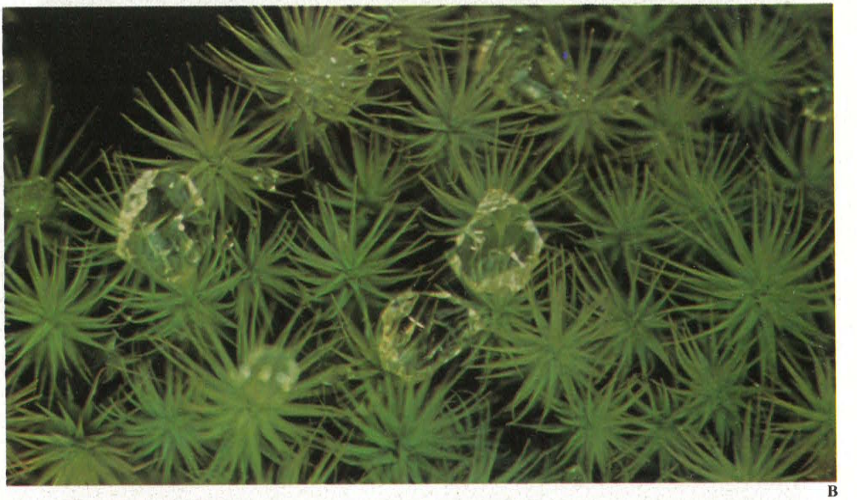
C

Plate 10. A, *Bryum torquescens* x3; B, *Gigaspermum repens* x4; C, *Funaria helmsii* x4.

A



C



B

Plate 11. A, *Bartramia hampei* x4; B, *Bartramia species A* x4; C, *Tayloria octoblepharis* x4.

A

B

Plate 12. A, *Breutelia affinis* x4; B, *Breutelia affinis* male x4.

A

B

C

Plate 13. A, *Pseudoleskea imbricata* x3; B, *Thuidium furfurosum* x4; C, *Campylopus austro-subulatus* x4.

A

B

C

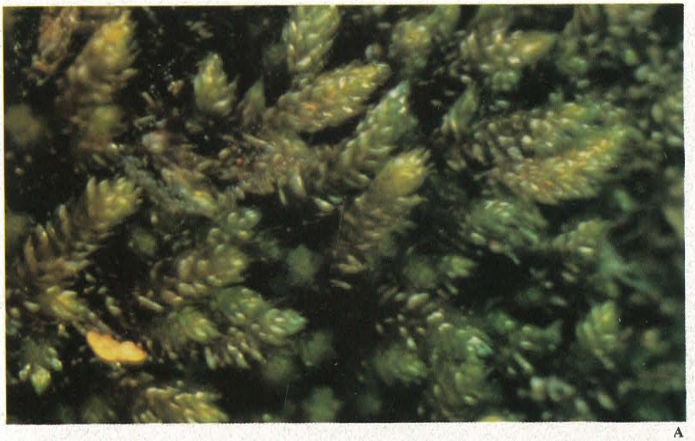
Plate 14. A, *Anomodon tasmanicus* x4; B, *Rhacopilum convolutaceum;* C, *Orthotrichum tasmanicum* x4.

A

B

C

Plate 15. A, *Ischyrodon lepturus* dry x4; B, *Ischyrodon lepturus moist* x4; *C, Sematophyllum homomallum* x4.



A

B

Plate 16. A, *Hypnum cupressiforme* var. *lacunosum* x3; B, *Hypnum cupressiforme* var. *lacunosum* x5.

wide, extending higher at the margin than at the costa, walls firm; upper cells (e) obscure, about 10 μm across, irregularly hexagonal, with numerous crescentic papillae on each cell. Seta (f) 1-2 mm tall, capsule (f) 1-1·4 mm long, emergent (a) from the perichaetium, oblong or cylindrical with a short thick conical apex and four basal and four apical ridges, sometimes showing on the rest of the capsule and most obvious in the dry state; calyptra cucullate, with a long pointed apex, covering nearly half of the capsule; spores (g), 30-35 (-40) μm, brown, coarsely verrucose, the verrucae flat or indented apically and sometimes confluent.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), endemic. Not uncommon in South Australia (2, 6, 8, 11, 15) on bare soil, usually in sclerophyll scrub with some shade.

WEISSIA Hedwig 1801, *Spec. Musc.* p.64.

Lectotype: *W.controversa* Hedw. *fid.* Mitten 1856, *Kew J. Bot.* **8**:258.

Small terrestrial plants in dense mats. Leaves crisped when dry, mostly lanceolate, canaliculate, the upper ones being larger; costa strong, excurrent; margin plane or incurved; basal cells hyaline, smooth and rectangular, passing gradually into the middle and upper ones, which are small, isodiametric and papillose on both surfaces. Axillary hairs of 3-5 hyaline cells. Perichaetial leaves similar; seta usually longer than perichaetium, but short in some; capsule erect, symmetrical or slightly inclined and gibbous, globose, oval or elliptical, cleistocarpous or stegocarpous; peristome none or of 16 short teeth, often rudimentary and undivided; operculum with a long oblique beak.

The genus was spelt *Weissia* by Hedwig, but because *Weissia* Ehrh. has also been used for the genus *Ulota,* many writers have used the spelling *Weisia.* It is said that the botanist from Göttingen, for whom the genus was named, spelt his name Weiss or Weis. It is preferable to adhere to Hedwig's usage which predates Ehrhardt's (1802) *hom. illeg.*

The genus is commonly divided into three subgenera, our species being distinguished as follows:

1. Capsule cleistocarpous ..... Subgen. *Astomum: W.willisiana,* p.194
   Capsule stegocarpous 2
2. Capsule without any peristome, broadly ovate subspherical
   Subgen. *Hymenostomum: W.brachycarpa,* p.196
   Capsule with peristome teeth, ovate, elliptical or cylindrical
   Subgen. *Weissia* 3
3. Leaves narrowly lanceolate, tapering, margin involute; capsule more or less ovate elliptical; spores very finely papillose ..... *W.controversa,* p.196
   Leaves lingulate to oblong, parallel sides, abruptly contracted to an acute apex, margin plane; capsule cylindrical, longer; spores more coarsely papillose ..... *W.rutilans,* p.197

Weissia willisiana (Sainsb.) comb. nov.

Basionym: *Pottia willisiana* Sainsb. 1956, *Rev. Bry. Lichenol.* **25**:237.

Type: Northern Territory, Standley Chasm, coll. Rica Erickson, July 1955, in Herb. Sainsb. no. 18, 280; dupl. in Herb. MEL.

Fig. 101

Plant (a) minute, total height including fruit 2 mm, growing on soil. Leaves (b) narrowly oblong lanceolate, carinate, spreading and recurved; upper leaf cells (c, d) small, 7-9 μm across, papillose, obscure, margin denticulate; passing below to smooth cells (e), larger and hyaline at the base and narrow and thinly walled at the margin (f). Seta very slender bearing a small globose, cleistocarpous capsule (a); calyptra (g) cucullate.

Distribution: Australia (N.T.) endemic. This and other minute species of the section *Astomum* probably occur in South Australia but are very inconspicuous.

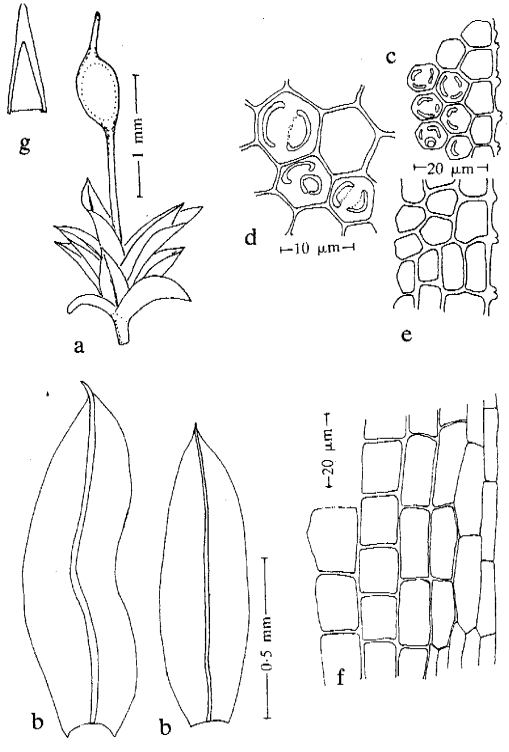


Fig. 101. *Weissia (Astomum) willisiana*

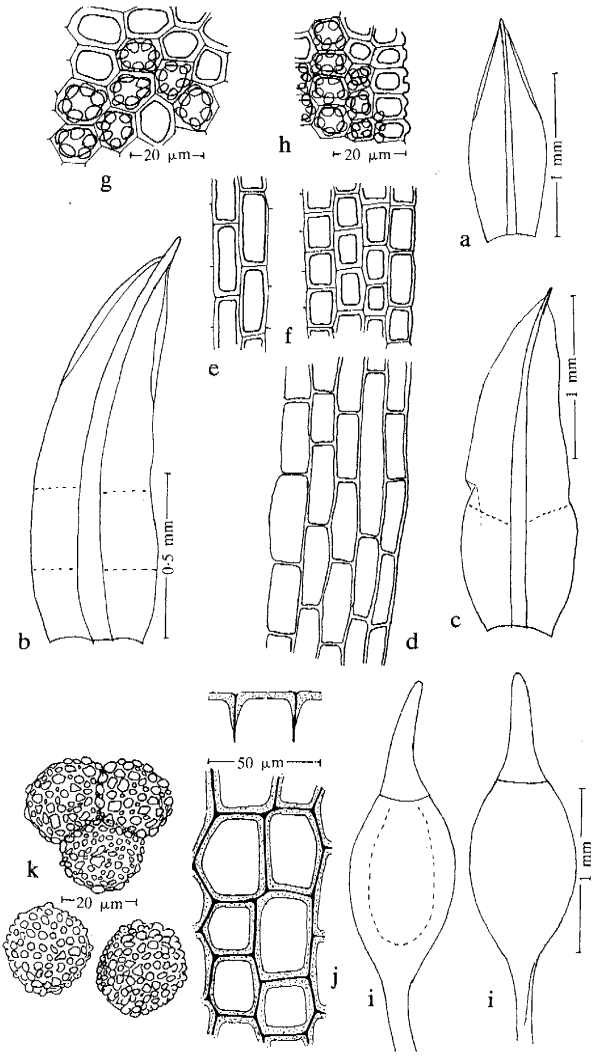


Fig. 102. *Weissia brachycarpa*

Weissia brachycarpa (Nees et Hornsch.) Jur. 1882, *Laubm. Oest. Ungarn.* p.9.

Basionym: *Hymenostomum brachycarpum* Nees et Hornsch. 1823, *Bryol. Germ.* **1**:196.

Type: Germany.

Weissia microstoma (Hedw.) C.Müll. var. *brachycarpa* (Nees et Hornsch.) C.Müll. 1849, *Syn.* p.662.

Fig. 102

Plants 2-10 mm tall, stems erect. Leaves (a, b) erecto-patent when moist, strongly crisped when dry, oblong-lanceolate, acute; costa strong, shortly excurrent, adaxial cells quadrate in upper part, elongated below; margin plane or somewhat involute above; perichaetial leaves (c) larger with a more sheathing base; basal cells (d) hyaline, rectangular, narrower near and at margin, becoming shorter and thicker upwards (e, f) especially near the margin (f); cells (g) in upper half to two thirds of leaf hexagonal, with thick walls and rounded cavities, densely papillose on both surfaces, cells rather obscure, 9-13 μm across, smaller towards margin (h). Seta 3-4 mm long, pale brown; capsule broadly ellipsoid, with a rostrate somewhat oblique operculum; no peristome; exothecial cells thickened at and towards the surface (j); spores (k) large, 22-26 μm diameter, often adhering in tetrads, densely and irregularly verrucose, the verrucae more or less flattened.

Distribution: Europe, Australia (S.A., Vic.). Rare in South Australia (2, 5) on dry soils. It is uncertain whether the plant is the same as the European one.

Weissia controversa Hedw. 1801, *Spec. Musc.* p.67.

Type: Germany.

W.nudiflora C.Müll. et Hamp. 1855, *Linnaea* **26**:496. Type: South Australia, Bugle Range, coll. F.v.Mueller no. 32, Herb. MEL 29186, 1002835.

W.riparia Hamp. 1860, *Linnaea* **30**:626. Type: South Australia, Gawler River, coll. F.v.Mueller no. 33, Herb. MEL 76046, 1002836.

Hyophila inflexa Hamp. et C.Müll. *in* C.Müll. 1900, *Gen. Musc. Fr.* p.394 *nom. nud.* Type: Part of same collection as *W.riparia* Hamp., Herb. MEL 76047. Also cited as *Pottia (Hyophila) inflexa in sched.*

Fig. 103

Autoecious. Small, bright green or yellowish green plants growing in dense turfs or cushions; stems erect, to 5 mm high. Leaves (a, b, c) increasing in size upwards, the upper leaves to 3 mm long, concave, strongly crisped when dry, erect to spreading when moist, linear-lanceolate tapering gradually from a short pale base, mucronate; margin plane below, strongly involute above; costa yellowish, 45-69 μm wide below, excurrent in a short mucro (d), adaxial cells more or less quadrate above; basal cells rectangular, hyaline; upper cells (e) hexagonal, walls thick, cavities rounded, 7-8 μm across, obscure, papillose. Seta 4-8 mm long, yellow; capsule (f, g) ovoid to elliptical, the theca up to 1·25 mm long, brown; operculum with an oblique beak; peristome teeth (i) poorly developed, to 120 μm long, inserted below the rim, brownish, papillose;

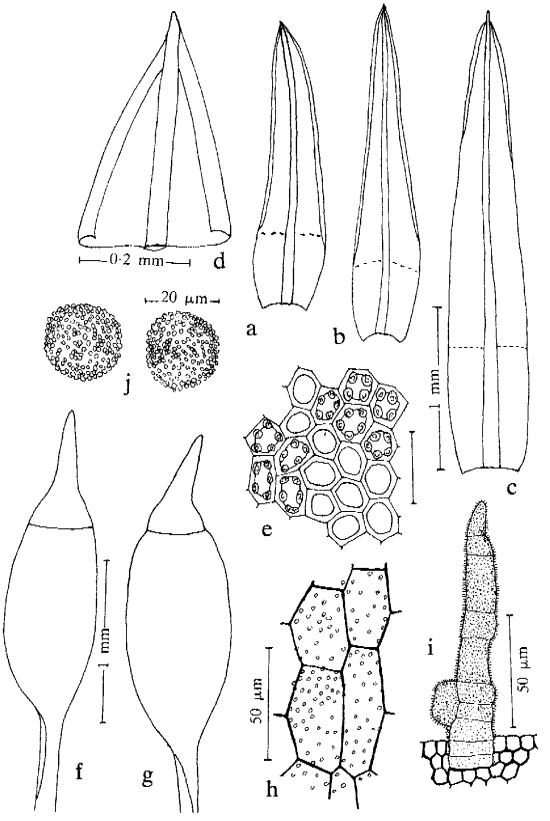


Fig. 103. *Weissia controversa*

exothecial cells (h) with rather thin walls and a faintly granular surface; spores (j) brown, finely papillose, 16-20 µm diameter.

Distribution: Almost cosmopolitan, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld., N.T.), New Zealand. Common in South Australia (1, 6, 14, 15, 17), on otherwise bare soil, usually fruiting abundantly.

Weissia rutilans (Hedw.) Lindb. 1863, *Oefv. K. Vet. Ak. Foerh.* **20**:417.

Basionym: *Gymnostomum rutilans* Hedw. 1801, *Spec. Musc.* p.37.

Type: Sudeten Mountains, coll. Rev. Starke.

W.muelleri Hamp. *in sched.* Australia coll. F.v.Mueller, in Herb. MEL 76048, 1002828 (fig.104f-j).

Fig. 104

Plants similar to *W.controversa,* growing in moister habitats. Leaves (a, b, f, g, h) increasing in size, especially in length, upwards (b, h), oblong lanceolate to linear lanceolate; margin plane throughout; costa excurrent in a mucro, the adaxial cells quadrate in the whole upper two-thirds; middle and upper laminal cells (c) irregularly hexagonal, 7-10 μm across, narrower at margin, very incrassate, obscure, densely papillose. Seta yellowish green, capsule (i) cylindrical or ovate ellipsoid; operculum with a moderate to long curved beak; peristome teeth (d) rudimentary, fugacious, reaching no more than 75 μm in length, pale, almost smooth; spores (e, j) 20-24 μm diameter, densely papillose.

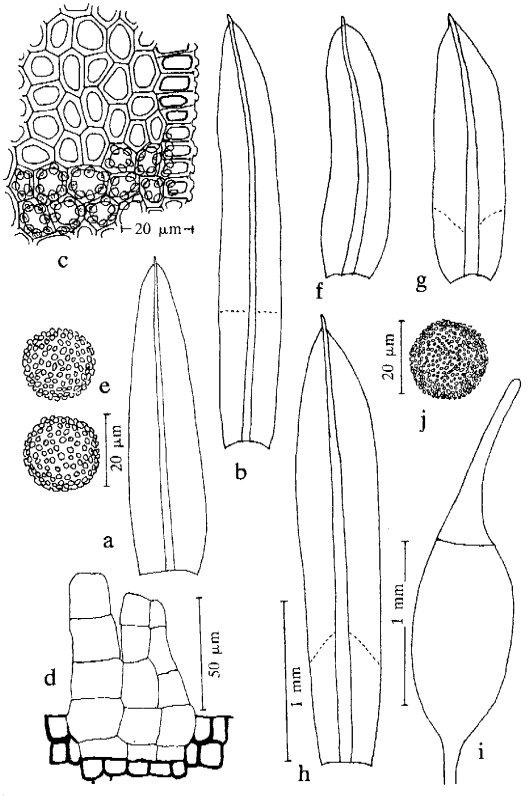


Fig. 104. *Weissia rutilans*

Distribution: Europe, N.Africa, Australia (S.A., Vic.), in South Australia (4, 6, 8, 12, 14, 15) in similar habitats to *W.controversa,* but usually wetter ones.

W.muelleri seems to belong here, though it differs, in the somewhat over ripe S. Australian plants examined in having a broader capsule, a longer operculum and more finely papillose spores.

TRICHOSTOMUM Bruch. 1829, *Flora* 2:295 *nom. cons.*

Lectotype: *T.brachydontium* Bruch.

Usually dioecious. Stem with central strand. Leaves linear-lanceolate to lingulate or lanceolate, acute or obtuse, margin plane or incurved, papillose-crenulate; costa ending below apex or excurrent, in section with two stereid bands, adaxial cells quadrate in surface view; basal laminal cells more or less rectangular, hyaline or yellowish; upper cells smaller, irregularly hexagonal, papillose, obscure. Axillary hairs 8-15 cells long, hyaline. Seta long; capsule erect, ellipsoid or cylindrical; operculum rostrate; peristome teeth entire, perforated or divided, straight; calyptra cucullate.

A plant belonging to this genus occurs at several sites in the MacDonnell Ranges, N.T. and in S.Australia. It cannot be assigned to any known species, but somewhat resembles *T.brachydontium* Bruch.

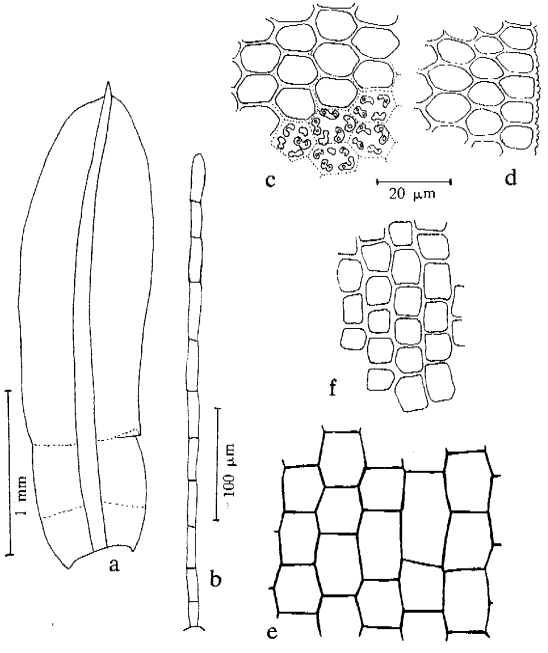


Fig. 105. *Trichostomum sp.*

Trichostomum sp. A.

Fig. 105

Plants short, dark green, shiny. Leaves (a) oblong-spathulate, to 3 mm long by 0·8 mm at the widest point, when dry involute and curled from apex; base slightly sheathing, top of leaf contracting quickly to an obtuse apex; costa strong, excurrent in a short green apiculus, flat on adaxial side with quadrate, papillose cells over upper two-thirds of leaf; margin plane throughout. Axillary hairs (b) 8-12 cells tall, hyaline. Upper laminal cells (c) more or less hexagonal, 8-10(-12) μm across, incrassate, papillose, papillae compound; cells smaller at margin (d); basal cells (e) more or less elongated, thinly walled, smooth; suprabasal cells (f) shorter, quadrate to oblong, very incrassate, smooth.

Distribution: Australia (S.A., N.T.), on soil (2, 12), in gorges and moist places; probably more widespread but overlooked as a large *Weissia*.

TORTELLA (Lindb.) Limpr. 1888, *Laubm. Deutschl.* **1**:520,599.

Mollia subg. 1879 *nom. cons.*

Lectotype: *T.caespitosa* (Schwaegr.) Limpr. *fid.* Haring *in* Grout 1938, *Moss Fl. N. Am.* **1**:165.

Short to tall plants in dense tufts on soil or rock. Leaves very curled when dry, widely spreading when moist, elongate, linearly lanceolate or subulate, concave above, margins plane or incurved, entire and undulate; costa strong, shortly excurrent, in section with two stereid bands, adaxial surface cells quadrate, papillose, abaxial linear-lanceolate, smooth; basal cells rectangular, hyaline, smooth, thin walled, extending obliquely higher up at the margin, sharply differentiated from the other cells of the lamina which are green, small rounded-quadrate and densely papillose on both surfaces. Axillary hairs of 10-20 cells, hyaline throughout. Perichaetium hardly distinct; peristome inserted under the rim of the capsule, borne on a short basal membrane, the 16 teeth each divided into two filiform papillose segments, spirally twisted to the left or straight; operculum elongately conical; annulus deciduous, in 1-3 rows.

Key to South Australian species:

1. Leaves narrowly linear to linear-lanceolate, not very tapering; capsules narrow, about 3 x 0·3-·35 mm; exothecial cells with thick walls; peristome teeth pallid salmon pink with blunt ends ..... *T.dakinii*, p.202
   Leaves linear-lanceolate to ligulate, finely acuminate; capsules wider, 2-2·5 x 0·35-0·4 mm; exothecial cells with thin walls; peristome teeth reddish brown with long tapered ends ..... *T.cirrhata*, p.200

Tortella cirrhata (Hamp.) Broth. 1902, *Nat.Pfl.* **1**(3):397.

Basionym: *Trichostomum cirrhatum* Hamp. 1844, *Icon. Musc.* 28.

Type: Western Australia, sand dunes near Perth.

Fig. 106

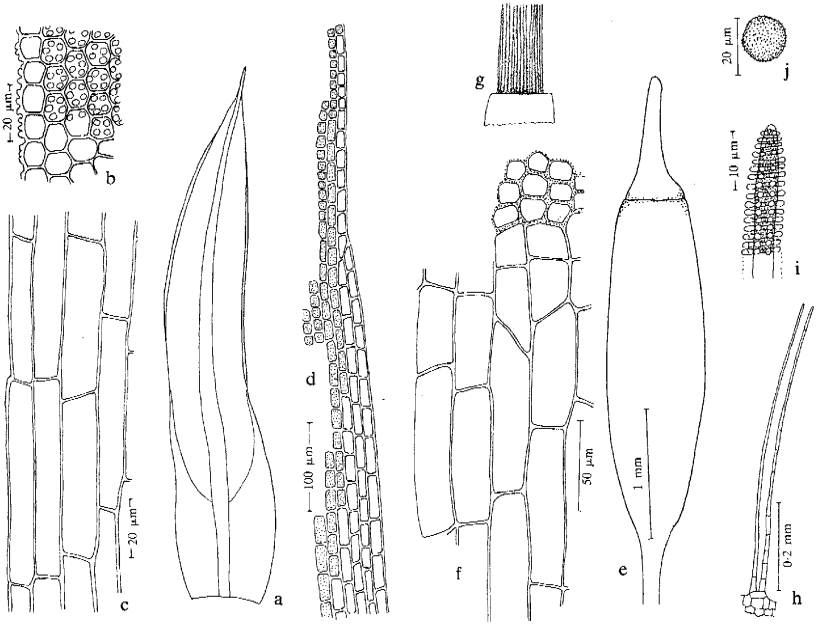


Fig. 106. *Tortella cirrhata*

In dense tufts on calcareous rock or soil, yellow-green to green. Stems 1-2 cm high, simple or branched. Leaves (1) 2·5-3·5 mm, long, crowded, crisped and shiny when dry, spreading when moist, from a widened oblong transparent base, linear-lanceolate to ligulate, finely acuminate, margins undulate, incurved especially above, entire; costa strong, excurrent in a bold sharp point; upper cells (b) quadrate, 7-8 µm, densely papillose; basal cells rectangular (c), 4-8 times as long as wide, hyaline, thinly walled, sharply delimited (d) from upper cells and extending obliquely upwards from costa to margin. Perichaetial leaves similar; seta 1-2 cm, slender yellow above, reddish brown below; capsule (e) 2-2·5 mm, long, narrowly cylindrical, erect, pale brown with a red or dark brown mouth; exothecial cells (f) with thin walls; peristome (g) inserted on the rim, of 16 short teeth each (h) divided to a short basal membrane into two papillose filaments (i), straight or slightly twisted to the right, reddish brown. Operculum with a straight erect beak, at least half the length of capsule; calyptra cucullate; spores (j) 15-18 µm.

Distribution: Australia (W.A., S.A., Vic.), Lord Howe Island. Common in South Australia (2, 5, 6, 9, 17) on light soils, especially sand dunes.

The spores of South Australian specimens are larger than are described for the type (8-10 µm), but no other differences have been seen.

T. knightii (Mitt.) Broth. of Eastern Australia and New Zealand has narrower, more tapering leaves and a peristome spirally twisted at least once and to twice around, nearly 1 mm high.

Tortella dakinii Willis 1955, *Victorian Nat.* **72**:6.

Type: Victoria, Pound Bend, Warrandyte, on shaded Silurian rocks of steep cliffs along Yarra River, coll. E.Dakin, 19.xi.1951, in Herb. MEL, no.170W.

Fig. 107

Autoecious. Stems to 1 cm tall; leaves (a) erecto-patent when moist, carinate, slightly concave, to 3 mm long, narrowly linear or linear-lanceolate, sides parallel contracting quickly to subacute; margin plane and entire; leaves when dry involute and contorted; perichaetial leaves similar, but smaller, costa strong,

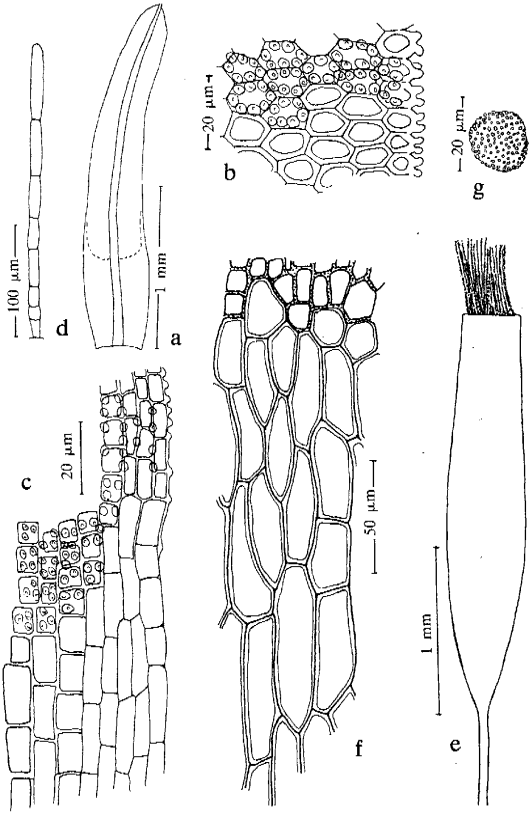


Fig. 107. *Tortella dakinii*

shortly excurrent as a mucro, adaxial cells quadrate, papillose; upper cells (b) hexagonal, 8-10 μm across, incrassate, smaller towards the margin, densely papillose, papillae dome shaped; basal cells rectangular, pellucid, higher at margin (c) than at costa. Axillary hairs (d) hyaline, 8-10 cells high. Seta very slender, 1·2-2 cm long, shiny, reddish; capsule (e) slender, the theca 2-3 mm long x 0·25-0·35 mm wide, narrowly cylindrical, light chestnut in colour; exothecial cells (f) with periclinal walls thickened towards the surface; operculum erect, narrowly conically rostrate, to 0·7 mm long; peristome teeth pallid salmon pink, with blunt tips; calyptra mitriform, nearly as long as theca; spores (g) 12-16 μm diameter, sparsely and minutely verruculose.

Distribution: Australia (S.A., Vic.). Rare in South Australia (5), sometimes with *T.cirrhata*.

Some colonies with the gametophytic characters of *T.cirrhata* have sporophytes similar to those of *T.dakinii*, in the capsule being narrowly cylindrical and having thickly walled exothecial cells. Their spores are very variable in size, many small and shrivelled and others not ornamented. These are evidently hybrid sporophytes.

Family **BRYOBARTRAMIACEAE** Sainsb. 1948, *Bryologist* **51**:10.

BRYOBARTRAMIA Sainsb. *loc. cit.* A monotypic family and genus with the characters of the only species.

Bryobartramia novae-valesiae (Broth. *ex* Roth) Stone and Scott 1973, *J. Bryol.* **7**:604.

Basionym: *Trachycarpidium novae-valesiae* Broth. *ex* Roth 1913, *Hedwigia* **53**:94.

Type: New South Wales, near Young, coll. W.W.Watts no. N.S.W. 7136, 29.viii.1905.

Bryobartramia robinsii Sainsb. 1948, *Bryologist* **51**:10. Type: Victoria, near Castlemaine, on ground in grassland or grass forest land, alt. 900 ft, leg. F. Robbins no. 40a, 1942 (?).

Figs. 108, 109, 47e

Small plants (a) clustered on a persistent, colourless, smooth, irregularly branched protonema, whose cross walls are usually oblique; plants sometimes 3 mm but usually much less, stem very short, of very delicate colourless thinly walled cells, no central strand. Lowest leaves less than 0·5 mm long, widely oblong, usually obtuse but sometimes bluntly acute; higher leaves (b) lengthening to 1 × 0·3 mm, variable in shape from oblong to broadly spathulate, acute or acuminate, more or less concave, margins plane and entire; costa absent or very weak at base of leaf, fairly strong above, 45μm wide, ceasing below apex or percurrent with 3 to 6 layers of cells in section, uniform and firm-walled in thinner parts, differentiated into larger adaxial and median cells with a small abaxial patch of stereids in the thicker part. Upper cells (c) of leaf 15 μm, irregularly hexagonal, each with several crescentic papillae, walls firm; lower cells (d) longer, rectangular, smooth, hyaline, firmly walled. Perichaetial leaves (e, f) to 1·75 mm long, lanceolate, subulate, subula often twisted (e), with plane

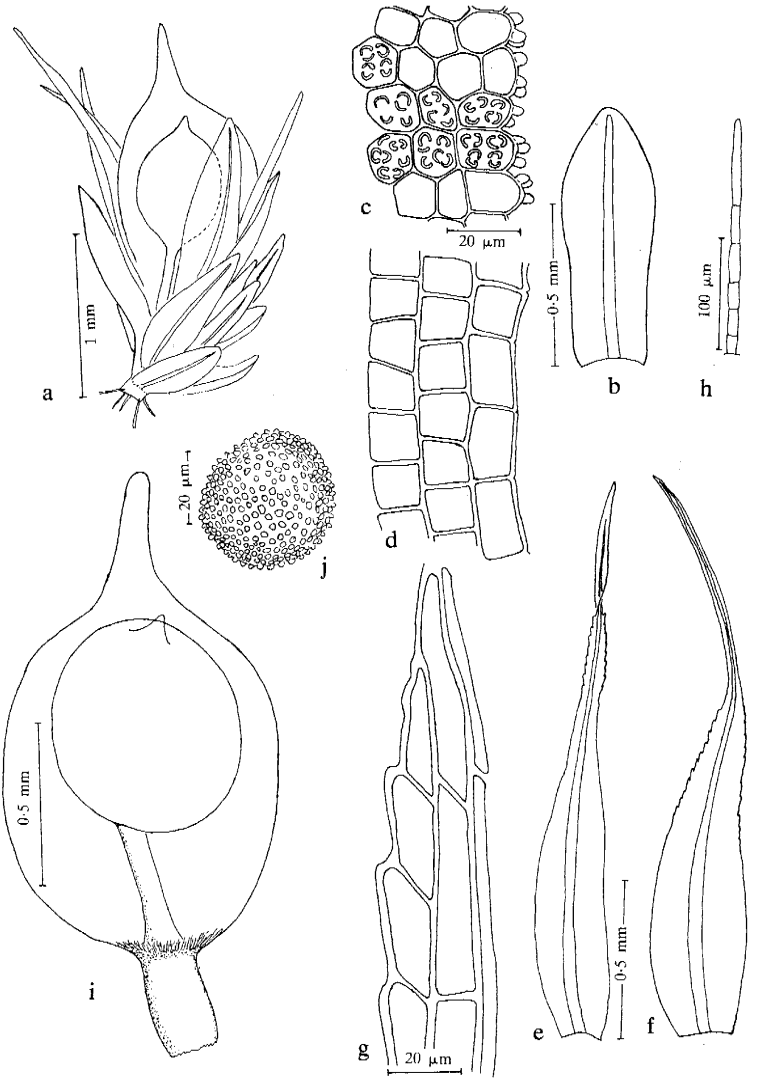


Fig. 108. *Bryobartramia novae-valesiae*

margins, denticulate above (g), costa ceasing in subula; cells 22-55 µm long, longer above, irregularly oblong or pentagonal, smooth with firm walls. Axillary hairs (h) hyaline, of 5-8 cells. Epigonium (derived from the archegonium and

not rupturing into vaginula and calyptra) remaining entire and forming, by its growth, a greatly inflated pseudocalyptra enclosing and much exceeding the seta and capsule; pseudocalyptra about 1·5 mm long by 0·7 mm wide, smooth and pale with a brown apiculus; seta about 180 μm long, reddish brown with firm cell walls; capsule (i) 0·75 × 0·55 mm, broadly ovate or suborbicular, shortly apiculate, cleistocarpous; exothecial cells with extremely thin and delicate walls, about 35 μm diameter, isodiametric, angled, hyaline, somewhat tumid; spores (j) 35-45 μm, brown, often irregularly shaped, with dense, high papillae. Monoecious.

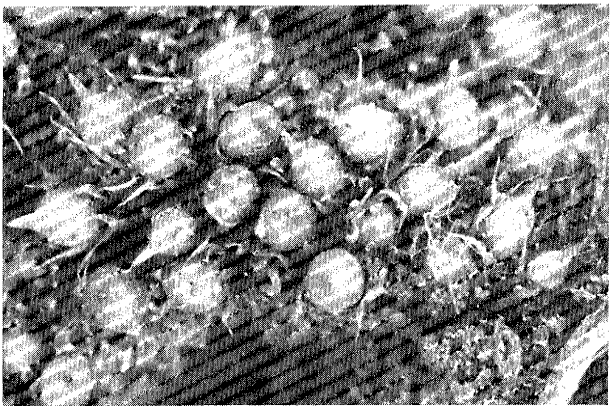


Fig. 109. *Bryobartramia novae-valesiae*

(After Stone, 1977) x12

Distribution: Australia (W.A., S.A., Vic., N.S.W., A.C.T.), South Africa. Very rare (14, 17) on soil, usually in small patches. Stone (1977) has described this interesting and unique moss very fully and discussed its affinities.

Family **ENCALYPTACEAE** Schimp. 1856, *Coroll. Bryol. Eur.* p.38.

ENCALYPTA Hedw. 1801, *Spec. Musc.* p.60.

Type species: *E. vulgaris* Hedw.

Erect tufted plants with simple or branched stems, densely leafy. Margin of leaf plane, entire; costa strong; upper cells of leaf isodiametric, chlorophyllose, densely papillose on both surfaces; basal cells rectangular, hyaline, with thin longitudinal and thickened transverse walls. Calyptra very large, campanulate, cylindrical, completely covering the capsule; seta long, smooth; capsule erect, cylindrical, peristome none or single or double; operculum with a long erect beak; spores large, coarsely papillose.

Encalypta vulgaris Hedw. 1801, *Spec. Musc.* p.60.

Type: Europe.

Fig. 110; Plate 5C

In dense tufts on rock or soil, generally calcareous, green to yellow green; stems 0·75-2 cm tall. Leaves (a) to 3 mm long, crowded, twisted and with apex incurved when dry, broadly oblong, narrowed below, concave above, obtuse or acute; margin entire, rough with papillae; costa strong, failing below apex or shortly excurrent; upper cells (b) 12-18 μm, isodiametric, obscure with dense papillae; papillae lobed; lower cells (c) rectangular, hyaline, with a few simple

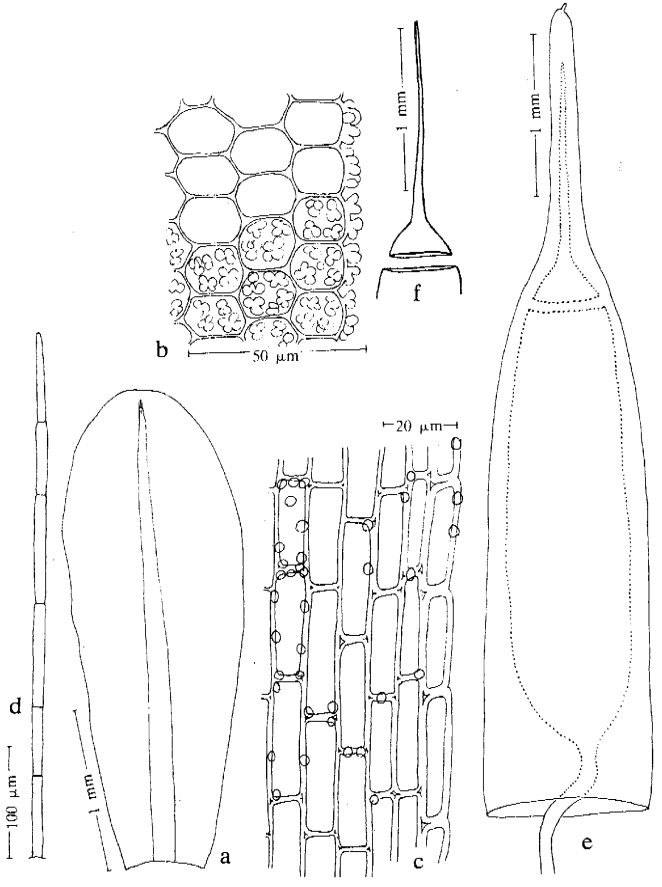


Fig. 110. *Encalypta vulgaris*

papillae, the marginal cells much narrower and forming a border. Axillary hairs (d) hyaline, slender, of 5-7 long cells. Seta about 1 cm long, red; capsule (e) 3-4 mm long, very narrowly cylindrical, smooth or becoming slightly striate with age; no peristome; operculum (f) with a long, slender erect beak; calyptra (e) very large, completely covering the capsule, usually smooth, but sometimes scabrous at the apex, base entire; spores angular and wrinkled, 32-36 μm diameter. Autoecious.

Distribution: Northern Hemisphere, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Rather rare in South Australia (12, 14, 15), only in Flinders Ranges.

Family **PTYCHOMITRIACEAE** Schimp. 1860, *Syn. Musc. Eur.* p.241.

Mosses usually in tufts or cushions on rocks. Leaves lanceolate to linear, crisped when dry, not shiny, costa ceasing below apex; basal cells rectangular, upper cells quadrate to hexagonal. Capsule erect, smooth, exserted on a long, straight or curved seta; peristome single, entire or each tooth perforated or divided; calyptra campanulate. A careful study of the peristome and its development is needed to determine whether this family is more closely related to the haplolepideous Grimmiaceae.

PTYCHOMITRIUM Fuernr. 1829, *Flora 12* Erg. **2**:19 *nom. cons.*

Type: *P.polyphyllum* (Sw.) B.S.G.

In dense tufts on rocks. Leaves curled when dry, narrowly lanceolate; cells often in two layers above, especially marginally; perichaetial leaves similar. Seta straight; capsule ovoid or elliptical, smooth; peristome teeth 16, narrowly lanceolate, papillose, each tooth deeply divided into two segments; operculum with a long, fine erect beak; calyptra mitriform, plicate, evenly divided all round.

Ptychomitrium australe (Hamp.) Jaeg. 1874, *Ber. S. Gall. Naturw. Ges.* **1872-73**:105.

Basionym: *Brachysteleum australe* Hamp. 1856, *Linnaea 28*:209.

Type: Australia, Victoria, Buchan River, F.v.Mueller.

P.acutifolium Hook.f.et Wils. 1859, *Fl.Tasm. 2*:180. Type: Tasmania.

Fig. 111; Plate 5D

In dense tufts on rocks, dark green above, blackish and denuded below; stem 0·5-2 cm high, simple or branched. Leaves (a) 1·75-2·5 mm long, densely crowded, curled when dry, spreading when moist, lanceolate to linear-lanceolate from a wide lanceolate or oblong base, apex subobtuse or acute, concave and slightly cucullate; margins entire, plane with the cells in two layers above; costa strong, percurrent or ceasing below apex and becoming obscure there. Upper cells (b) hexagonal, very incrassate, the cavities circular or transversely oval, especially at the margin (c) 6-8 μm smooth, lower cells (d, e) rectangular with thinner walls. Seta short, 2·5-3 mm long, straight; capsule (f) 1-2 mm long widely ovate, tapered to the seta, pale brown with a red

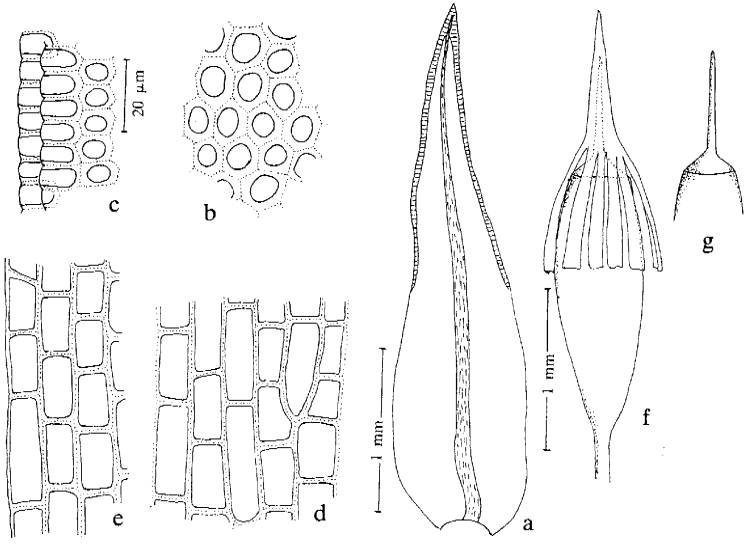


Fig. 111. *Ptychomitrium australe*

mouth; annulus persistent; peristome teeth lanceolate, spreading when dry, orange and smooth at the base, pale brown and papillose above, each tooth deeply divided or irregularly split or cracked along the middle; operculum (g) with a straight, erect slender beak about half the length of the capsule; calyptra long, covering the capsule to half way, mitriform, plicate, divided into segments. Spores 12-16 µm, brown, finely papillose. Autoecious; male inflorescence gemmiform, on a short branch.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand.

Rare in South Australia (12), on rock ledges in moist shady gorges in the Flinders Ranges.

P. mittenii Jaeg. may also occur; it is taller with shorter leaves, toothed above.

Family **ORTHOTRICHACEAE** Arnott 1825, *Disp. Méth. Mousses* p.13.

Plants usually in tufts on the bark of trees or on rocks. Leaves lanceolate to linear, margin usually recurved, costa reaching near to apex or excurrent; cells smooth or papillose, rounded-hexagonal above, elongated basally. Capsule immersed to exserted, apophysis often long, theca more or less ellipsoid, striate when mature, sulcate when dry and empty; peristome double, single or none, the teeth often paired; calyptra mitriform or cucullate, often hairy.

ORTHOTRICHUM Hedw. 1801, *Spec. Musc.* p.162.

Lectotype: *O.anomalum* Hedw. *fid.* Grout 1935, *Moss Fl.N.Am.* **2**:106.

Short to tall plants, in dense or loose tufts on bark or rock; stems erect, branched. Leaves erect and appressed when dry, spreading when moist, very hygroscopic, lanceolate, acute to obtuse; costa strong, usually ceasing below apex; upper cells small, rounded, papillose, incrassate; basal cells rectangular, smooth. Seta short; capsule immersed to shortly exserted, with 8 or 16 ribs or striae; stomata superficial or immersed; peristome of 16 outer papillose teeth in 8 pairs; inner peristome with 8 or 16 narrow processes; operculum conically rostrate; calyptra large, campanulate, smooth or slightly hairy.

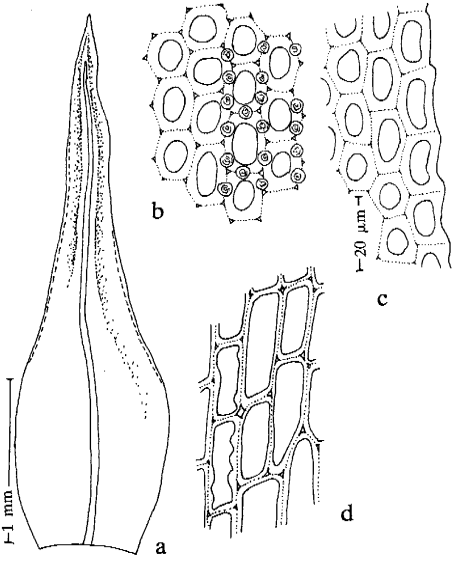


Fig. 112. *Orthotrichum tasmanicum*

Orthotrichum tasmanicum Hook.f. & Wils. 1848, *London J. Bot.*, 7:27.
Type: Tasmania.

Fig. 112; Plate 14C

Plants in tufts on bark; brownish green, yellow green or yellow brown, darker below; stems to 1·5 cm high. Leaves (a) usually crisped when dry, but sometimes imbricate and little altered; erecto-patent when moist; narrowly or sometimes widely lanceolate from a widened and shortly ovate or oblong sheathing base, carinate below, narrowed to an acute or subacute point; margins plane or somewhat recurved, entire or erose-denticulate at the apex; costa ceasing below apex. Upper cells (b) 8-15 µm long, hexagonal, usually strongly incrassate, rounded or shortly oval, papillose or nearly smooth; more elongate at the margin (c); basal cells (d) elongated, smooth, incrassate, a few rows at

margin subquadrate. Perichaetial leaves smaller, slightly plicate; vaginula narrow, somewhat hairy; seta 1-4 mm, straight or slightly curved; capsule 1-2·25 mm, ovate, oblong or subcylindrical, usually fully exserted, but sometimes emergent or nearly immersed, pale, leptodermatous, smooth or ribbed; stomata superficial, in the middle or upper parts of the capsule. Outer peristome of 8 pairs of papillose teeth, recurved when dry, pale or red; inner peristome of 8 wide, hyaline, papillose, white or reddish processes, each of two rows of plates, rarely narrower by suppression of one row of plates; operculum conical rostellate, erect, red-rimmed; calyptra smooth or rather hairy; spores 16-28 μm, brown, finely papillose or smooth. Autoecious; perigonia gemmiform, in axils of leaves below perichaetium.

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Rare in South Australia (6), only in regions of high rainfall on twigs of shrubs or small trees or on rough bark of trees, usually of exotic species.

AMPHIDIUM (Nees) Schimp. 1856, *Coroll. Bryol. Eur.* p.39, *nom. cons.*

Small plants in compact tufts or cushions. Leaves linear lanceolate, acute, curled and twisted when dry; costa ending just below the apex; upper cells rounded quadrate densely papillose, basal cells rectangular, smooth at insertion. Seta short; capsule erect, striate, sulcate when dry, barely exserted, mouth wide, no peristome; spores small.

Amphidium cyathicarpum (Mont.) Broth. 1902, *Nat. Pfl.* **1**(3):460.

Basionym: *Zygodon cyathicarpus* Mont. 1845, *Ann. Sci. Nat. Bot.* ser. 3 **4**:106.

Type: Chile.

Fig. 113

Plants small, compactly tufted, olive green at the tips, dark brown or blackish below; stems to 10-15 mm tall, dichotomously branched, densely radiculose below. Leaves (a) spreading, flexuose, curled and contorted when dry, erect and flexuose when moist, linear-lanceolate, acute, carinate, 2-3·5 mm long by about 0·3 mm wide; margin plane or slightly reflexed on one side about middle of leaf, sometimes entire but usually indistinctly notched with distant teeth especially below (b, c); costa about 75 μm wide at base, prominent at the back, ending just below apex; upper leaf cells (d) rounded-quadrate or transversely oval, 10-12 μm wide, becoming longer basally, the basal cells (e) being rectangular, pellucid or hyaline but still papillose; the papillae very numerous. Perichaetial leaves erect, sheathing, with elongate, smooth cells, margin irregularly sinuate above; seta 1·5-2 mm long, erect; capsule erect, barely exserted above the tips of the perichaetial leaves, oval, gradually contracted to a distinct neck, 1-1·5 mm long by 1 mm wide, greenish brown, reddish brown when dry, urceolate, with eight strong striae; no peristome and no annulus; spores pale, 8-12 μm diameter. Autoecious. Perigonia in a terminal cluster on short, lateral branches or shortly stalked and axillary just below the perichaetium, antheridia few with a few short paraphyses, enclosed by 6-8 acute or obtuse costate leaves.

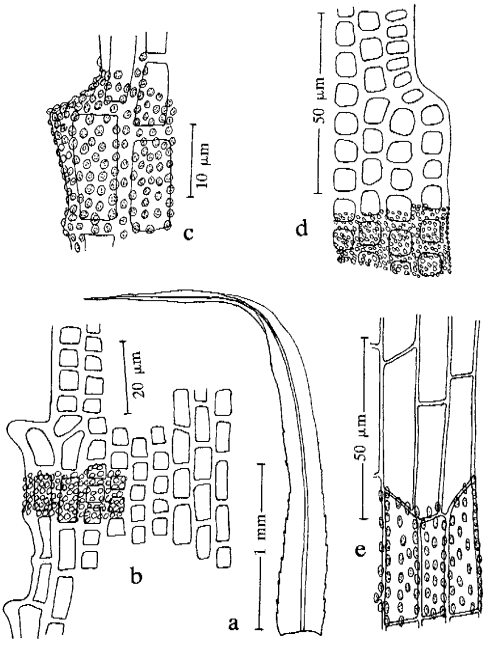


Fig. 113. *Amphidium cyathicarpum*

Distribution: S.America, Australia (W.A., S.A., Vic., Tas., N.S.W.), New Zealand, S.Africa. Rare (6) on rocks in moist gorges.

MACROMITRIUM Brid. 1819, *Mant. Musc.* p.132.

Type: *M.aciculare* Brid.

Plants slender to robust, in mats or tufts on bark or rocks. Stems creeping, with abundant erect branches which are simple or fasciculately branched. Leaves crowded, appressed and rigid or crisped when dry, sometimes spirally twisted on the stem, erecto-patent or spreading when moist, lanceolate or lanceolate ligulate, acute, acuminate or mucronate; costa usually ceasing below the apex, but percurrent or excurrent in some species. Upper cells small, rounded, papillose or smooth; basal cells elongate, incrassate, often spiculosely papillate. Seta elongated, usually smooth; capsule elliptic or elliptic oblong, often turgid, sometimes plicate above and narrowed at the mouth; stomata superficial; peristome single, double or none; operculum with a long, slender, erect beak; calyptra campanulate, plicate, smooth or hairy.

The only South Australian species belongs to the section *Macropoma*, which has been raised to the rank of genus by Vitt (1973). *Macropoma* is characterised mainly by the dry leaves being closely appressed, the basal cells rounded, rather than linear, and the calyptra very large and mitrate and always with at least a

few hairs. *Macromitrium* is a very large genus, with about 500 named species (about 50 in Australia), but acceptance of further splitting of it into smaller genera should await monographic treatment.

Macromitrium tenue (Hook. et Grev.) Brid. 1826, *Bryol. Univ.* **1**:737.

Basionym: *Orthotrichum tenue* Hook. et Grev. 1824, *Edin.J.Sci.* **1**:120.

Type: S.Africa, Cape of Good Hope, coll. Menzies and Burchelle.

M.eucalyptorum C.Müll. et Hamp. 1853, *Linnaea* **25**:500.

Type: Australia, Bunip Creek, F.von Mueller.

Fig. 114; Plate 7A

Plants slender and rigid in mats on bark, reddish brown to yellowish brown or dark green; stems more or less pinnately branched; branches 0·5-1·5 cm long, simple or branched. Leaves (a) small, 0·6-1 mm long, appressed and strict when dry, more or less spreading when most, broadly lanceolate with rather obtuse points, concave or carinate below; margins entire, plane or slightly recurved; costa usually ceasing below the apex. Upper cells (b) 6-10 μm isodiametric, usually incrassate, smooth or weakly papillose; cells becoming gradually larger below, slightly mamillate and elongated near the costa (c). Perichaetial leaves

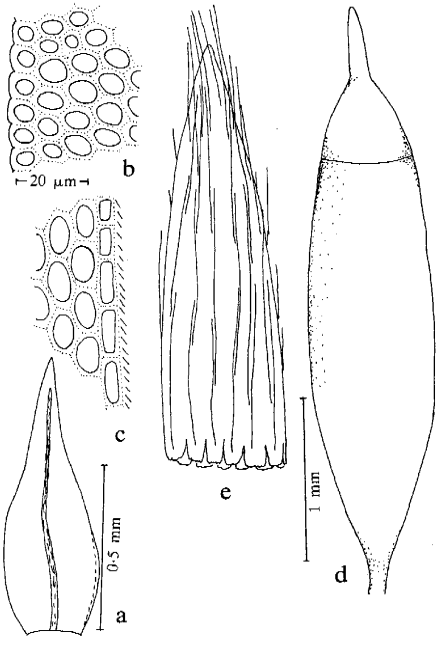


Fig. 114. *Macromitrium tenue*

larger; seta 3-6 mm long; capsule (d) 1·5-2·5 mm long, erect, narrowly elliptic oblong but sometimes widened, when dehisced usually slightly sulcate and with the mouth plicate and narrowed; no outer peristome, inner peristome a short, pale, papillose membrane; operculum conical with a straight erect beak, about a third of the length of the capsule; calyptra (e) variably pilose, sometimes nearly smooth, lobed at the base; spores 35 μm or more, finely echinulate or nearly smooth. Autoecious; perigonia terminating short branches.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Rare in South Australia (6), only seen occasionally on *Exocarpus.*

ZYGODON Hook. et Tayl. 1818, *Musc. Brit.* p.70.

Type species: *Z.conoideus* (Dicks.) Hook. et. Tayl.

Autoecious or dioecious. Plants growing in tufts. Leaves flexuous or twisted when dry, linear-lanceolate to ovate, margin plane or recurved below, entire or dentate near apex; costa ceasing below the apex or excurrent; lower cells rectangular and smooth, upper cells hexagonal to rounded, pellucid or obscure and papillose; small cylindrical or fusiform gemmae frequent on upper part of stem. Seta long; capsule ovoid to ellipsoid or pyriform, with 8 longitudinal striae; calyptra cucullate, small, smooth; peristome double, single or none, the teeth joined in pairs.

The genus was monographed by Malta (1926), who divided the genus into four sections, two of which are represented in South Australia.

Key to South Australian species:

1. Upper leaf cells papillose ..... Section *Zygodon* 2
   All leaf cells smooth ..... Section *Bryoides* 3
2. Dioecious; leaf margin entire ..... *Z.intermedius,* p.213
   Synoecious; leaf margin usually with prominent teeth near apex *Z.hookeri,* p.214
3. Leaf margin recurved from base to above middle of leaf; apex blunt *Z.menziesii,* p.215
   Leaf margin plane throughout; apex acute ..... *Z.minutus,* p.216

Zygodon intermedius B.S.G. 1838, *Bryol. Eur.* **3**:41.

Type: Abyssinia, coll. W. Schimper.

Fig. 115

Dioecious. Plants in bright green, yellowish green to brownish, rather dense tufts on rock or bark. Stems 1-3 cm, tall and densely tomentose below. Gemmae elliptical, small, mostly with 3 cells, colourless. Leaves (a) patent when moist, crisped when dry, linear-lanceolate to broadly lanceolate, slightly undulate, margin entire, tapered gradually to an acute apex; costa ceasing below the apex; cells (b), except for those at the leaf base, hexagonal, 8-11 μm across, incrassate, the cavities roundish, thickly papillose; basal cells rectangular and smooth. Seta erect; capsule (c) elliptical to pyriform, contracted at the crimson mouth; peristome evanescent and variably developed, the exostome usually rudimentary with short rounded teeth, the endostome of short narrow

processes; operculum with a rather long oblique beak; spores verrucose, 13-18 μm diameter.

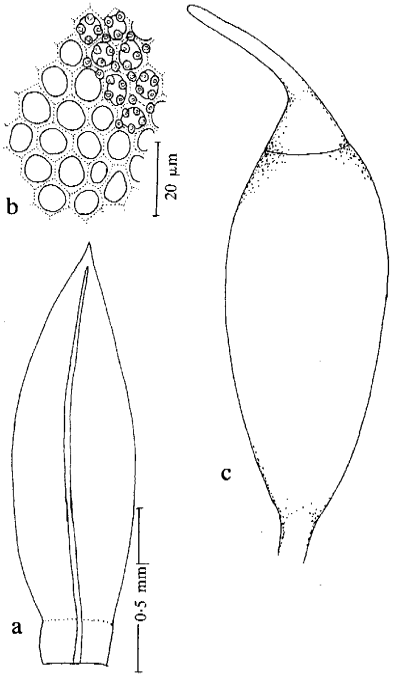


Fig. 115. *Zygodon intermedius*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, S.America, monsoonal Asia, S.W. and S.Africa. Rare in South Australia (6), on rocks in moist, sheltered habitats.

Zygodon hookeri Hamp. 1859, *Linnaea* **30**:632.

Type: Tasmania.

Fig. 116; Plate 7B

Synoecious. In dense green tufts matted below with reddish brown tomentum, stems to 2 cm tall. Gemmae usually three cells long. Leaves (a) crisped when dry, patent and somewhat arched from a clasping base when moist, linear-lanceolate undulate, tapered to an acute apex; costa ceasing in or below the apex; margin plane, generally with a few sharp teeth near the apex (b); upper leaf cells (c) hexagonal, 10-13 μm across, somewhat thickened at the corners, papillose; basal cells rectangular, hyaline, smooth. Seta long, to 2 cm, yellowish; capsule erect or somewhat inclined, elliptical to cylindrical;

operculum with a long beak; calyptra smooth; peristome deeply inserted below the mouth, consisting of 16 small lanceolate teeth; spores papillose, 23-26 μm diameter.

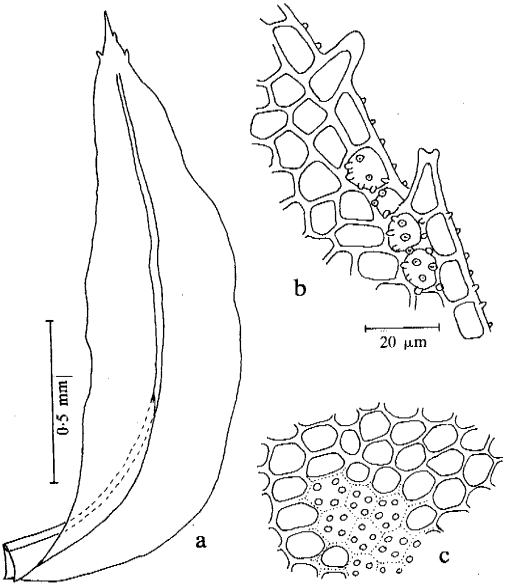


Fig. 116. *Zygodon hookeri*

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Rare in South Australia (6) chiefly on *Exocarpus*.

Z.hookeri Hamp. is considered a subspecies of the pantropical *Z.reinwardtii* (Hornsch.) Braun by Malta; the members of this section of *Zygodon* require revision.

Zygodon menziesii (Schwaegr.) Arnott 1827, *Mem.Soc.Linn. Paris* 5:233.

Basionym: *Codonoblepharon menziesii* Schwaegr. 1824, *Spec.Musc.* Suppl. 2(1):142.

Type: New Zealand. Fig. 117

Dioecious. Plants in dense greenish brown tufts on bark or rotting logs; stems to 1 cm tall. Gemmae cylindrical, 7-8 cells long, sometimes some cells divided longitudinally. Leaves (a) twisted when dry, erect when moist, elliptical to lingulate, keeled, apex blunt, sometimes cucullate, margin revolute from base to above middle; costa usually ceasing below apex; basal cells hyaline, thinly walled, rectangular or elongated hexagonal, upper cells (b) hexagonal or rhomboid, 8-13 μm across, with strongly thickened walls; one row of marginal

cells at base elongate and narrow, denticulate, extending at least a third of the way up the leaf as one to two rows of elongated thickly walled cells outside the isodiametric cells; all cells quite smooth. Seta reddish yellow, bent or twisted, to 5 mm long; capsule (c) elliptical or pyriform, straw coloured with the mouth red; operculum with a red rim, conical, shortly rostrate; peristome double, the exostome of 8 paired, papillose teeth, the endostome of 16 or 8 narrow processes, striate below and papillose above; spores smooth, 13-17 μm diameter. Perigonia bud like with numerous antheridia and golden yellow paraphyses.

Distribution: Australia (W.A., S.A., Vic., Tas.), New Zealand, Chile. Uncommon in South Australia (1, 6, 7, 12) on trees with rough bark in gorges and on limestone rocks.

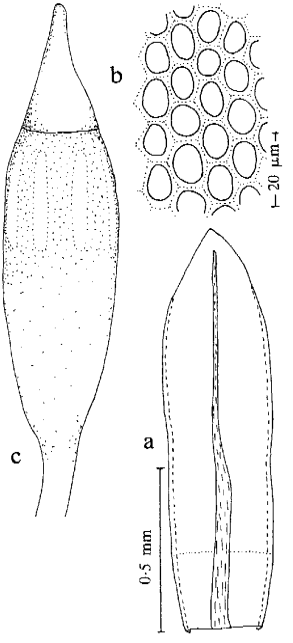


Fig. 117. *Zygodon menziesii*

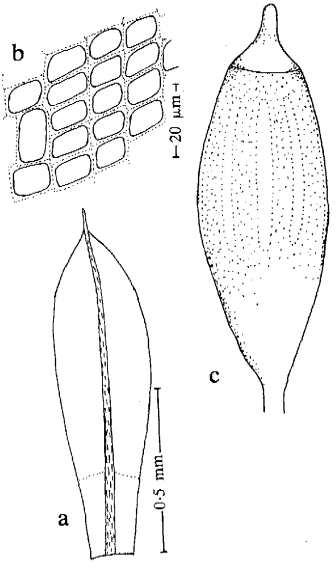


Fig. 118. *Zygodon minutus*

Zygodon minutus C.Müll. et Hamp. 1856, *Linnaea* **28**:209.
Type: Victoria, Sealers' Cove, coll. F. von Mueller.

Fig. 118

Dioecious. In yellowish green tufts on the bark of trees. Stems of female plants scarcely 1 mm tall. Gemmae cylindrical to elliptical, with 7 cells. Leaves (a) curved when dry, erect when moist, lanceolate, sharply pointed, flat, margins plane; costa usually excurrent; leaf cells all smooth, basal cells rectangular, hyaline and thinly walled, upper cells (b) mostly rhombic, sometimes hexagonal, about 10-13 μm across, walls not very thick; marginal cells not elongated. Seta 1·5-3 mm long; capsule (c) wholly straw coloured, large in proportion to the plant, elliptical to pyriform; apophysis often somewhat swollen; operculum conical with a short thick beak; peristome double, the exostome of 16 papillose teeth, in 8 pairs, reflexed when dry, the endostome of 8 processes; spores finely papillose, green, 15-20 μm diameter. Perigonia terminal or apparently lateral, with 8-10 antheridia and no paraphyses.

Distribution: Australia (S.A., Vic., Tas.), New Zealand. Rare in South Australia (1, 6), on trees especially in gorges.

Family **GIGASPERMACEAE** Lindb. 1865, *Oefv. K. Vet. Ak. Foerh.* **21**:592.

One genus *Gigaspermum* Lindb. 1865, *loc.cit.*:599 possibly monotypic, with the characters of the species.

Gigaspermum repens (Hook.) Lindb. 1865, *loc.cit.*:599.

Basionym: *Anictangium repens* Hook. 1819, *Musc. Exot.* **2**:8, plate 106.

Type: Western Australia, coll. D.Menzies 1791.

Figs. 119, 120; Plate 10B

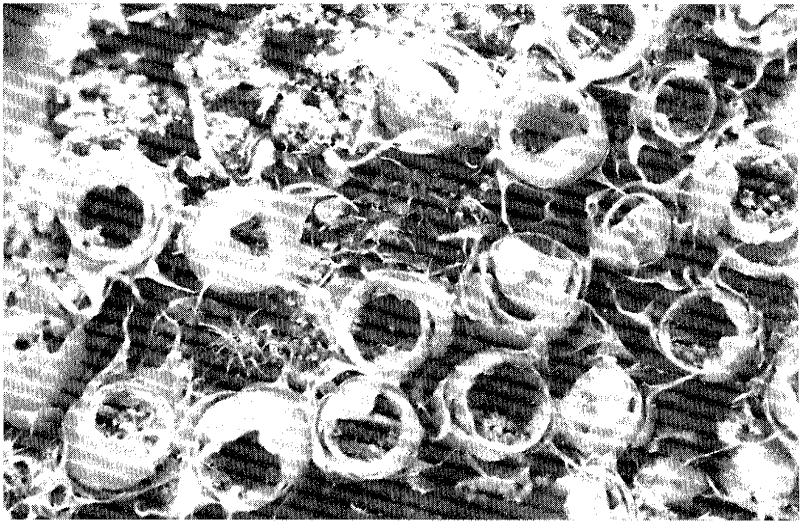


Fig. 119. *Gigaspermum repens* (Photo A. G. Stone) x12.

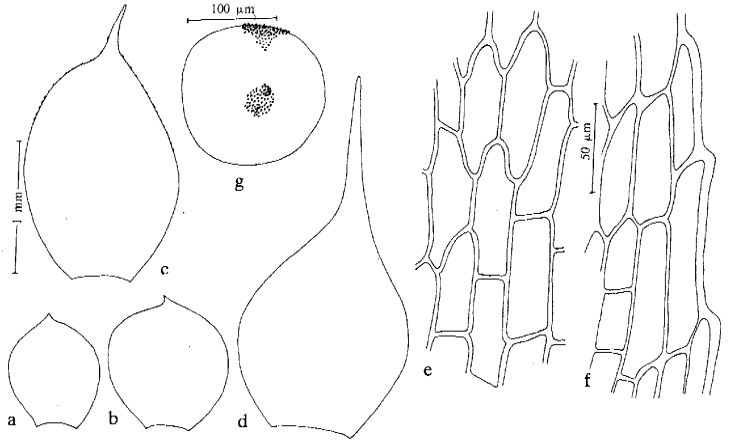


Fig. 120. *Gigaspermum repens*

Plants either scattered or more usually in short dense white or silvery turfs on otherwise bare soil, often calcareous, in semi-arid or moist areas. The erect leafy shoots spring from a perennial underground rhizome which is almost leafless. Male and female shoots apparently arising from the same rhizome. Shoots short, 3-6 mm tall, the lower leaves (a, b) spreading, nearly orbicular, apiculate, quite without any costa; cells (e) rhomboid to hexagonal, large, those at the margin (f) usually longer and forming faint denticulations; upper leaves (c) larger with a longer point of one or a few long cells. Perichaetial leaves (d) still larger, closely imbricate at first, spreading when mature with long flexuous somewhat reflexed narrow points. Capsule light brown, large, immersed, globular with a very wide mouth, but no peristome, and closed by a horizontal membrane; operculum lowly convex with a small apiculus; calyptra mitriform, very small, smooth, covering only the top of the operculum; spores (g) brown, very large, reaching 150 µm diameter, coarsely papillose all over. Male shoots smaller, with broad imbricate pale green leaves with long reflexed hair points; antheridia mixed with filiform paraphyses.

Distribution: Australia, in all States except N.T., New Zealand, S.Africa. Widely distributed in South Australia (1, 4, 6-8, 10, 13-15, 18, 20, 21) and abundant in semi-arid districts on light calcareous soils.

G.subrepens C.Müll, said to have more pointed leaves, is scarcely distinct. This moss has the remarkable distinction of having been described as a minute flowering plant, *Trianthema humillima* F.von Muell. in the Aizoaceae; the large spores were mistaken for seeds in a pyxidate capsule.

Family **FUNARIACEAE** Schwaegr. *in* Willd. 1830, *Spec.Pl.*, ed. 4.**5**(2):43.

Plants mostly annual or biennial, with short stems. Leaves soft, mostly ovate or ovate-lanceolate, concave or flat; costa usually present, excurrent or ceasing

below apex; cells large, rhomboid to hexagonal, with thin walls, smooth. Seta long or short; capsule stegocarpous, but cleistocarpous in some, usually pyriform with stomata at the base or globose; peristome none, single or double; calyptra large, cucullate or mitrate, usually with a long apex; protonema evanescent.

Key to genera:

1. Capsuled exserted on a fairly long seta 2
   Capsuled immersed or barely emergent 3
2. Operculum flat or shortly conical; calyptra cucullate ..... *Funaria*, p.219
   Operculum with a long beak or conical; calyptra mitrate
   Physcomitrium, p.231
3. Capsule cleistocarpous ..... *Physcomitrella*, p.238
   Capsule with a convex operculum ..... *Goniomitrium*, p.234

FUNARIA Hedw. 1801, *Spec. Musc.* p.172

Small to medium-sized plants growing gregariously on soil. Leaves subulate to ovate or obovate, usually wide, with large thinly walled, smooth cells; costa ceasing below the apex or excurrent. Capsule pyriform, erect and symmetrical or oblique and curved; peristome double, single or none; exostome teeth usually slanting upwards to the right, lanceolate subulate; endostome teeth opposite the exostome ones; operculum flat, convex or bluntly conical; calyptra persistent, large, inflated, cucullate with a long beak, smooth; spores medium sized, usually with minute ornamentation.

Usually divided into two subgenera, *Entosthodon* and *Funaria*, which are sometimes treated as genera.

Key to South Australian species:

1. No peristome 2
   Peristome present 3
2. Leaves lanceolate, subulate; seta much longer than capsule
   F.producta, p.221
   Leaves ovate to obovate; seta usually shorter than capsule
   F.apophysata, p.221
3. Capsule sulcate 4
   Capsule smooth 5
4. Operculum large, about 0·7 mm diameter; exostome teeth appendiculate; endostome well developed; spores smooth, 12-16 μm diameter
   F.hygrometrica, p.228
   Operculum small, about 0·3 mm diameter; exostome teeth not appendiculate; endostome merely a low membrane; spores minutely papillose, 24-30 μm diameter ..... *F.salsicola*, p.230
5. Capsule very asymmetrical, curved; peristome large and persistent, double ..... *F.glabra*, p.227
   Capsule erect, symmetrical; peristome small, single and fragile 6
6. Costa distinctly excurrent ..... *F.cuspidata*, p.224
   Costa ceasing below apex 7

7. Leaves nearly plane, longly cuspidate, the cusp ending in a long cell; margin serrulate above ..... *F.helmsii*, p.225
   Leaves strongly concave, cochleariform, blunt or shortly cuspidate; margin entire 8
8. Seta 1-2·5 cm tall, capsule pyriform, 1·5-2 mm long..... *F.gracilis*, p.223
   Seta 0·7 cm tall, capsule smaller and broader, 1-1·5 mm long
   F.bullata, p.224

Subgenus ENTOSTHODON

Capsule erect and symmetrical. Peristome single or none. Leaves sometimes bordered.

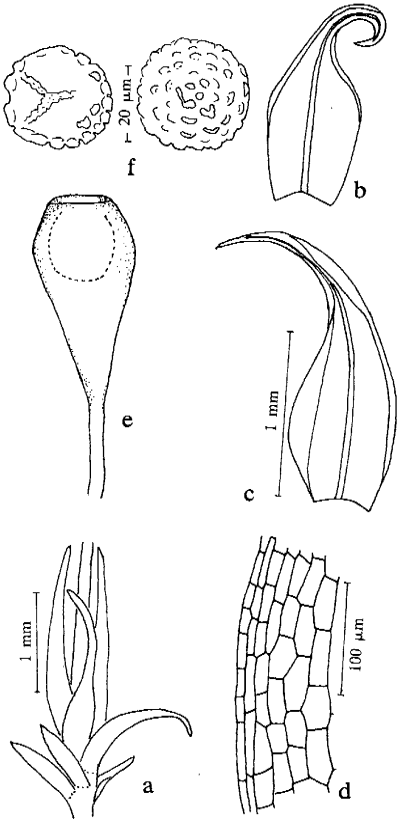


Fig. 121. *Funaria producta*

Funaria producta (Mitt.) Broth. 1903, *Nat. Pfl.* **1**(3):522.

Basionym: *Entosthodon productus* Mitt. 1859, in Hook. *Fl.Tasm.* **2**:197.

Type: Tasmania, coll. Archer.

Fig. 121

Very small plants, gregarious on clayey soil; stems (a) to 2 mm tall. Leaves (b, c) up to 2 mm, suberect when dry or moist, ovate-lanceolate, subulate, curved, concave; margin plane, entire; costa ceasing in subula; cells oblong hexagonal or rhomboid, narrow, 40-70 μm long, one or two rows at margin narrower. Seta 3-6 mm long; capsule (e) pyriform; no annulus, nor peristome; operculum slightly convex; spores (f) 32-36 μm pale brown, with irregular ridges and warts. Autoecious; antheridia on basal branches.

Distribution: Australia (W.A., S.A., Vic., Tas.), New Zealand. Common in South Australia (6, 11) on soil in moist situations; ephemeral.

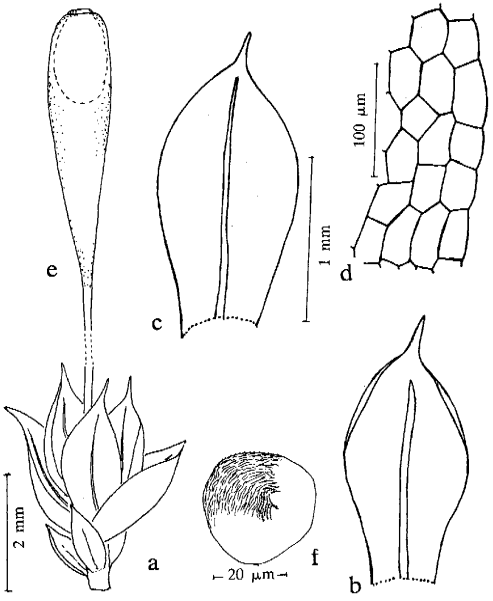


Fig. 122. *Funaria apophysata*

Funaria apophysata (Tayl.) Broth. 1903, *Nat. Pfl.* **1**(3):523.

Basionym: *Gymnostomum apophysatum* Tayl. 1846, *London J. Bot.*, **5**:43.

Type: Western Australia, Swan River.

Fig. 122

Plants small, gregarious on soil; stems (a) about 3-4 mm tall. Leaves (b, c) 1·5-1·75 mm long, incurved when dry, erecto-patent when moist, oblong or obovate, acuminate, concave, the upper leaves cuspidate or with a hair point; margins plane, entire or faintly crenate; costa ceasing below the apex; upper cells shortly oblong or irregularly hexagonal, 40-60 μm long; lower cells longer and rectangular. Seta short, usually 2-3 mm, but sometimes to 5 mm. Capsule 3-4 mm long, clavate, reddish brown, apophysis equal to or longer than spore sac; no annulus and no peristome; operculum slightly convex; spores 28-32 μm, brown, densely and finely wrinkled or ridged.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand. Common on soil (1, 4, 6, 8, 12, 14, 15, 21).

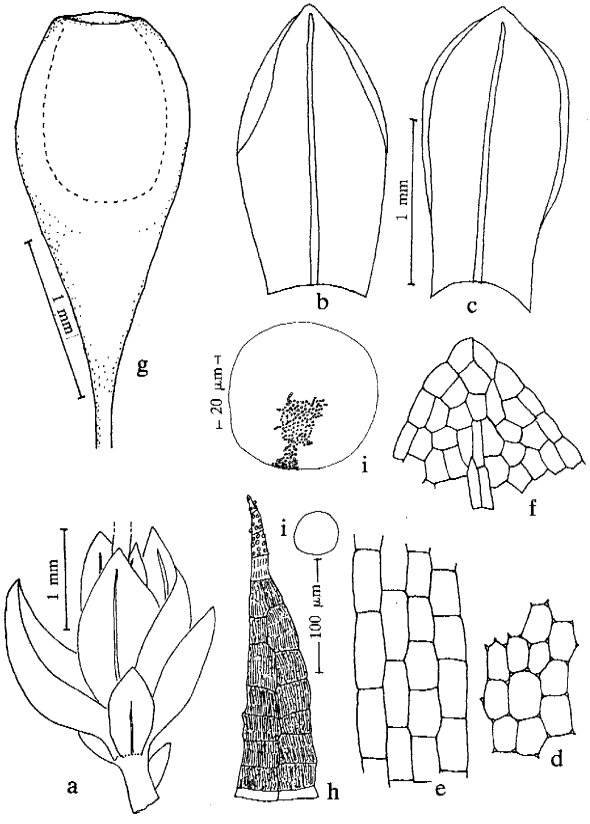


Fig. 123. *Funaria gracilis*

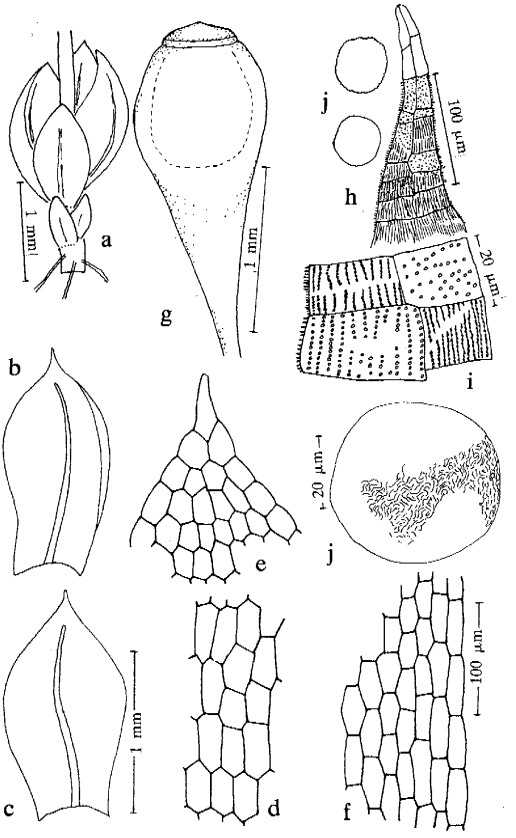


Fig. 124. *Funaria bullata*

Funaria gracilis (Hook.f. et Wils.) Broth. 1903, *Nat. Pfl.* **1**(3):524.
Basionym: *Entosthodon gracilis* Hook.f.et. Wils. 1854, *Fl.Nov. Zel.* **2**:91.
Type: New Zealand.

Fig. 123

Small plants, scattered or loosely gregarious on soil, yellow or yellow green; stems (a) 2-3 mm tall. Leaves (b, c) 1·5-1·7 mm long, erecto-patent, forming a bulbous bud, oblong ovate, the upper ones being relatively broader, concave; margins plane and entire; costa ending below the blunt or shortly cuspidate apex (f); cells oblong below (e), relatively narrow, becoming quadrate to hexagonal and smaller above (d); marginal cells shortly oblong or square, the outer wall

slightly protruding to produce a vague crenulation (f). Seta 1-2·5 cm tall, reddish; capsule (g) 1·5-2 mm long, erect, symmetrical, pyriform, reddish brown; no annulus; peristome single, of 16 short exostome teeth (h), each lanceolate, with the margins somewhat sinuous, plates vertically striolate except at the pale papillose apex, inserted below the rim; operculum somewhat convex, with a red rim; spores 32-40 μm, brown, very finely punctulate.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., N.T.), New Zealand. Common on soil, especially in sclerophyll scrub (6, 7, 17). This and the next three species constitute a closely related group, in which there may be yet further members.

Funaria bullata Broth. 1916, *Proc. Linn. Soc. N.S.W.* **41**:584.

Type: Victoria, Heyington, Railway Station, on ground, W.W.Watts nos. 198 and 208.

Fig. 124

Closely related to *F.gracilis,* but smaller, with the leaves more cochleariform and the capsule relatively more swollen.

In scattered groups on soil, pale green, the stem (a) 1-2 mm tall. Leaves (b, c) cochleariform concave, little altered when dry, shortly and broadly spathulate-obovate from a short base, mucronate or apiculate; costa reddish, ceasing well below the apex of the leaf; cells hexagonal above (d, e) smaller towards the margin (f), becoming rectangular in mid leaf and relatively more elongate basally. Seta short, 5-7 mm tall, erect, yellowish red; capsule (g) reddish brown, small, swollen pyriform with an equally long apophysis; peristome simple, teeth lanceolate, reddish brown, striolate (i) or papillose on different plates; spores 30-40 μm, rust-coloured, finely ridged; operculum nearly flat.

Distribution: Australia (S.A., Vic.) endemic. Rare, on soil in sclerophyll forest in valleys (6, 11, 17).

Funaria cuspidata Hook.f.et Wils. 1854, *Fl.Nov.Zel.* **2**:91.

Type: New Zealand.

Fig. 125

Similar size (a) and appearance to *F.gracilis,* but leaves (b, c, d) less concave and more spreading, costa excurrent (e) as a short to long arista. Cells in mid leaf (f) irregularly polygonal to rectangular. Capsule (g) pyriform; spores 35-40 μm diameter, finely punctulate.

Distribution: Australia (W.A., S.A., Vic., N.S.W., Qld), New Zealand. On soil in similar situations as *F.gracilis. F.aristata* Broth. may be synonymous.

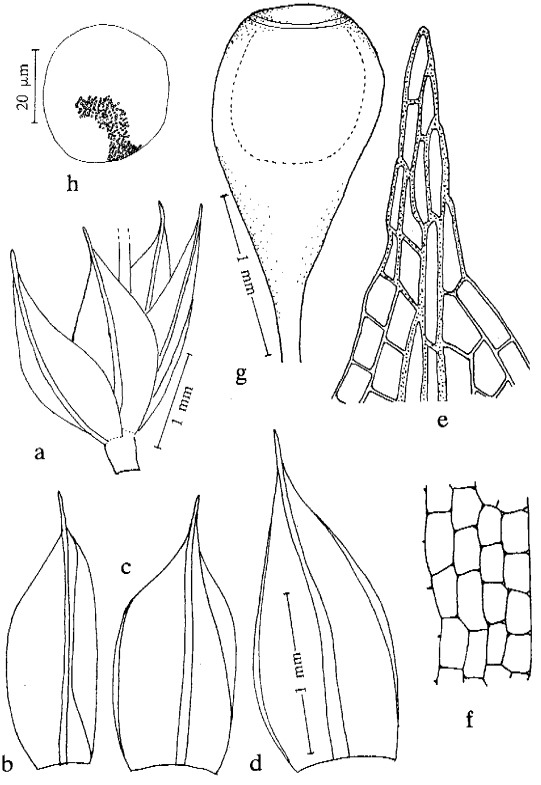


Fig. 125. *Funaria cuspidata*

Funaria helmsii Broth. et Geh. 1898, *in* Broth., *Oefv.Finska Vet.Soc.Foerh.* **4**:172.

Type: South Australia, Camp 10 of Sir Thomas Elder Expedition of 1891-2, coll. R.Helms, June 1891.

Fig. 126; Plate 10C

Distinguished from *F.gracilis* by the leaves being almost plane and ending in a cusp (c), terminating with a single narrow cell; by the cells of the leaf being larger and by the margin (d) being denticulate to dentate from at least midway to the apex.

Plants gregarious on soil, the stem (a) 3-4 mm tall. Lower leaves few and small, the upper ones (b) much larger, to 2 mm long, patent, slightly concave but almost plane, oblong-obovate, cuspidate, ending in a narrow cell (c) which may be very long; margin plane, serrulate from at least midway (d) to the apex; costa green or reddish brown, ceasing below the apex; basal cells shortly

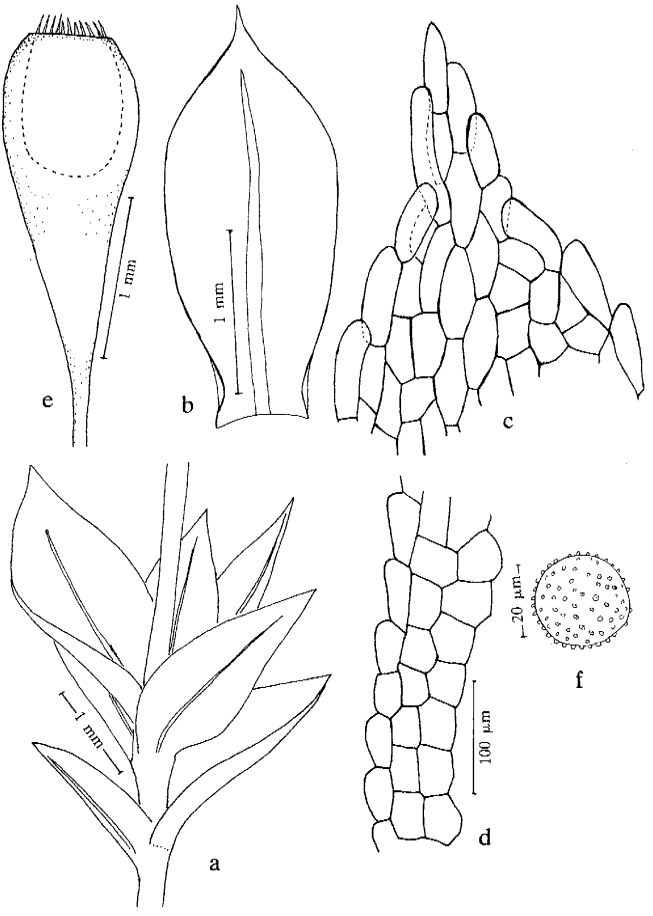


Fig. 126. *Funaria helmsii*

rectangular, upper oval hexagonal or irregular, larger than in *F.gracilis*. Seta 5-11 mm tall, slender, pale red; capsule (e) erect, narrowly clavate pyriform, pale, nearly smooth when dry, but the apophysis rugulose and equal to or slightly longer than the urn; no annulus; peristome single, with 16 striolate, orange exostome teeth, each lanceolate subulate, about 170 µm long and 45 µm wide at the base; operculum flat, small, about 0·5 mm diameter, with the cells in oblique rows; spores 20-25 µm, yellowish brown, smooth or with low scattered granules.

Distribution: Australia (W.A., S.A., Vic., N.S.W., N.T.) endemic. Fairly common (4, 14, 15, 21).

When described by Brotherus and Geheeb (1898) *F.helmsii* was recorded as having been collected in New Zealand. The label on the type reads: "ex hb. Melb. 11 June 1892, No 815 Entosthodon *Helmsii* Broth. Geh. (c.peristom.) *Nova-Seelandia:* Camp 10, leg Helms, Junio 1891". The "*helmsii* Broth. Geh." is in Brotherus' writing, but the rest is not. The species has never been found in New Zealand since it was described and it is now clear that it was not collected there. In fact the type came from the north westerly region of South Australia. R.Helms, its collector, was naturalist with the Sir Thomas Elder Expedition of 1891-2 into the interior of Australia and the area in which Helms collected the type can be traced from the records of the camp numbers marking the stages of the expedition. The site of Camp 10 of the Elder Expedition was at the Cardilkinna Rock Hole, amongst granitic rocks, about 150 km south west of Mount Woodroffe in the Musgrave Ranges.

Recognition of these facts is due to Mr. Lindley D. Williams, who realised that a *Funaria,* collected by Dr. Hj. Eichler in the Gammon Ranges, in the northern part of the Flinders Ranges in South Australia, was referable to *F.helmsii* Broth. et Geh. Comparison with the type confirmed this identification. Further study has shown that the species is widely spread and the commonest *Funaria* in the inland arid zone on soil especially by seasonal rivers and washes and on or near granite outcrops.

Subgenus EUFUNARIA Lindb.

Capsule obliquely pyriform curved and inclined or cernuous; peristome usually double; leaves scarcely bordered.

Funaria glabra Tayl. 1846, *London J. Bot.,* **5**:57.

Type: Western Australia, Swan River, J.Drummond.

Entosthodon clavaeformis C.Müll. et Hamp. 1853, *Linnaea* **26**: Type: South Australia, Torrens River, F. von Mueller.

Fig. 127; Plate 8A

Plants gregarious on soil, yellowish to green; stems to 5 mm tall. Leaves (a) 1·5-3·5 mm long, patent or spreading when moist, wrinkled or little altered when dry, obovate or widely oblong-spathulate, concave, lower ones obtuse, upper subacute and apiculate; margin plane, serrulate from midway to near apex; costa ceasing below the apex; middle and upper cells lax, hexagonal or polygonal, 30-80 μm long, basal cells longer and rectangular; marginal cells (b) in upper half of the leaf narrower for 1-2 rows and often yellowish, forming a more or less distinct border. Seta 0·5-2 cm long; capsule (c) 1·5-2 mm long, smooth, clavate pyriform, strongly arcuate, gibbous, mouth wide; no annulus; peristome double, the 16 exostome teeth lanceolate, subulate, slightly oblique, variably striolate on the outer surface (d) and trabeculate on the inner surfaces (e); the endostome teeth pale, papillose, sometimes shaped like the exostome teeth but often rudimentary (f); operculum nearly flat; spores (g) 24-32 μm diameter, brown, covered with flat irregular verrucae.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.),

New Zealand, New Caledonia. Fairly common in South Australia (6, 14, 15, 17, 18, 20, 21), in small patches on verges of roads and banks by paths, but best developed in moister habitats in gorges.

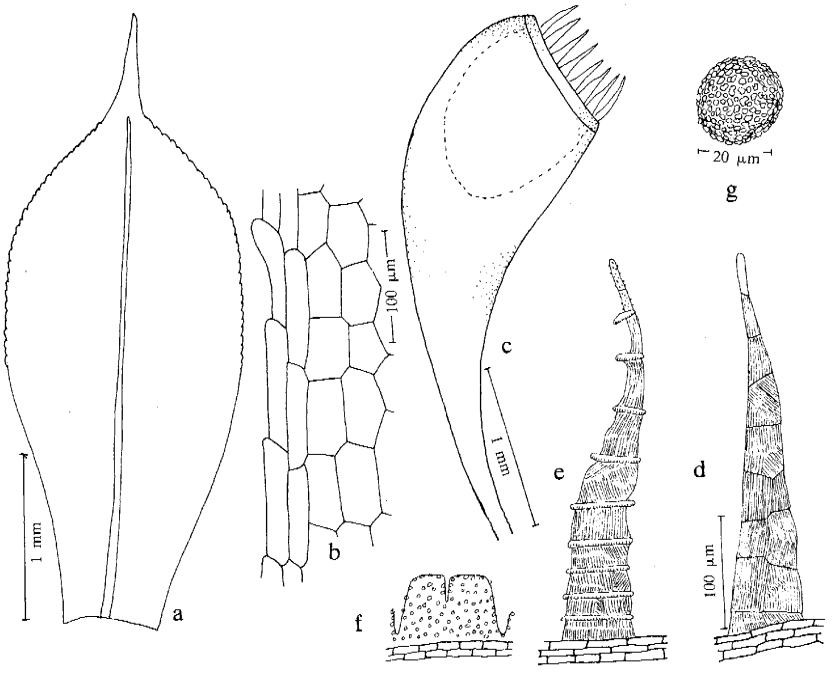


Fig. 127. *Funaria glabra*

Entosthodon clavaeformis is almost certainly this species. Type material in herb. MEL (76044) has two fragmentary capsules and one reasonable one which could be *F.glabra*. The leaves are concave with a point, the costa ceasing well below the apex and the margin serrulate in the upper third. Brotherus (1925) illustrates the plant at fig. 279 on p.329 and shows a slightly asymmetrical and smooth capsule and a peristome in which the inner peristome is absent (as he states in the text) or feebly developed.

Funaria hygrometrica Hedw. 1801, *Spec. Musc.* p.172.

Type: Germany.

Fig. 128; Plate 8B

Gregarious, often growing in large patches, on soil, often appearing after a fire; pale yellowish green; stems 0·5-2·5 cm tall, but usually short. Lower leaves

(a) spreading, upper leaves (b) erect, 2-4 mm long, very concave, ovate-lanceolate to oblong-obovate, shortly tufted, closely imbricated in a comal tuft, contorted when dry; perichaetial leaves (c) very wide and involute; margin essentially entire, plane below, weakly inflexed above; costa thin, ending just below the apex or percurrent. Cells (d) lax, rectangular or hexagonal, 60-80 μm long, and 2-3 times as long as wide, narrower towards the margin, longer towards the base. Seta to 4 cm long, reddish when old, arcuate and flexuose; capsule (e) reddish brown with age, obliquely pyriform, curved and rounded on the back, asymmetrical, sulcate when dry, the mouth oblique; annulus very broad; operculum convex, 0·7 mm diameter (e), the cells spirally arranged (f), those at the red rim radially elongated; calyptra cucullate, inflated, with a long beak. Peristome (g) double, the teeth oblique, united at the top by a small disc; exostome teeth vertically striolate (h) on lower part of outer surface, papillose

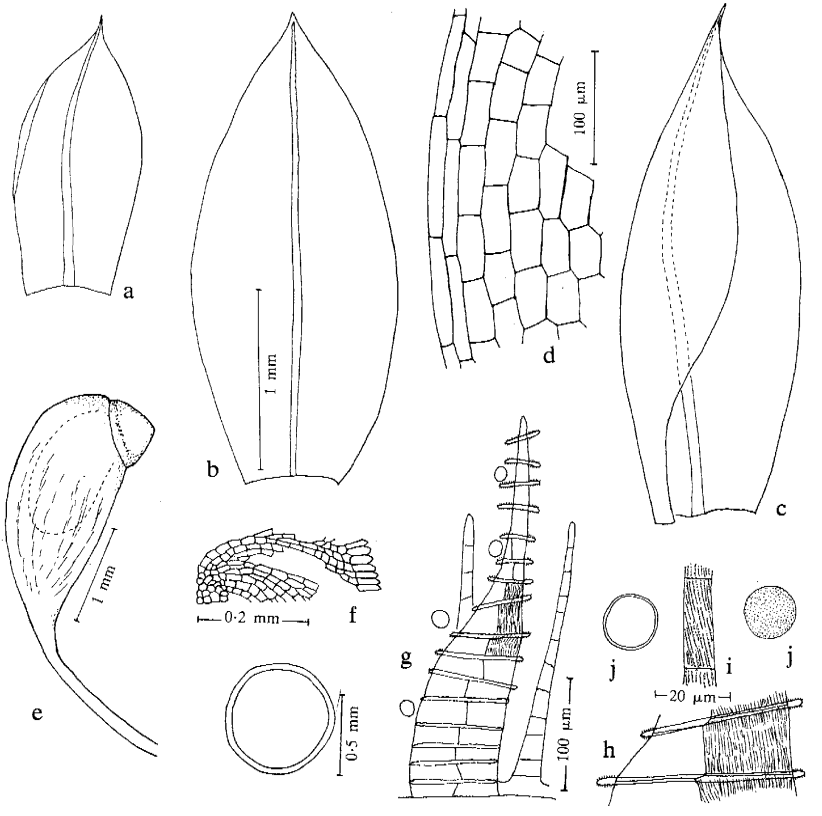


Fig. 128. *Funaria hygrometrica*

above, strongly trabeculate and appendiculate on the inner surface, showing through to the outside (g); endostome (g) of 16 lanceolate pale yellow processes, as long as or shorter than and opposite to the exostome teeth, lightly striolate (i); spores (j) 12-15 μm diameter, smooth or faintly punctulate.

Distribution: Cosmopolitan, all States in Australia. Common on disturbed soils, burnt ground, waste places, heaths, etc. (1, 2, 5, 6, 8-10, 12, 14, 15, 17).

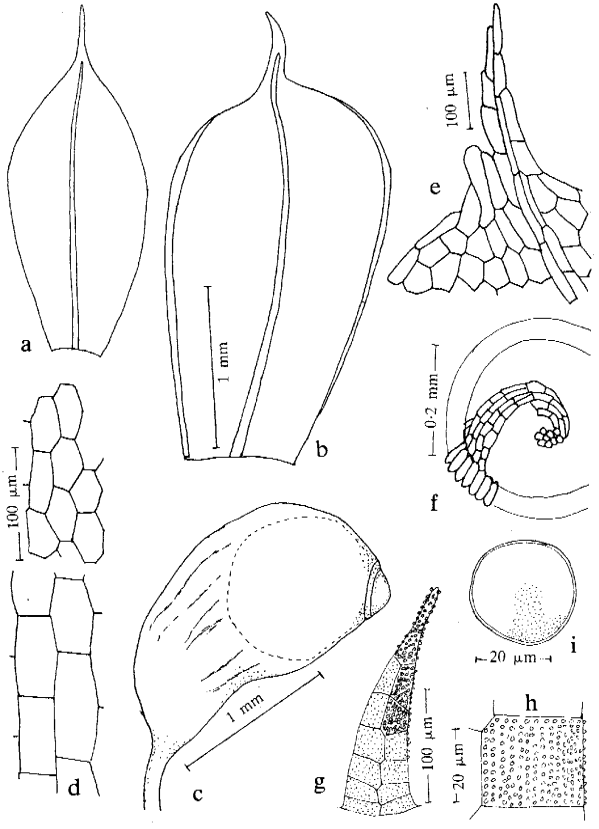


Fig. 129. *Funaria salsicola*

Funaria salsicola C.Müll. 1902, *Hedwigia* **41**:120. Type: Australia.

Fig. 129

Resembling *F.hygrometrica* but smaller throughout. Leaves (a, b) broadly obovate, very concave, with a slender rather long point (e); costa vanishing at base of point; upper cells (c) irregularly hexagonal, basal cells (d) longer and more nearly rectangular. Seta to 1 cm long or a little more; capsule (e) 1·5-2 mm long, obliquely broadly pyriform, rather weakly sulcate; operculum (f) small, 0·3 mm diameter, less than half that of *F.hygrometrica;* exostome teeth (g) shorter, with fewer trabeculae and not appendiculate, hyaline at the apex and tuberculate throughout, more sparsely above, the tubercles rather tall on the lower plates; endostome rudimentary, consisting of a low membrane adhering to the exostome; spores large, 25-30 μm diameter, smooth or very finely punctulate.

Distribution: Australia (W.A., S.A., Vic.) endemic? Fairly common (2, 5, 9, 17) on saline soil by swamps and in salt marshes, often on the hummocks of soil accumulated around *Salicornia* and *Arthrocnemon* plants.

This species has often been identified with *F.microstoma* B.S.G. of the Northern Hemisphere. This is a rare species in Europe, usually in high alpine habitats, and resembles small forms of *F.hygrometrica,* but differs in the small operculum and other features shared with *F.salsicola.* It differs in having longly acuminate leaves with the costa continuing nearly to the apex.

PHYSCOMITRIUM (Brid.) Fuernr. 1829, *Flora* **13**:9,59.

Gymnostomum subgenus *Physcomitrium* Brid. 1826.

Lectotype: *P.sphaericum* (Ludw.) Fuernr. *fid* Grout 1935, *Moss Fl.N. Amer.* **2**:74.

Resembling the species of *Funaria* with erect fruits. Capsule erect, symmetrical, operculum apiculate to rostellate, the cells arranged in straight lines from centre to periphery; usually no peristome. Calyptra mitriform, covering half of the capsule, fugacious, symmetrical, with 2 to 3, rarely more, lobes at the base.

Key to species:

1. Leaves ovate elliptical, acuminate; no peristome; spores with numerous sharply conical papillae ..... *P.pyriforme,* p.231
   Leaves ovate, aristate; peristome present; spores with large, flat roughened warts. ..... *P.phymatodeum,* p.233

Physcomitrium pyriforme (Hedw.) Hamp. 1837, *Linnaea* **11**:80.

Basionym: *Gymnostomum pyriforme* Hedw. 1801, *Spec. Musc.* p.38.

Type: Europe.

Fig. 130

Gregarious on soil, often in wide patches, bright green; stems 2-5 mm tall. Leaves (a) rather large, spreading to patent or erect, concave, ovate elliptical or obovate from a narrow base, acuminate, serrate above; costa narrow, ceasing at or below the apex; cells large, rectangular at the base, becoming irregularly hexagonal above (b), 20-50 μm wide in mid leaf, narrower towards the margin (c). Seta 5-15 mm red; capsule (d) subglobose to pyriform and almost turbinate,

somewhat narrower at the mouth; 6-8 rows of transversely rectangular cells at the mouth, passing below to subquadrate and then rectangular to rhomboidal cells with only moderately thick walls; operculum convex and apiculate, with a long beak; calyptra erect, finally 4-5 lobed at the base, the lobes divaricate; annulus broad, fugacious; spores (e) 28-36 μm diameter, papillose, the papillae conical. Autoecious.

Distribution: Europe, N.Africa, Siberia, S.W.Asia, N.America, Australia (S.A.). On damp, fertile soil, such as potted plants in nurseries (8), probably introduced.

The name assigned is uncertain because the capsule is more turbinate and the operculum more longly beaked than is usual in *P.pyriforme*.

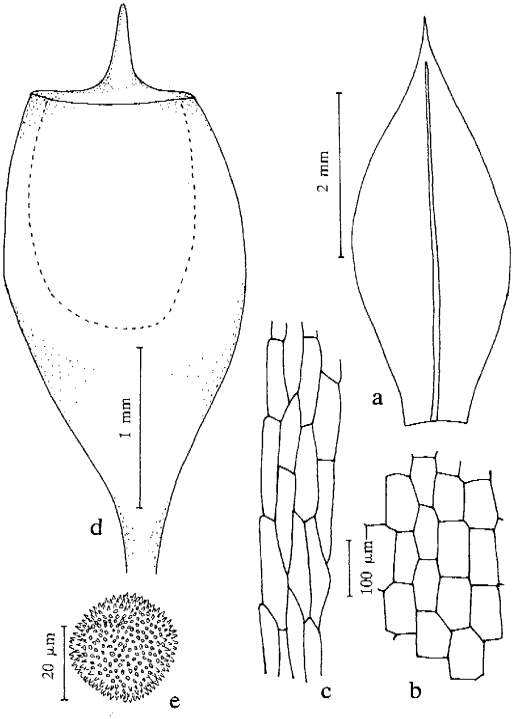


Fig. 130. *Physcomitrium pyriforme*

P.conicum Mitt. *in* Hook. 1859, *Fl. Tasm. 2*:197, occurs in the Eastern States (Vic., Tas., N.S.W.) on moist alluvial soil or stream banks. It is smaller with leaves not exceeding 2·5 mm long, the capsule pyriform not exceeding 1·8 mm long, the operculum with a short blunt beak. The following species cannot be *P.conicum* which has echinulate spores.

Physcomitrium phymatodeum Catcheside sp. nov.

Plantae parvae. Foliae ovatae sed late ellipticae, aristatae, costa sub apicem dessinens. Capsula erecta exserta, apophysis longa, opercule conice umbonata. Peristomium duplex, dentes breves irregulariter. Sporae magnae, 32-36 μm diametro, cum verrucis magnis, circa 8 trans diametrum.

Type: South Australia, Flinders Ranges, on earth bank, Spear Creek, north of Horrock's Pass, coll. D.G.Catcheside 53.246, 27.viii.1953, in Herb. D.G.Catcheside.

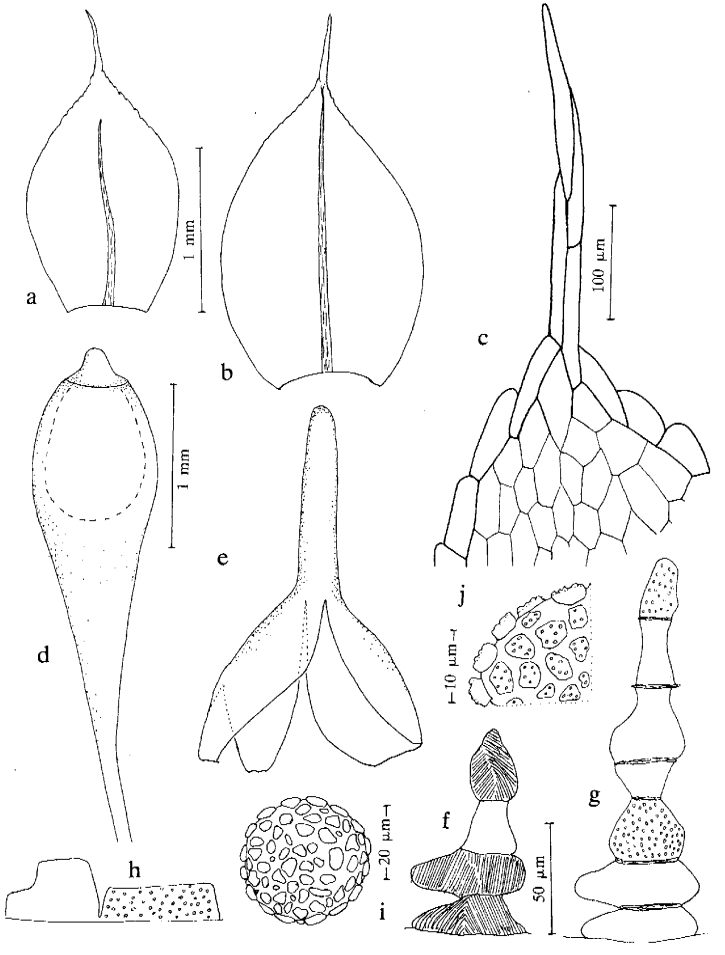


Fig. 131. *Physcomitrium phymatodeum*

Fig. 131

Small plants, gregarious on soil, 6-8 mm tall, with the leafy shoot 1·5-2 mm tall. Leaves (a, b) erect, somewhat concave, ovate or broadly elliptical, 1·1-2 x 0·8-1·2 mm, with a yellow arista about 0·25 mm long, of thickly walled cells; costa yellow, ceasing below the apex in the lower leaves, longer in the upper leaves and appearing to fuse with the arista, so that the costa appears excurrent; lamina cells oblong rhomboid 40-60 μm long x 20-30 μm wide, the marginal ones longer above, yellow and slightly protruding as denticulations, but no distinct border; lower cells shortly rectangular, shorter at the margin. Seta about 4-5 mm, reddish brown; capsule (d) erect, pyriform, reddish brown, about 2-2·3 mm long with a fairly long tapering apophysis; with 3-4 rows of transversely rectangular cells with thick horizontal walls at the mouth of the capsule, passing to about 2 rows of larger subquadrate cells with thin walls and then to the exothecial cells of prosenchymatous cells with thick walls. Operculum conical, umbonate. Peristome double; exostome (f, g) of short, narrow, irregularly shaped teeth; the outer surface of exostome teeth (f) with more or less vertical striae bearing spinous papillae, the plates scarcely distinct; the inner surface of exostome teeth (g) with prominent trabeculae and scattered papillae on the intervening plates; endostome (h) of low, membranous papillate segments. Spores (i) brown, 32-36 μm diameter, coarsely verrucose, with 7-8 verrucae across the face, each verruca (j) 2-5 μm across, flat but with an irregular or papillate surface. Calyptra (e) mitrate, split into 2 or 3 segments.

Distribution: Australia (S.A.) endemic. Rare, usually on the banks of creeks or rivers (1, 14, 15).

This species is unusual for *Physcomitrium* in having a peristome. However, the mitrate calyptra places it in this genus rather than in *Funaria*. The warted spores, to which the specific name refers, are very distinctive.

GONIOMITRIUM Wils. 1846, *London J. Bot.*, **5**:142.

Paroecious: very small (a), in dense troops on soil, pale to yellow green. Leaves appressed when dry, erecto patent to spreading when moist, keeled to spoon-shaped, small at the base of the stem (b) much larger above (c), ovate to ovate-lanceolate, more or less longly pointed, costa none or strong and excurrent; cells very lax, shortly rectangular at the base of the leaf, rhomboid to longly hexagonal above (d), smaller at the margin (e) forming a fairly distinct border. Seta very short, capsule erect (f), immersed to emergent, spherical to obovoid, the wall thin with lax cells; no peristome; operculum convex without a point; calyptra (a, g) inflated, campanulate, shortly beaked, with eight more or less projecting longitudinal ribs from eight pleats when young, covering the whole capsule (a), lobed at the base, toothed near apex, not hairy; spores very large, about 75-100 μm diameter, surface reticulate with low ridges, the areolae polygonal or roughly hexagonal. Two species in Australia, separated as follows:

1. No costa ..... *G.enerve*, p.235
   Costa strong, excurrent ..... *G.acuminatum*, p.236

Goniomitrium enerve Hook.f. et Wils. 1846, *London J. Bot.*, **5**:142.
Type: Western Australia, Swan River, J. Drummond.

Fig. 132, 47F

Upper leaves (c) ovate, to 1·5 mm long, acuminate with a twisted point; no costa; middle and upper cells (d) rounded hexagonal, 22-40 μm across, with firm walls, thickened at the corners, marginal cells with thinner walls, the marginal row (e) quadrate to rectangular, 17-20 μm wide. Capsule globose when fresh, turbinate when dry; operculum convex, about 0·35 mm diameter; spores (h) 75-100 μm diameter, reticulate, with about 14 to 16 low ridges around profile and with about 7 to 8 areolae across the face. Male shoots very small, with broad concave leaves.

Distribution: Australia (W.A., S.A., Vic., N.S.W., A.C.T.) endemic. Rare (4, 17).

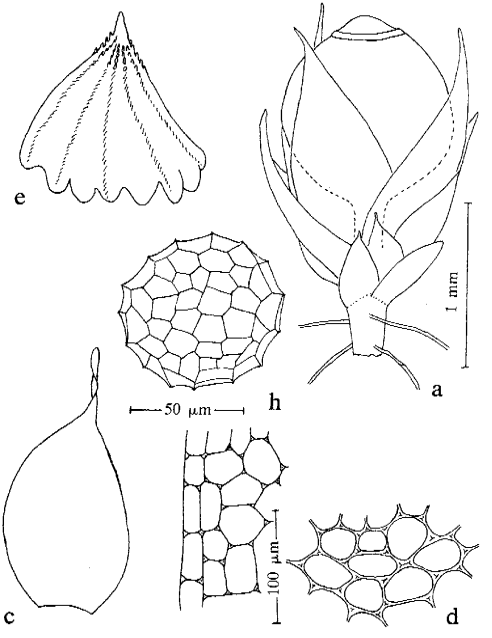


Fig. 132. *Goniomitrium enerve*

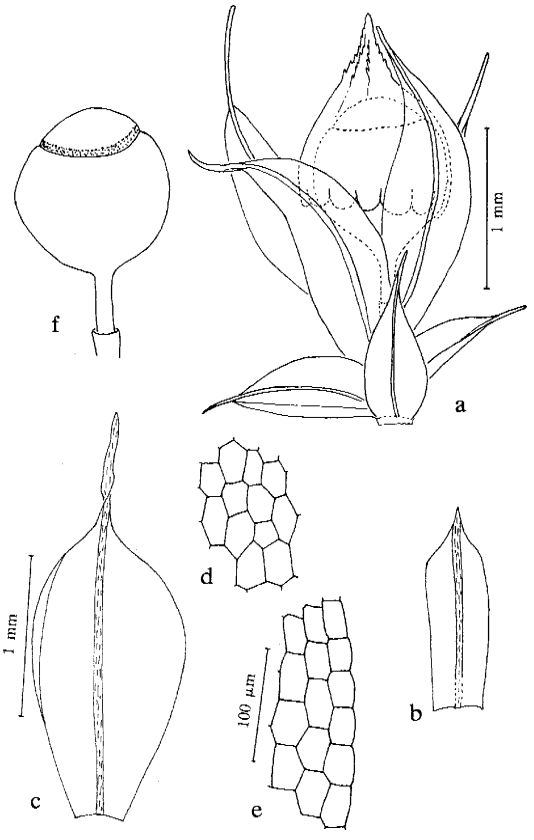


Fig. 133. *Goniomitrium acuminatum*

Goniomitrium acuminatum Hook.f. et Wils. 1846, *London J. Bot.*, **5**:143.
Type: Western Australia, Swan River, J. Drummond.

Figs. 133, 134

Plants (a) larger than *G.enerve*; lower leaves oblong, acute; the upper leaves (c) obovate, acuminate from a narrow base, reaching 2·5 mm long; costa firm, excurrent in a twisted, slightly denticulate, hyaline arista; cells (d) irregularly hexagonal, 20-35 µm across, the marginal row hardly distinct. Capsule (b) globose on a short seta; operculum convex, 0·55-0·6 mm diameter; spores about 75 µm diameter, the reticulum similar.

Distribution: Australia (W.A., S.A., N.S.W., Qld, N.T.) endemic. Rare (17, 21).

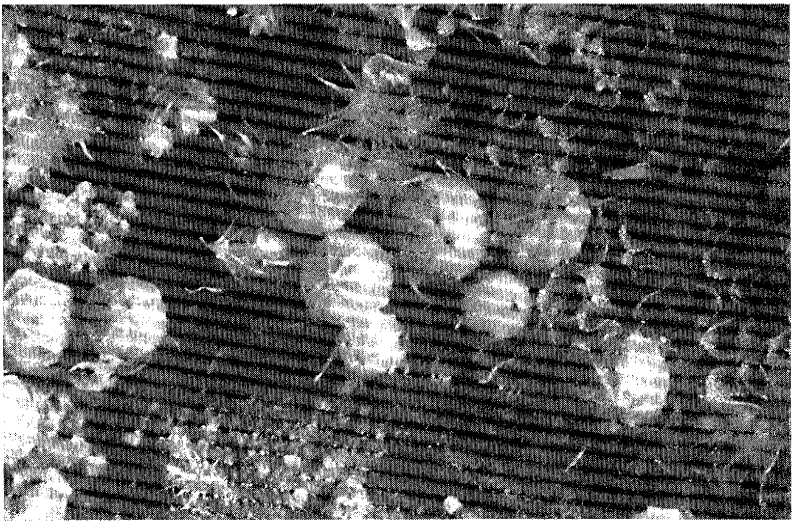


Fig. 134. *Goniomitrium acuminatum* (Photo A. G. Stone) x12.

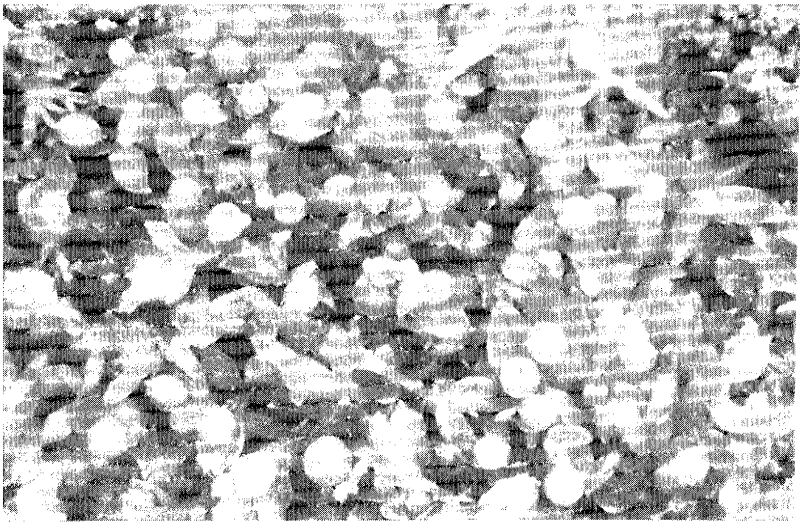


Fig. 135. *Physcomitrella readeri* (Photo A. G. Stone) x5·5.

PHYSCOMITRELLA B.S.G. 1849, *Bryol. Eur.* **1**:13.

Type: *P.patens* (Hedw.) B.S.G.

Paroecious or synoecious. Small ephemeral plants, without persistent protonema. Seta very short; capsule globose, cleistocarpous, with a differentiated conical apiculus, stomata superficial.

Physcomitrella readeri (C.Müll.) Stone et Scott 1973, *J. Bryol.* **7**:604.

Basionym: *Ephemerella readeri* C.Müll. 1902, *Hedwigia* **41**:120.

Type: Australia.

Physcomitridium readeri (C.Müll.) Roth. 1911, *Aussereurop. Laubm.* **1**:250.

Figs. 135, 136

Small plants scattered or in dense patches on moist silty soil, recently flooded. Stems 0·5-2 mm tall, simple. Leaves (b, c) bright green pellucid, very soft, erect when moist but shrivelled when dry, enlarging and widening up the stem from

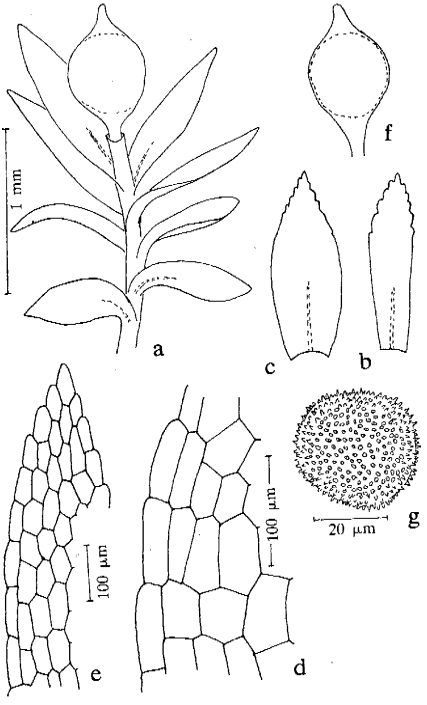


Fig. 136. *Physcomitrella readeri*

linear oblong (b) ones to oval (c) to obovate at the top, tapering to an acute point, margin plane, faintly denticulate above from projecting cells (d, e); costa narrow, faint, not reaching mid leaf; cells (d, e) very large, thinly walled, hexagonal, 20-35 μm wide and 2 to 3 times as long as wide; lower cells larger, especially near the costa. Seta very short, reddish; capsule globose to ovoid, apiculate, light brown with a darker apex; calyptra mitriform, long and narrow above, the widened part covering only a small part of the capsule; spores dark brown, 30-45 μm diameter, echinulate, the spines slightly hooked.

Distribution: Australia (S.A., Vic.), California, Japan. In South Australia (4, 5) on silt by the Murray River and edges of billabongs.

Ephemerella was made a genus by C.Müller from being a section of *Ephemerum; Physcomitridium* was then a section of *Ephemerella* and raised to a genus by Roth on the grounds of immersed stomata on the capsule. This is not so and our species is clearly congeneric with *Physcomitrella patens* of the Northern Hemisphere.

Family **EPHEMERACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.3

Plants minute, ephemeral, borne on a persistent protonema. Leaves forming a rosette, ovate lanceolate to narrowly lanceolate, margin toothed or entire; with or without a costa; cells large, rather narrowly hexagonal. Capsule immersed, cleistocarpous or stegocarpous and gymnostomous, globose, the wall thin and the spores large.

EPHEMERUM Hamp. 1837, *Flora* **20**:285 *nom. cons.*

Lectotype: *E.serratum* (Hedw.) Hamp. *fid* Grout 1935, *Moss Fl.N.Amer.* **2**:67.

With the vegetative characters of the family. Capsule cleistocarpous, globose, minutely apiculate, the wall of two layers of cells, stomata present; calyptra small, thin, campanulate, torn at the base, sometimes only on one side.

Ephemerum cristatum (Hook.f. et Wils.) C.Müll. 1847, *Bot. Zeit.* **5**:101.

Basionym: *Phascum cristatum* Hook.f. et Wils. in Hook. 1845, *Icon. Pl. Rar.* **8**:plate 737.

Type: Tasmania, coll. Archer.

Fig. 137

Plants very small, about 0·5 mm tall, on a filiform, persistent dichotomous protonema. Leaves (a, b, c) loose, inwardly arched or spreading, spathulate or narrowly lanceolate, acuminate, increasing in size and complexity from below (a) upwards (b, c) deeply incised dentate, especially in the upper half, teeth often recurved, many springing from the abaxial surface (c); costa present in the upper leaves, ceasing below the apex; cells (d) large, more or less rhomboid to rectangular, 10-20 μm wide, 2 to 9 times as long as wide. Capsule immersed, glossy reddish brown, subsessile, ovate globose with a minute apiculus; spores (e) large, 40-80 μm in diameter, brown, coarsely warted; calyptra campanulate, reddish brown, covering about half of the capsule.

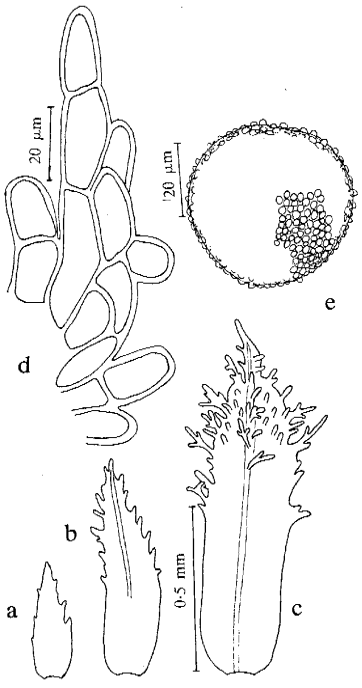


Fig. 137. *Ephemerum cristatum*

Distribution: Australia (W.A., S.A., Vic., Tas.) endemic. On soil (5) rich in humus, along river banks and on margins of ponds, clay pans subject to periodic flooding, usually under shrubs.

Family **SPLACHNACEAE** Grev. et Arnott 1824, *Mem. Wernerian Nat. Hist. Hist. Soc.* **5**:442.

Leaves soft, lanceolate to obovate; costa thin; cells hexagonal to rectangular, lax, smooth. Seta long; capsule erect, theca of capsule ellipsoid to shortly cylindrical, apophysis long and similar to theca to greatly enlarged; peristome single; columella sometimes extending at maturity. Plants usually on decaying organic material, the spores often dispersed by flies.

TAYLORIA Hook. 1816, *J.Sc.Arts* **2**(3):144

Type: *T.splachnoides* (Schwaegr.) Hook.

Capsule with a pyriform or cylindrical apophysis, narrower than the theca, which has a wide mouth; calyptra conical, constricted at the base.

Tayloria octoblepharis (Hook.) Mitt. 1882, *Trans.R. Soc.Vict.* **19**:65.

Basionym: *Splachnum octoblepharum* Hook. 1819, *Musci Exot.* **2**:plate 167.

Type: Tasmania, on dead trunk, coll. D.Brown.

Fig. 138; Plate 11C

In dense tufts on decaying wood or other organic debris, pale yellow-green; stems 0·3-1·5 cm high, matted with pink or purple tomentum. Leaves (a) 2-3·5 mm long, contracted and patent when dry, patent when moist, usually narrowly obovate, but sometimes widely spathulate; margins plane, entire to slightly denticulate; costa usually excurrent in a long arista; cells lax, upper (b) 50-80 μm long and 2-3 times as long as wide, hexagonal or polygonal, the lower (c) longer, to 150 μm, with thinner walls. Seta 0·2-2 cm long, reddish; capsule (d) 2-4·5 mm long erect, purplish black, oblong-clavate; peristome of eight pairs of short thin teeth, inserted under the rim, reflexed on to the wall of the capsule when dry, sculptured throughout on the face, not striolate; operculum very

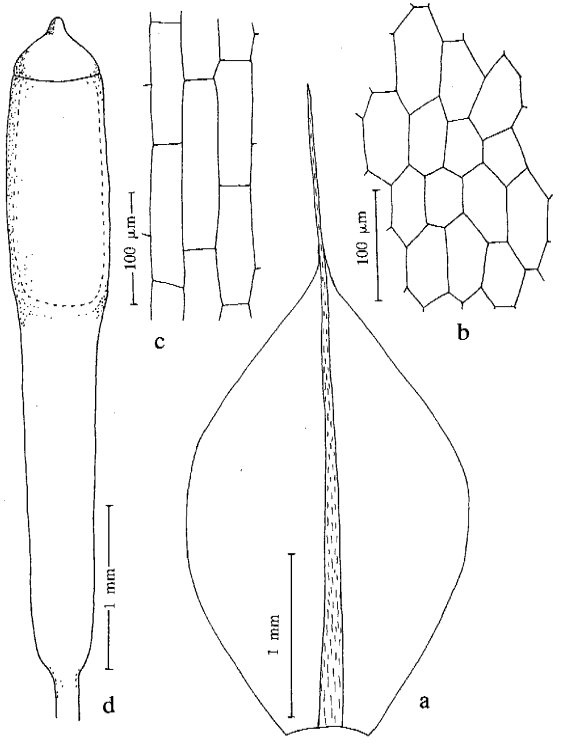


Fig. 138. *Tayloria octoblepharis*

bluntly conical; calyptra four lobed at the base, with a persistent point; spores 8-14 μm diameter. Dioecious; perigonium subdiscoid, terminal.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, East Indies. Rather common (1, 6) on decaying organic material, especially wood, in moist habitats, especially those rich in nitrogenous compounds.

Order **BRYALES**

Family **BRYACEAE** Schwaegr. in Willd. 1830, *Sp.Pl.* ed. 4. **5**(2):47.

Usually erect plants in tufts. Leaves ovate to lanceolate or linear, often in a comal rosette at the apex of the stem, often bordered with narrow incrassate cells; cells smooth, more or less rhomboidal, walls thin or incrassate. Seta long; capsule inclined to pendulous, ovoid to cylindrical; peristome usually double, the endostome often with a basal membrane, the processes alternating with the exostome teeth, with or without cilia.

Divided into three subfamilies, all with species in South Australia:

MIELICHHOFERIOIDEAE. Inflorescence apparently lateral; capsule erect to inclined; sometimes no exostome. *Mielichhoferia,* p.242

ORTHODONTIOIDEAE. Inflorescence clearly terminal; capsule more or less erect; endostome without a basal membrane or a very short one. *Orthodontium,* p.243

BRYOIDEAE. Inflorescence clearly terminal; capsule usually inclined, cernuous or pendulous; endostome with a distinct basal membrane. *Leptobryum,* p.246; *Brachymenium,* p.248; *Bryum,* p.250

MIELICHHOFERIA Nees et Hornsch. 1831, *Bryol. Germ.* **2**:179.

Fruit apparently lateral, on a short basal shoot. Seta long and thin; capsule erect or cernuous, pyriform to clavate; annulus broad, deciduous; exostome rudimentary or none; endostome with a short basal membrane bearing 16 linear processes; operculum small, shortly conical. Some species are known to be indicators of the presence of copper.

Mielichhoferia bryoides (Harv.) Wijk et Marg. 1962, *Taxon* **11**:221.

Basionym: *Schizymenium bryoides* Harv. 1840, in Hook. *Icon.Pl.Rar.***3:** plate 202.

Type: South Africa.

Mielichhoferia australis Hamp. 1856, *Linnaea* **28**:204.

Type: E.Australia.

Fig. 139; Plate 9A

Plants usually in dense, yellowish green tufts on soil or rock; shoots to 2 cm tall, with one or more long basal branches, tomentose and matted together below with papillose rhizoids. Leaves (a) 0·8-2 mm long, rather glossy, smaller distant and rudimentary below, larger and more crowded above, spreading

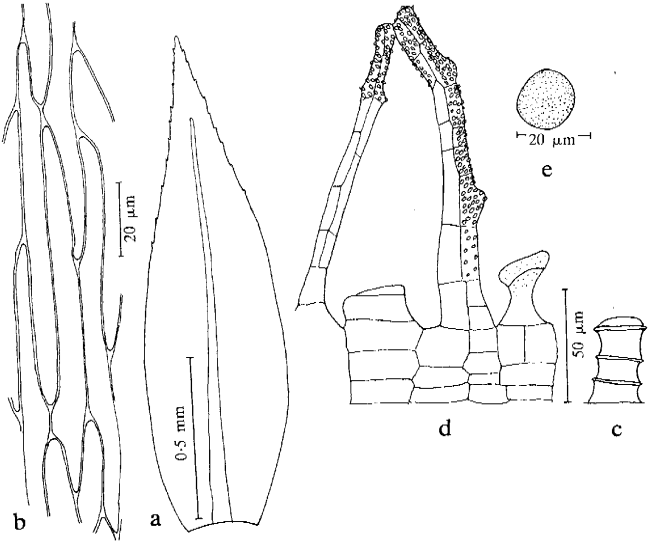


Fig. 139. *Mielichhoferia bryoides*

whether moist or dry, lanceolate from a narrow base, acuminate; margins plane, denticulate towards the apex; costa ceasing below the apex; cells (b) linear-rhomboid, to 120 µm long, 15 to 20 times as long as wide, walls thin. Perichaetial leaves smaller; seta 1-3 cm, reddish, slender, flexuous; capsule 2·5-3 mm long, inclined, slightly asymmetrical, clavate or narrowly pyriform, the mouth narrower, but wider when old; annulus broad, persistent; operculum shortly conical, mamillate. Exostome none or of very short blunt segments (c); endostome of 16 processes borne on a short basal membrane, the processes to 0·25 mm high, hyaline, narrowly linear, variably nodose, rarely slightly appendiculate, smooth or papillose; spores 15-20 µm diameter, finely papillose. Paroecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, South Africa, Malagasy. Fairly common on moist shady banks of soil or on rock (6).

M.australis is a form with a very low basal membrane to the endostome, but this feature is too variable to be used as a specific distinction in the absence of any other characters.

ORTHODONTIUM Schwaegr. 1826, *Spec. Musc.* Suppl. **2**(2):123

Lectotype: *O.lineare* Schwaegr. *cf* B.S.G. 1844, *Bryol.Eur.* **4**:69.

Plants small and delicate, in low tufts, with radiculose stems. Leaves linear-lanceolate, flexuous; costa usually ceasing below the apex; cells linearly hexagonal or rhomboid, but wider and shorter at the base of the leaf. Seta

slender, flexuous; capsule erect or inclined, ovoid to clavate or cylindrical, wall thin, ribbed, the cells forming the ribs being thickened on the outer wall except centrally or to one side; no annulus or a rudimentary one; operculum with a short oblique beak. Peristome double, inserted below the rim; exostome often shorter than endostome; the processes narrow or filiform, on a basal membrane, without cilia. Several species, all rather similar, described from Australia; good fruit is needed for specific identification.

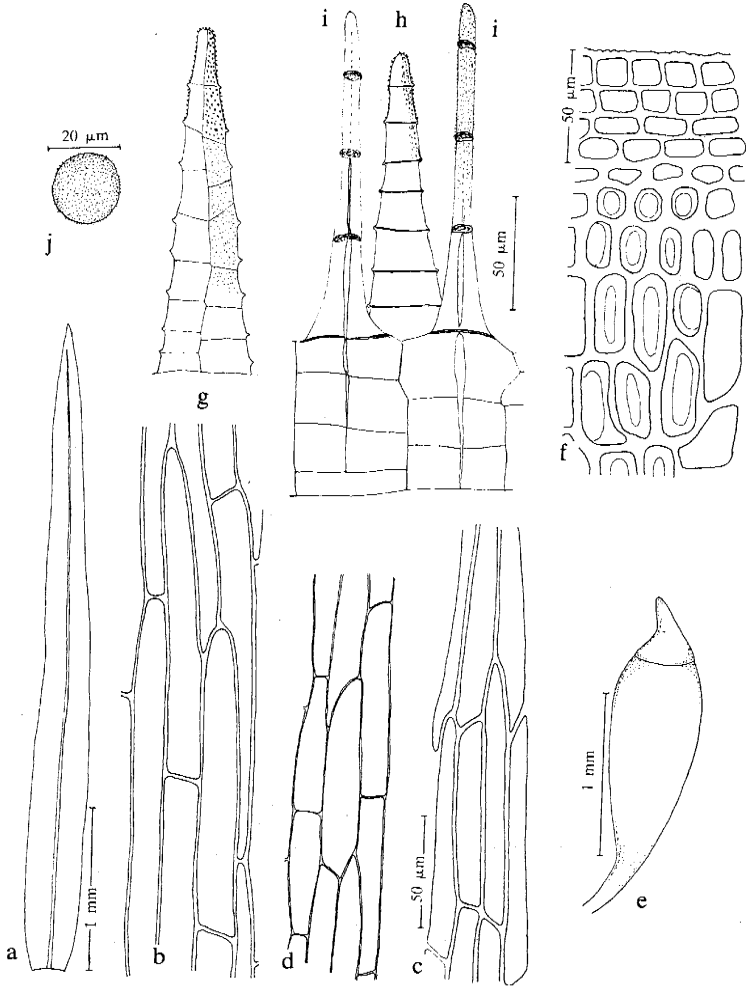


Fig. 140. *Orthodontium lineare*

Orthodontium lineare Schwaegr. 1827, *Spec. Musc.* Suppl. **2**(2):188.
Type: South Africa

Fig. 140

Plants on rotting bark or wood, burnt wood, more rarely on soil or rocks. Leaves (a) up to 3·5-4·5 mm long by about 0·3 mm wide; cells irregularly rhomboid, longer and wider in the middle (c) of the leaf than higher up (b), the basal cells shorter, wider and with thinner walls. Seta 5-12 mm long, orange; capsule (e) narrowly pyriform, about 1·5 mm long, slightly sulcate when dry, light brown with a darker mouth; exothecial cells (f) with rather thick periclinal walls as well as thickened outside walls; peristome teeth to 150 μm long; exostome teeth pale yellow, hyaline at the extreme apex, the plates scarcely marked on the outer side (g), the inner side (h) with strong trabeculae, the teeth papillose above, less so in the middle regions and almost smooth at the base; the endostome (i) processes linear, taller than the exostome, nodulose above, hyaline, papillose, split down the middle (rimose) below the nodules, the cleft extending into the basal membrane; spores (j) 16-22 μm diameter, pale brown to brown, rather finely papillose. Synoecious or autoecious.

Distribution: S.Africa, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, introduced to Europe. Not uncommon on rotting bark, the bases of trees and charred logs (6).

Orthodontium species A

Fig. 141

Plants on rotting bark; rather smaller than *O.lineare*. Leaves (a) 2-3 mm, long by 0·3 mm wide; cells rather regularly rhomboid-hexagonal, the upper (b) and mid-leaf (c) cells similar. Seta 4-6 mm; capsule (e) broadly pyriform, about 1·5 mm long, pale brown; exothecial cells (f) with thin periclinal walls; operculum with a short oblique beak; peristome smooth; the exostome teeth pale yellowish grey to about 160-175 μm tall, not very tapering, the outer side (g) with two rows of plates, rounded above; the inner side (h) with thin horizontal bars, scarcely trabeculate; the endostome (i) without processes, hyaline, consisting of broad blunt "teeth" about half to two-thirds the height of the exostome teeth, hyaline, smooth, standing opposite to the exostome teeth; spores (j) 26-30 μm diameter, brown, densely verrucose. Synoecious.

Distribution: Australian (W.A., S.A.?) endemic? The figure was drawn from W.A. material; presumably similar South Australian material (6) has only old and damaged capsules.

This species may be *O.inflatum* (Mitt.) Par., which agrees in the broadly pyriform capsule and large spores. The endostome "teeth" are derived from the basal membrane divided along lines which correspond to where the clefts would descend from rimose processes.

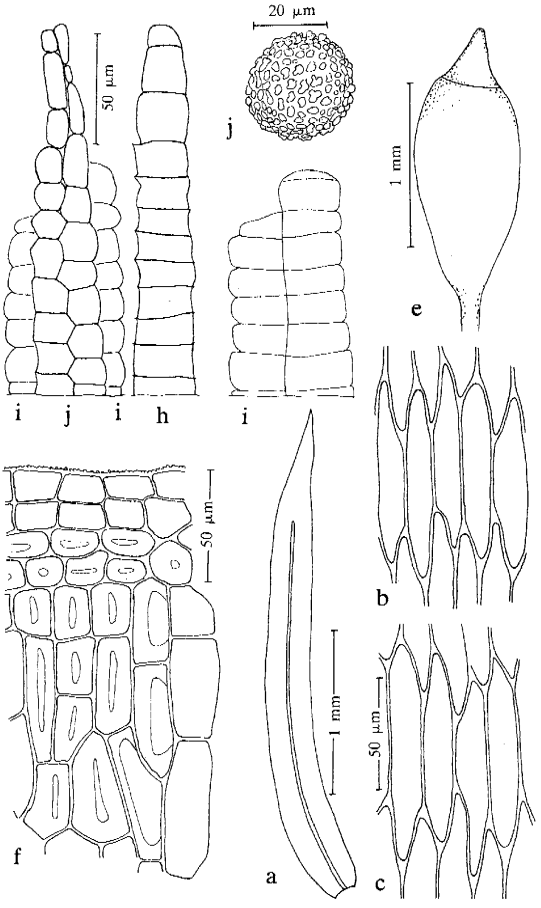


Fig. 141. *Orthodontium species A.*

LEPTOBRYUM (B.S.G.) Wils. 1855, *Bryol. Brit.* p.219.

Bryum subgenus *Leptobryum* B.S.G. 1851, *Bryol. Eur.* **4**:1.

Annual plants growing in tufts. Upper leaves setaceous with a wide costa occupying most of the subula; cells linear. Capsule pyriform, pendulous, glossy; peristome as in *Bryum*, with cilia.

Leptobryum pyriforme (Hedw.) Wils. 1855, *Bryol. Brit.* p.219.

Basionym: *Webera pyriformis* Hedw. 1801, *Spec.Musc.* p.169.

Type: Europe.

Fig. 142

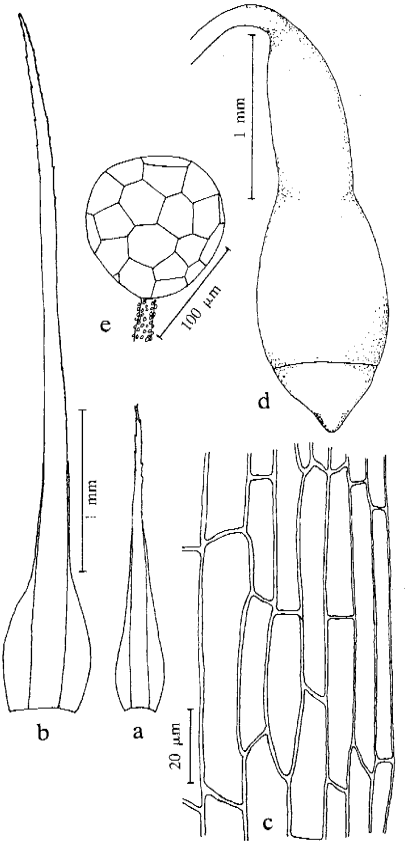


Fig. 142. *Leptobryum pyriforme*

Slender, silky plants, 1-2·5 cm tall, in pale green glossy tufts. Rhizoids purple, densely papillose; plants bearing tubers (e), red to nearly black, ovoid, attached by short rhizoids, especially in the axils of the lower leaves. Leaves flexuous when dry, flexuous and spreading when moist, lower (a) lanceolate, acuminate, the upper (b) and perichaetial leaves forming a comal tuft, the leaf (b) abruptly narrowed from a broad erect base to a long setaceous subula, composed mainly of the costa, tapering to a fine point, denticulate above; costa broad and thin, about one third of the width of the base; leaf cells (c) linear rhomboid, smooth, narrower at the margin of the base. Seta long, 2·5-5 cm, reddish, flexuous; capsule (d) inclined to pendulous, pyriform with a long tapering apophysis, bright reddish brown, glossy; operculum convex, apiculate; peristome yellow, cilia of the endostome long, appendiculate; spores 14-20 µm. Synoecious.

Distribution: Almost cosmopolitan. On soil and sandstone rocks (6, 8), often a weed in nurseries and on flower-pots, appearing also on the sites of fires.

BRACHYMENIUM Schwaegr. 1824, *Spec.Musc.*Suppl. **2**(1):131.

Tufted plants with the habit of *Bryum*. Seta long, bent at the apex; capsule suberect or inclined; peristome double, the exostome of 16 lanceolate teeth, the processes of the endostome linear, shorter than the exostome teeth, no cilia.

Brachymenium preissianum (Hamp.) Jaeg. 1875, *Ber.S.Gall. Naturw.Ges.* **1873-74:**113.

Basionym; *Bryum preissianum* Hamp. 1844, *Icon. Musc.* p.25.

Type: Western Australia, Freemantle, on limestone, Herb. Preiss, nos. 2451 and 2453, 14 Aug. 1823.

Fig. 143

Small plants in dense green or yellow-green tufts, usually on limestone or calcareous soil, 3-8 mm tall; stem very short, with several branches innovating from below the perichaetia. Leaves (a) to 1 mm long, erect whether dry or moist, lanceolate or ovate-lanceolate, acuminate, margin plane and entire; costa yellowish brown, strong and wide, excurrent in a stout cuspidate point. Upper cells (b) 25-35 μm long by about 10-12 μm wide, pellucid, the walls firm or

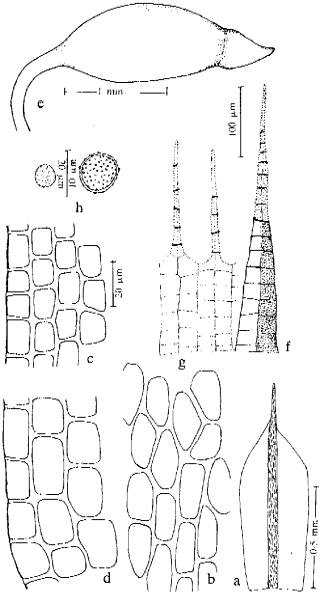


Fig. 143. *Brachymenium preissianum*

incrassate, rhomboid hexagonal; one or two marginal rows (c) narrower and shortly rectangular, but not forming a distinct border; basal cells (d) wider, more or less rectangular. Seta 0·5 to 1·5 cm long, slender, flexuous, yellow above and reddish below; capsule (e) 2-2·5 mm long, inclined or horizontal, oblong-elliptical, dark reddish brown, with a distinct apophysis and a narrow mouth; operculum conical, usually shortly rostellate. Exostome teeth (f) narrowly lanceolate, subulate, to 400 μm long; yellow and finely papillose to nearly smooth below, hyaline and papillose above, the median line nearly straight and the inner surface lamellate; processes of the endostome (g) narrowly linear to 150 μm tall, papillose, slightly rimose, shorter than the exostome teeth, borne on a papillose basal membrane about a third of the height of the exostome teeth; spores (h) 8-10 μm, lightly papillose. Dioecious, but commonly in fruit.

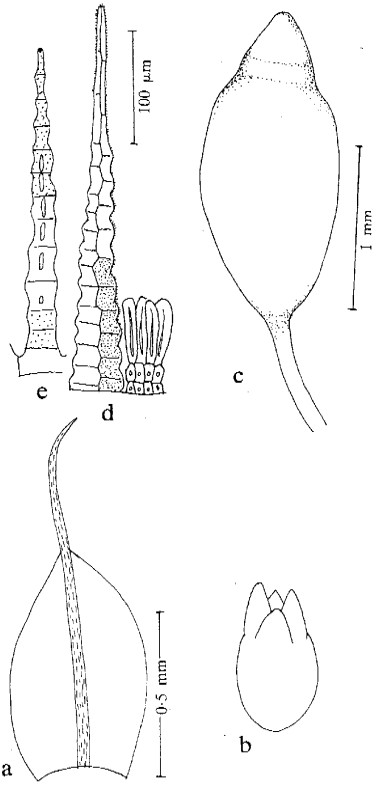


Fig. 144. *Brachymenium exile*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., Qld, N.T.), New Zealand. Probably common in South Australia (1, 6), restricted to limestone rocks and soils.

Brachymenium exile (Doz. et Molk.) Bosch et Lac. 1860, *Bryol. Jav.* **1**:139.

Basionym: *Bryum exile* Doz. et Molk. 1844, *Ann. Sci. Nat. Bot.* ser. 3, **2**:300

Type: Java.

Fig. 144

Small plants in dense tufts or mats, similar in habit to *B. preissianum*. Leaves (a) erect, imbricate, to 1 mm long, ovate concave; costa shortly excurrent; upper cells hexagonal-rhomboid, with thin walls, to 35 x 10 μm, narrower towards the margins, more rectangular and lax at the base. Axillary bulbils (b) common on sterile stems; bulbils ovoid, 0·1-0·25 mm long, with short leafy tips. Seta 1-1·5 mm long, red; capsule (c) erect or inclined, obovid to broadly clavate, brown, up to 2 mm long;, operculum conical, apiculate; exostome teeth (d) yellow, lanceolate, to 300 μm long, the tips hyaline and papillose; endostome membrane low, bearing very rudimentary processes and occasional long ones (e) the processes usually 50 μm tall, split at the apex; spores 8-10 μm diameter. Dioecious.

Distribution: Indo Malaya and East Indies, Hawaii, Australia (N.T.).

BRYUM Hedw. 1801, *Spec. Musc. p.178*

Lectotype: B.argenteum Hedw. *fid.* Britton 1916, *Fl.Bermuda* p.442.

Plants small or large, in tufts or turfs; stems innovating from below the inflorescences and usually with abundant rhizoids basally; rhizoids usually papillose. Leaves usually concave, ovate to lanceolate or elliptical or spathulate, entire or denticulate, sometimes with a hair point; costa strong, percurrent or excurrent as a rule; upper cells hexagonal or rhomboidal, the marginal sometimes forming a distinct border; basal cells rectangular or subquadrate. Seta long; capsule clavate or pyriform, horizontal or pendulous, brown to reddish purple; operculum convex, mamillate or apiculate; calyptra small, cucullate, fugacious. Peristome double, the exostome teeth lanceolate, sometimes bordered; endostome with high basal membrane, about a third to a half of the height of the exostome, bearing perforated processes alternating with the exostome teeth and with up to four cilia between each pair of processes; cilia simple, nodulose (thickened knobs where transverse walls were) or appendiculate (thickenings of cross walls, projecting beyond the cilium).

This is a very large genus with about 1050 species in the world; about 100 names have been applied to Australian plants, but Ochi (1970) reduced these to 28, some of them being doubtfully distinct. However, the more variable species may be aggregates and it must be said that no satisfactory account is yet available, nor can it be given without much more study. The plants are difficult taxonomically and not all specimens can be identified with confidence. Good ripe fruit, either not dehisced or recently dehisced is needed for examination of the peristome. Leaves tend to vary in development according to whether they

are on the main stems or on innovations. Tubers are present on the rhizoids of some species and provide significant taxonomic characters. Since these are buried in the soil, to a depth of 1 to 2 cm, careful collection is necessary followed by washing away of the soil. The following account describes the species known to be in South Australia or at least recorded more or less reliably and a few, especially of the *B.erythrocarpum* complex, which are likely to occur in urban areas or on disturbed soil. Those unconfirmed by further work may be deleted and for the present it may be better to have too much information than too little. Names are not available in all cases and eponyms have been given in the form of letters until they are better known.

The key is only a guide to identification and the plants must be carefully compared with descriptions, illustrations and with one another.

Key to species of *Bryum:*

1. Leaves imbricate, concave, the apices hyaline and contracted abruptly to a short point; shoots silvery white when dry, sometimes julaceous *B.argenteum*, p.269
   Apices of leaves not hyaline, nor shoots silvery white when dry 2
2. Bulbils or roughly spherical tubers or filamentous gemmae present in leaf axils, particularly of sterile shoots 3
   No axillary propagula, but tubers may occur on rhizoids of some species .. 7
3. Plants with axillary bulbils 4
   Plants with axillary filamentous gemmae or axillary tubers 6
4. Bulbils without rudiments of leaves; capsule contracted abruptly into the seta, the apophysis swollen and corrugated when ripe *B.pachytheca*, p.266
   Bulbils with rudiments of leaves 5
5. Rudimentary leaves on bulbils covering at least two-thirds of bulbil; apophysis tapering very gradually to the seta..... *B.dichotomum*, p.269
   Rudimentary leaves on bulbils very small, restricted to apex; apophysis tapering abruptly to the seta ..... *B.species C*, p.268
6. Filamentous light brown gemmae in leaf axils; perichaetial leaves coarsely toothed ..... *B.albo-limbatum*, p.257
   Deep red spherical tubers, in axils of lower leaves ..... (*B.rubens*, p.276)
7. Leaf apex rounded or obtuse, on wet rocks in or by streams *B.species A*, p.273
   Leaf apex acute or acuminate 8
8. Plants with mature capsules 9
   Plants without mature capsules or sterile; only some can be safely identified; go to couplet 10 and follow the alternatives provided by vegetative characters as far as possible 10
9. Cilia of endostome simple, rudimentary or sometimes none *B.inclinatum*, p.253
   Cilia of endostome appendiculate or nodulose 10
10. Leaves widest at or above the middle, obovate, spathulate or obovate oblong..... 11
    Leaves widest below the middle, ovate, ovate-lanceolate or lanceolate .. 16

11. Costa excurrent in a long arista or hair; cells of mid leaf relatively thinly walled; tubers present on rhizoids 12
    Costa excurrent in a short to medium point; cells of mid leaf thickly walled and porose; no tubers 14
12. Dioecious; leaves spirally twisted around stem or self twisted when dry; exothecial cells below mouth of capsule not in longitudinal rows; processes of endostome tapered gradually to a slender point; capsule brown; paraphyses with rounded tips 13
    Usually synoecious; leaves usually appressed and not shrunken or much twisted when dry; exothecial cells below mouth of capsule more or less in longitudinal rows; processes of endostome abruptly contracted to a slender point; tubers red; capsule red; paraphyses with tapered tips. *B.torquescens*, p.257
13. Leaves spirally twisted around the stem; tubers brown to reddish brown, spherical or oval, 100-250 μm across; perichaetial leaves entire *B.capillare*, p.255
    Leaves weakly twisted individually; tubers orange, spherical or oval, 250-400 μm across; light brown, papillose filamentous gemmae in leaf axils; perichaetial leaves serrate ..... *B.albo-limbatum*, p.257
14. Medium-sized plants; leaves closely imbricate both moist and dry; costa excurrent, brownish, nearly straight, cilia 2, nodose, not appendiculate *B. campylothecium*, p.263
    Plants large; leaves spreading when moist; costa excurrent, green, recurved in a short hook; cilia 3, appendiculate 15
15. Leaves obovate, shrinking laterally and becoming appressed when dry *B. billardieri*, p.262
    Leaves spathulate, not shrinking much and remaining more or less spreading when dry ..... *B. species B*, p.262
16. Costa excurrent, usually in a long arista, but sometimes rather short 17
    Costa percurrent or very shortly excurrent in a small point 26
17. Capsule ovate or broadly elliptical, usually with a swollen apophysis broader than the theca 18
    Capsule pyriform, the apophysis narrower than the theca and tapering gradually into the seta 21
18. Apophysis strongly corrugated; small bulbils usually present in the axils of leaves on sterile stems; leaf margin plane ..... *B. pachytheca*, p.265
    Apophysis smooth or nearly so when fresh or moist; leaf margin revolute 19
19. Leaves with a long, hyaline, denticulate arista; apophysis slightly corrugated; bulbils with apical rudimentary leaves ... *B. species C*, p.268
    Leaves with a short, coloured arista; apophysis smooth 20
20. Leaves lanceolate; cilia mostly nodose ..... *B. species D*, p.269
    Leaves ovate; tubers present on rhizoids; cilia appendiculate *B. species E*, p.275
21. Upper and middle leaf cells rhomboid to hexagonal, 14-30 μm wide, narrower towards the margin in several rows, forming a border 22

Upper and middle-leaf cells not so broad, rarely exceeding 16 μm wide, one or two narrower rows at margin, but no clearly defined border 23

22. Mid-leaf cells hexagonal, 16-30 μm wide, about 2-2·5 times as long wide; cell walls thin; dioecious ..... *B. pseudotriquetrum*, p.260
Mid-leaf cells rhomboid to hexagonal, 14-24 μm wide, about 4-5 times as long as wide; cells incrassate, especially at the margin; autoecious *B. creberrimum*, p.259

23. Dioecious; cilia appendiculate 24
Synoecious; cilia nodulose ..... *B. intermedium*, p.254

24. Leafy bulbils in the axils of leaves on sterile stems; leaf margin plane or nearly so ..... *B. dichotomum*, p.269
No bulbils; leaf margin revolute 25

25. Upper leaves larger and more crowded than the lower, forming a comal tuft; no tubers ..... *B. caespiticium*, p.264
Upper leaves hardly larger or more crowded than the lower, not forming a comal tuft; plants with tubers, usually on the rhizoids *B. erythrocarpum* complex, p.277

26. Capsule ovate or elliptical with a broad apophysis, either much corrugated or slightly corrugated in the broad part; bulbils often present in the axils of leaves on sterile stems 4
Capsule clavate or pyriform, the apophysis narrow and not corrugated; no bulbils on sterile stems 27

27. Leaves with a distinct border of several rows of narrow cells at the margin; basal angle of leaf slightly decurrent; margin plane *B. erythrocarpoides*, p.271
Leaf with one or two rows of narrow cells at margin, but no distinct margin; leaf base not decurrent, but revolute ..... *B. chrysoneuron*, p.273

Bryum inclinatum (Brid.) Bland 1809, *Übers. Mecklenb. Moos.* p.6
Basionym: *Pohlia inclinata* Brid. 1803, *Musc. Rec.* **2**(3):144.
Type: Sweden.

Fig. 145

Synoecious. Plants yellowish green, to 1 cm tall; leaves (a) crowded above, in comal tufts, appressed and straight or somewhat crisped when dry, erecto-patent when moist, ovate-lanceolate to lanceolate, acuminate, base of leaf reddish; margin recurved, bordered; costa yellowish to brownish, excurrent; upper cells (b) rhomboid hexagonal, 12-20 μm wide in mid leaf, with 3-4 marginal rows very narrow, more incrassate; basal cells rectangular, the angular cells somewhat swollen. Capsule inclined to pendulous, narrowly pyriform, mouth yellowish; 2 to 4 rows of exothecial cells at mouth narrowly transversely rectangular, next cells quadrate to hexagonal and about 20-25 μm wide, then longitudinally rectangular; operculum mamillate; exostome teeth reddish below, yellow above; processes of endostome (c) with wide perforations, papillose, but less so at the margins than centrally, the cilia rudimentary.

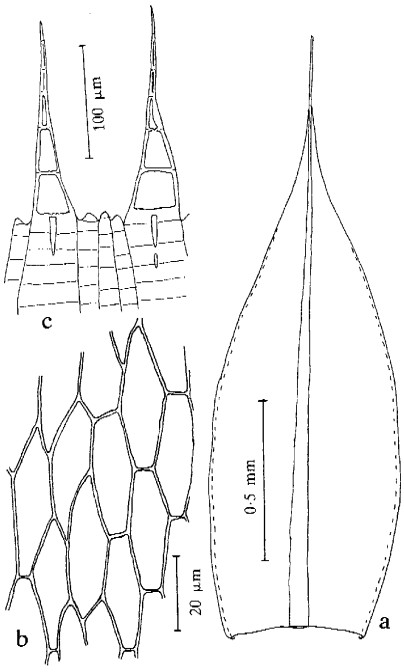


Fig. 145. *Bryum inclinatum*

Distribution: Europe, N.Africa, N.America, Asia, Tierra del Fuego, Australia (?S.A.). In tufts on soil, rock and sand dunes, especially basic habitats.

Bryum intermedium (Brid.) Bland. 1809, *Übers. Mecklenb. Moos.* p.6

Basionym: *Pohlia intermedia* Brid. 1803, *Musc. Rec.* **2**(3):144.

Type: Norway

Fig. 146

Synoecious. Plants green, to 2·5 cm tall; upper leaves (a) in a comal tuft, imbricate, straight when dry, erect when moist, lanceolate, acuminate; margin revolute from base to apex, entire, base of leaf reddish; costa reddish, excurrent; middle and upper cells (b) rhomboid to hexagonal, 12-18 µm wide in mid leaf, with 2 to 3 rows narrow and rhomboid at the margin, forming an indistinct border; basal cells (c) similar, but wider and longer, with one row at margin narrower. Capsule (d) pendulous, narrowly pyriform; operculum conical; exostome teeth brown; endostome processes (e) slender with narrow perforations, the cilia linear and nodulose; spores 18-22 µm diameter, finely papillose.

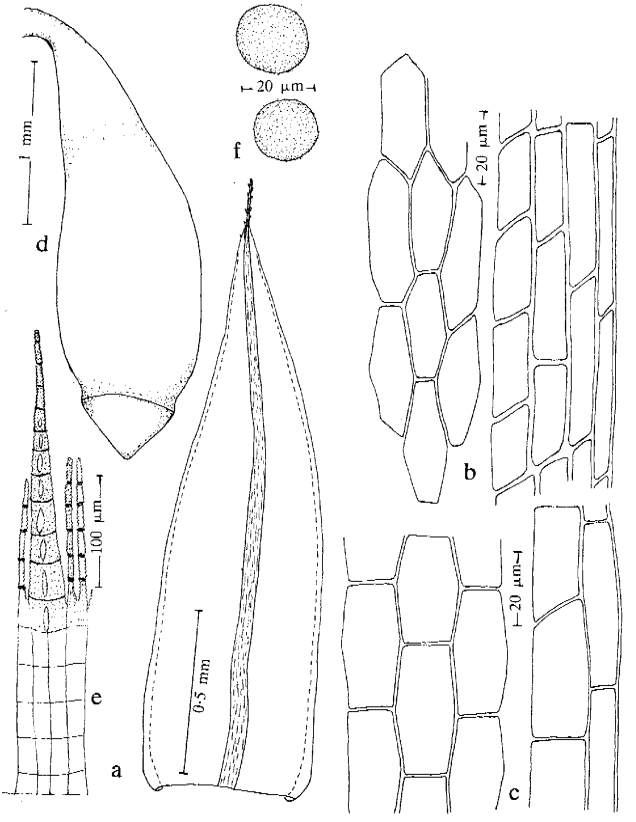


Fig. 146. *Bryum intermedium*

Distribution: Europe, E.Asia, N.Africa, N.America, Australia (S.A., Tas.). On basic soil and sand dunes. Confused with *B.caespiticium* which is dioecious and has smaller spores as well as appendiculate cilia.

Bryum capillare Hedw. 1801, *Spec. Musc.* p.182

Type: Europe.

Fig. 147

Dioecious. Plants 1-2·5 cm tall, in loose or dense tufts, usually deep green, reddish brown below soft. Leaves shrunken and twisted when dry and usually strongly spirally twisted around the stem with the points flexuous, patent when moist and slightly bent in the direction of twisting; lower leaves narrowly lanceolate, the upper comal ones (a) obovate-spathulate, flat or concave, shortly acuminate, rather abruptly aristate from the excurrent costa; arista

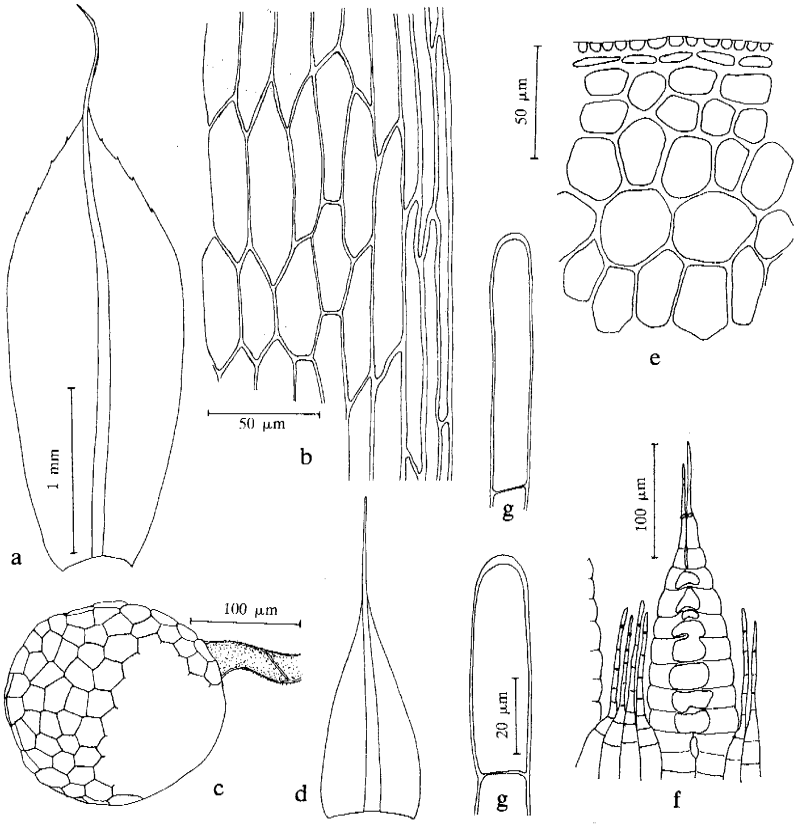


Fig. 147. *Bryum capillare*

straight or bent; margin entire below, usually denticulate above, recurved to about half way or more; basal cells shortly rectangular; the upper cells (b) hexagonal or rhomboid-hexagonal, 35-50 × 15-25 µm, the walls thin; cells longer and narrower in 2-4 rows at the margin, the wall sometimes yellowish but usually colourless. Rhizoids (c) brown to dark reddish brown, papillose, bearing tubers of a similar colour, spherical or ovoid in shape and 60-250 µm across, the outer cells not protuberant. Perichaetial leaves (d) green, narrowly lanceolate with a long arista, the excurrent costa; paraphyses hyaline; seta long, capsule cernuous or pendent, cylindrical to pyriform, light brown to brown; operculum conical, bluntly apiculate; exothecial cells at mouth (e) few rows of short cells, not in vertical rows, nor transversely elongated; cells of operculum in fairly regularly concentric rings; exostome teeth papillose on the outer side, the papillae densely and randomly arranged, not in rows; endostome (f) processes

tapered to a long fine point, the cilia nodose; spores 8-12 μm diameter, smooth. Perigonial leaves much smaller than vegetative leaves, usually orange, ovate, concave with a hairpoint, costa ceasing below apex; paraphyses orange, apical cells (g) rounded at tip.

Distribution: Europe, N.E. and S.W.Asia, N. and Central Africa, N. and Central America, N.W. S.America, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.) New Zealand. Uncommon (6, 8-10, 12) on soil or sand, on dunes, in forest, in gorges, or on rocks and trees, on basic or acidic substrates.

Bryum albo-limbatum (Hamp.) Jaeg. 1875, *Ber. S. Gall. Naturw. Ges.* **1873-4**:191.

Basionym: *Rhodobryum albo-limbatum* Hamp. 1870, *Linnaea* **36**:517.

Type: Western Australia, Porongorup, F. von Mueller, Oct. 1867.

Dioecious. Resembling *B. capillare* in loose tufts 0·5-1·5 cm tall, deep green or maroon. Leaves soft, obovate spathulate or ovate, 1·5-3·5 mm long, flat, not much shrunken when dry, slightly twisted; costa brown, excurrent; margin coarsely dentate at least in upper half of the leaf; upper cells rhomboid to hexagonal, short and narrow, 30-60 × 12-20 μm, walls thin, rarely porose; at the margin a border of 3-4 rows of narrow elongated cells; basal cells rectangular 40-100 × 15-22 μm porose. Rhizoids brown, finely papillose, bearing orange tubers which are spherical or oval and about 250-400 μm across, the superficial cells not protruding; filamentous gemmae in axils of leaves, light brown, papillose, 15-35 μm wide. Perichaetial leaves narrow, lanceolate, with an excurrent costa and a coarsely dentate margin; paraphyses orange. Capsule brown, subcylindrical, 2-4 mm long, cernuous, apophysis distinctly tapered; exothecial cells below mouth irregular in shape, roughly isodiametric, transverse walls thick, longitudinal thinner; operculum conical, acuminate, cells very narrow mixed with some broad cells; spores 12-16 μm diameter. Perigonial leaves small, ovate, concave, orange, costa excurrent; paraphyses orange.

Distribution: Australia (W.A., S.A., Qld) endemic. Rare (6), on trees or rocks in moist habitats.

Bryum torquescens Bruch ex De Not. 1838, *Syll.* no. 163; Bruch 1839, *Bryol. Eur.* **4**:49.

Type: Italy, Sardinia, auf Meersand, coll. Mueller, 1828.

Fig. 148; Plate 10A

Usually synoecious, rarely autoecious or dioecious. Resembling *B.capillare*. In loose or dense tufts 1-2·5 cm tall, green, sometimes tinged with red. Leaves (a) hardly shrinking, but slightly twisted, usually appressed when dry, rarely twisted around the stem, more or less patent when moist, upper leaves obovate-spathulate, 1·5-4 mm long; costa excurrent, brown or reddish; margin recurved, usually dentate to serrate; upper cells (b) longly hexagonal, 45-80 x 12-18 μm, with a border of 3-4 rows of narrow thickly walled cells at the margin; basal cells elongate, 35-75 x 15-22 μm. Rhizoids (c) brown, usually bearing abundant red to crimson tubers, orange when young, spherical, 75-250 μm diameter, the surface

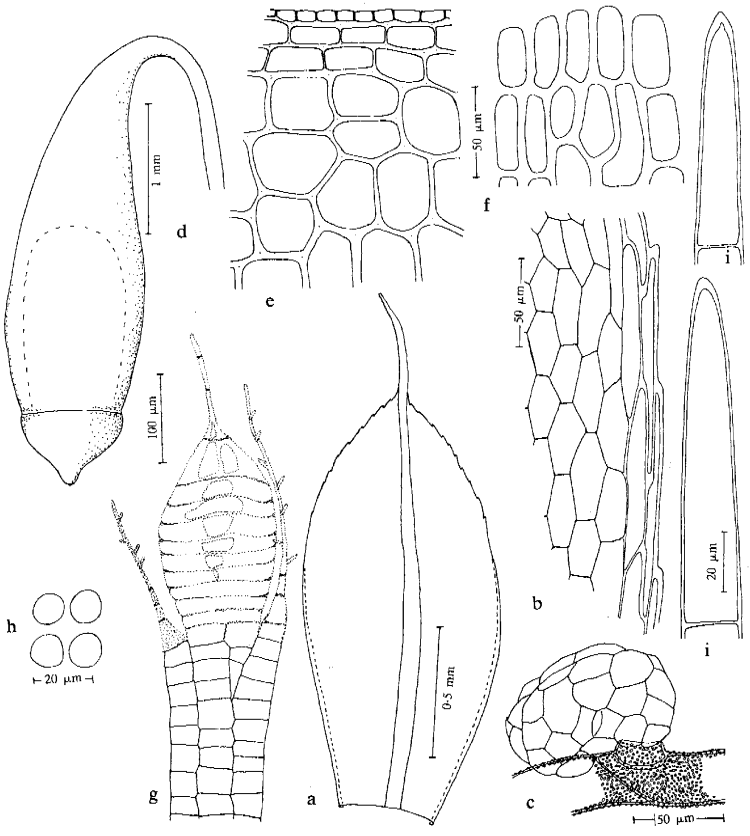


Fig. 148. *Bryum torquescens*

cells not protruding. Perichaetial leaves narrow, lanceolate, cuspidate with the excurrent costa; paraphyses hyaline. Capsule (d) cylindrical or narrowly pyriform, 3-5 mm long, cernuous to pendulous, reddish brown to crimson; exothecial cells (e) at mouth of urn with 1-2 rows of transversely elongated cells, with thick transverse and thin longitudinal walls and the cells below the mouth in roughly longitudinal rows; operculum hemispherical with a short point, the cells (f) in broken concentric rings; outer surface of exostome teeth papillate, the papillae in transverse rows; processes of endostome (g) contracting abruptly above to a long narrow point; spores (h) 10-15 µm diameter. Perigonial leaves pale orange or colourless, small, ovate concave, with a short to long arista formed of the excurrent costa; paraphyses (i) orange or pale, apical cell tapered to an acute tip.

Distribution: Europe, S.Asia, Africa, N. & S.America, Australia (S.A., Vic.).

Common (6, 9, 10, 17, 21) on basic soils, especially maritime sand dunes, grassland, earthy banks, sandy soil, and calcareous rock covered with soil, but not on tree trunks. Commoner than *B.capillare*.

Bryum creberrimum Tayl. 1846, *London J. Bot.*, **5**:54

Type: W. Australia, Swan River, J. Drummond.

Fig. 149

Synoecious. Plants 1-4 cm tall, in dense tufts, green above and reddish brown below, where matted with rhizoids. Leaves (a) erecto-patent when moist, a little twisted when dry, lanceolate to ovate-lanceolate, tapering to an acuminate apex; margin generally strongly recurved and bordered, entire or denticulate near the apex; costa reddish, excurrent; the mid (b) and upper cells rhomboid to hexagonal, 15-25 μm wide, to 80 μm long, several marginal rows (c) narrower

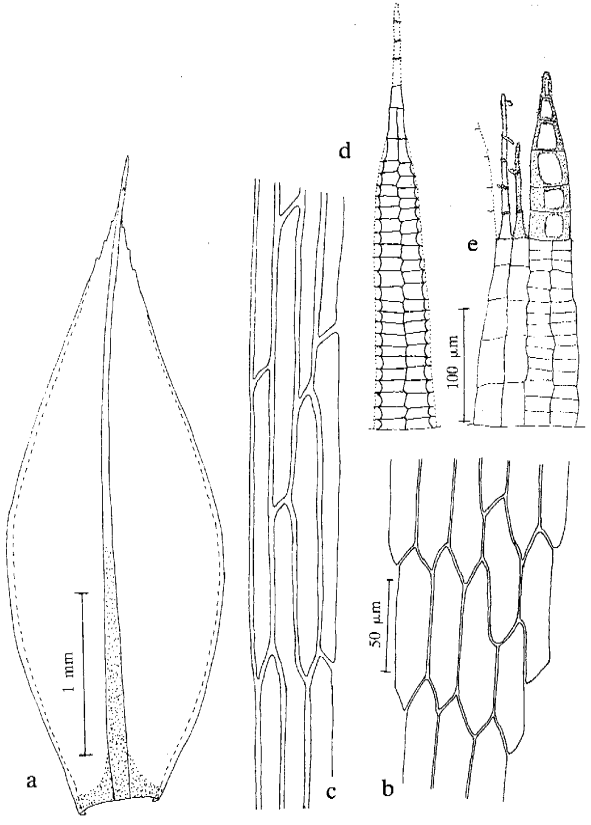


Fig. 149. *Bryum creberrimum*

longer and more incrassate forming a distinct border; basal cells rectangular, with the alar cells slightly inflated. Capsule inclined to pendulous, symmetrical, narrowly pyriform; operculum mamillate; exostome teeth (d) narrowly lanceolate; the membrane of the endostome (e) to about half their height, bearing processes with perforations about as wide as long and appendiculate cilia, usually two between each pair of processes; spores 14-16 μm.

Distribution: Europe, N.America, N.Asia, India, Australia (W.A., S.A., Vic.), New Zealand. Uncommon on soil and in crevices of rocks, preferring basic substrates.

Bryum pseudotriquetrum (Hedw.) Schwaegr. 1816, *Spec. Musc.* Suppl. **1**(2):110

Basionym: *Mnium pseudotriquetrum* Hedw. 1801, *Spec. Musc.* p.190

Type: Europe

Fig. 150

Dioecious. Plants glossy, green to reddish, 1-5(-10) cm tall, stems matted below with brown rhizoids. Leaves (a) fairly uniform on the stem, not particularly crowded at the apex, shrunken when dry, erecto-patent when moist, ovate to ovate-lanceolate, acuminate, margin narrowly recurved, with a wide border of narrow cells; costa stout, reddish brown, percurrent to shortly excurrent. Upper cells (b) hexagonal, 16-30 μm wide, becoming rhomboid-hexagonal near the margin (c) and passing into several rows of very narrow elongated cells, 200-250 x 15-18 μm; basal cells reddish, shortly rectangular, those towards the angles larger, inflated, with very thin walls. Capsule (d) large, more or less pendulous, broadly pyriform; operculum conical; exothecial cells

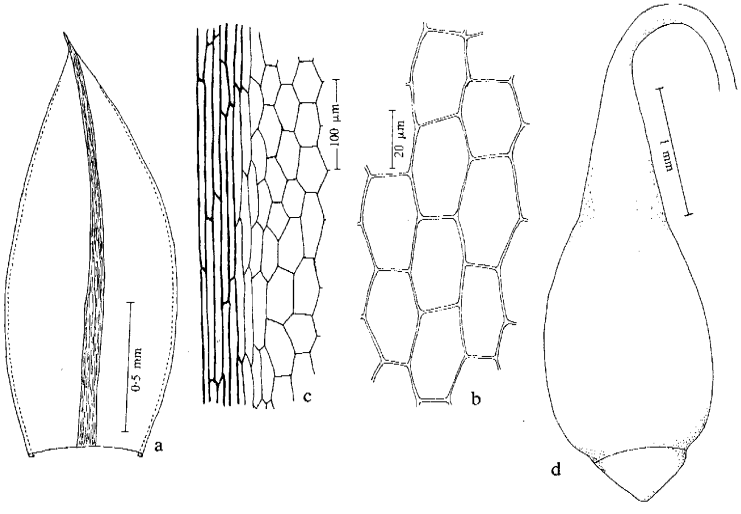


Fig. 150. *Bryum pseudotriquetrum*

horizontally rectangular in one or two rows at the mouth, walls thick and reddish; lower cells elongate, rectangular, rhomboid, walls sometimes a little sinuous; exostome teeth orange brown below, yellow at the tips, papillose; processes of endostome with wide perforations, cilia filiform longly appendiculate, the basal membrane about half of the height of the exostome; spores 12-18 μm diameter, finely papillose.

Distribution: Europe, Asia, N. & S.America, W.Africa, Australia (S.A., Vic., Tas., N.S.W., A.C.T.). A plant of wet soils, fens, wet heaths and marshes; usually low alpine, but also in lowland acid marshes.

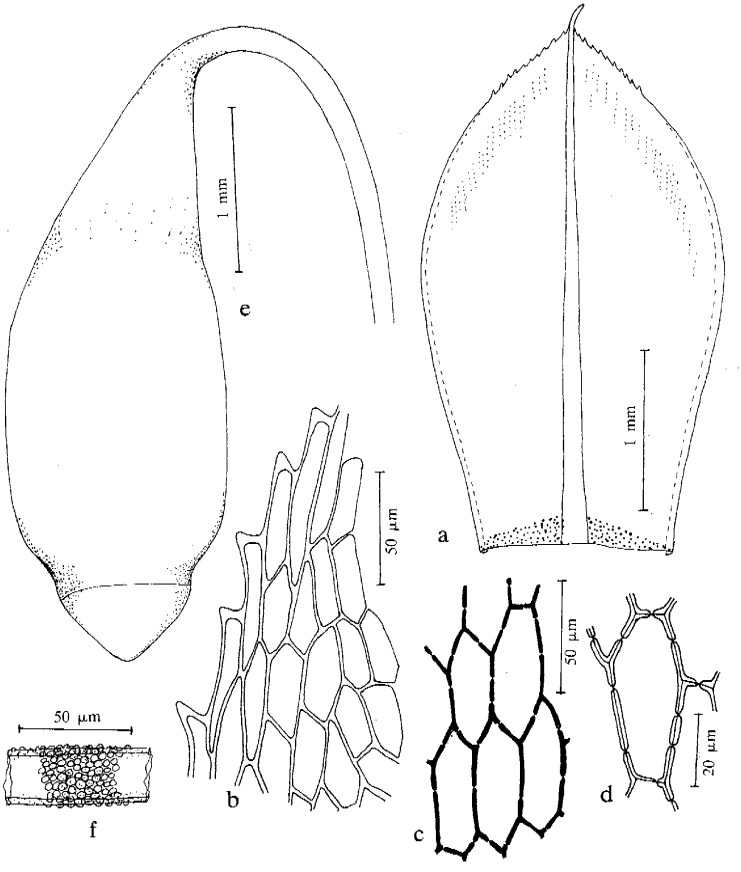


Fig. 151. *Bryum billardieri*

Bryum billardieri Schwaegr. 1816, *Spec. Musc.* Suppl. **1**(2):115.

Type: Tasmania(?)

Fig. 151

Dioecious. In tufts, green or yellowish green above, darker below 1-6 cm tall; stems stout, reddish, with abundant brown radiculose tomentum below, sometimes matting the stems, more or less comose; rhizoids (f) coarsely papillose. Leaves (a) oblong-obovate to broadly obovate, acute, somewhat concave, 1·5-4·5 mm long, spreading or patent when moist, shrunken laterally, somewhat twisted at the apex and appressed when dry, margins recurved below and usually for three-quarters of the leaf, dentate above (b); costa shortly excurrent in a reflexed point. Upper cells (b, c, d) hexagonal to rhomboid-hexagonal, 40-60 μm long by 16-20 μm wide, 2·5-3·5 times as long as wide, the walls moderately thickened (c, d) and porose; basal cells oblong; marginal cells above rhomboid, elongated, forming a border of 2-4 rows of incrassate cells, the marginal ones projecting as teeth; seta 1·5-4 cm long, red below, orange above; capsule (e) 2-4 mm long, usually cernuous, sometimes horizontal, oblong, pyriform with a shortly tapered apophysis, slightly constricted below the mouth, light brown throughout; operculum conical, blunt or shortly apiculate. Exostome teeth lanceolate, yellowish, hyaline apically, finely papillose on the outer surface, border hyaline; endostome with a basal membrane more than half the height of the exostome, the processes split widely and with three appendiculate cilia between each pair; spores 10-14 μm, smooth.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, South America. Common (1-3, 5-11, 15, 17) on soil, rocks, logs and stumps and sand dunes, on basic or acidic substrates.

A study of *B. billiardieri* Schwaegr. and related species by Mohamed (1979) was seen too late for his results to be considered. The presence of rhizoidal tubers is reported.

Bryum species B.

Fig. 152

Dioecious. Similar to *B. billardieri* but in looser tufts, dark green above and dark brown below, with ginger-brown tomentum below. Leaves (a) oblong spathulate, 5-6 mm long by about 2 mm wide, almost flat, widely spreading when moist, somewhat shrunken, flexuous and more or less spreading when dry, apex acute, margin strongly dentate; costa excurrent in a fairly long flexuous, reflexed arista, margin revolute from base for three quarters of the leaf; upper cells (b) longly hexagonal to rhomboid, 55-80 μm long by 16-22 μm wide, 3 to 5 times as long as wide, the walls firm and porose; marginal cells narrower, much longer and with thicker walls for 4-6 (-8) rows forming a border. Setae 3-5 cm long, capsule (c) cernuous, pyriform, incurved, light brown, 3-5 mm long; operculum conical, apiculate; spores 10-12 μm smooth.

Distribution: Australia (W.A., S.A.). Much less common (1, 2, 6), on litter in sclerophyll scrub.

This species has some resemblance to *B. truncorum* Brid.

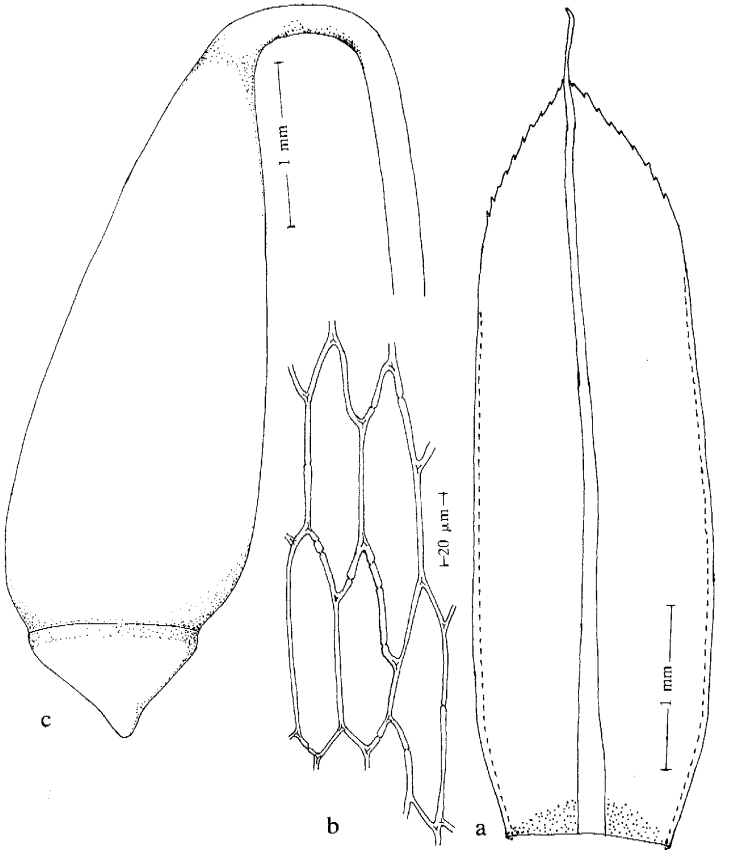


Fig. 152. *Bryum species B.*

Bryum campylothecium Tayl. 1846, *London J. Bot.*, **5**:52.
Type: Western Australia, Swan River, J. Drummond.
Fig. 153

Dioecious. Plants usually in dense tufts, 1-2 cm high, yellowish green to bronze, darker below; stems stout, densely clothed below with dark brown tomentum. Leaves (a) 2-3 mm long, usually in dense comal tufts, closely imbricate, not altered when dry, broadly obovate, acute, concave; costa excurrent in a long, straight, smooth or denticulate arista; margins recurved, entire below, slightly denticulate above; cells (b) hexagonal to rhomboid-

hexagonal 35-45 x 18-20 μm the walls very incrassate and porose; marginal cells not much different in shape, but walls thicker and yellow forming an indistinct border. Seta 1·5-3 cm, yellowish or reddish, slender; capsule small, 1·5-2·5 mm long, horizontal or cernuous, clavate or oblong-pyriform, brown; operculum conical, apiculate; exostome teeth similar to *B. billardieri*, but darker in colour; basal membrane of endostome less than half the height of the exostome, cilia 2, nodose but not appendiculate; spores (c) 16-20 μm diameter, finely papillose.

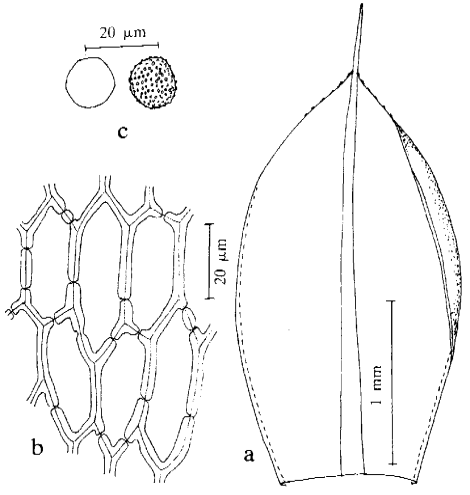


Fig. 153. *Bryum campylothecium*

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Fairly common (6, 7, 9-11, 14, 15, 17) on sandy soils, especially dunes and in mallee.

Bryum caespiticium Hedw. 1801, *Spec. Musc.* p.180.

Type: Europe

Fig. 154

In dense tufts, 1(-2) cm high, pale bright silky green; stems slender, often with slender innovations. Leaves (a) imbricate and slightly twisted when dry, imbricate to erect when moist, the uppermost forming a crowded coma, ovate to oblong-lanceolate, widest below the middle, acuminate; margin revolute to near the apex, almost entire; costa yellowish to reddish brown, excurrent in a long, usually entire, arista. Cells firm, the upper ones (b) narrowly hexagonal to rhomboid, the marginal (c) very narrow but not forming a distinct border, especially apically; basal cells shortly rectangular, the angular cells of the comal

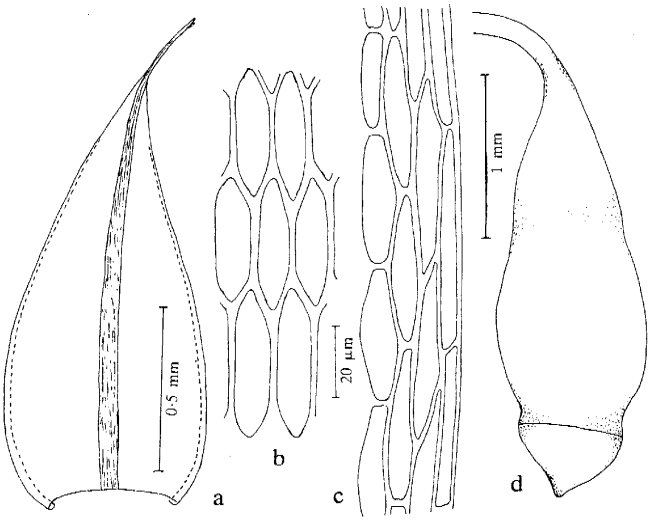


Fig. 154. *Bryum caespiticium*

leaves swollen. Capsule (d) oblong pyriform or clavate, 2-2·5 mm long, cernuous or pendulous, the apophysis often gibbous, the capsule straight or somewhat upcurved, brown, mouth wide; operculum orange, mamillate; exostome teeth pale brown, cilia of endostome appendiculate; spores 10-14 µm.

Distribution: Europe, Asia, N. & C. Africa, America, Australia (Tas., Vic., S.A., N.S.W., A.C.T.), New Zealand. Probably common (1, 6) on dry sandy or silty soils, especially in the mallee and sclerophyll scrub.

The following three species are related to the complex surrounding *B.bicolor* Dicks., widely distributed in the Northern Hemisphere. *B.bicolor* and its relatives are low growing species, green in colour, with ovate to ovate-acuminate leaves, with bulbils in the axils. The species are dioecious and have deep purplish red capsules, ovoid in shape, tapering quickly into the seta, which is rather short. There is considerable variation in vegetative characters, especially in the leaves and bulbils. Cultivation experiments (Smith and Whitehouse, 1978) have disclosed several taxa which differ consistently in the morphology of the bulbils and to a lesser extent in the leaves. Altogether, some five or six species are distinguished by them and by Wilczek and Demaret (1976) among European populations. Some of them may occur here, as introductions. Plants assigned to *B.pachytheca* C.Müll. and *B.dichotomum* Hedw. also show variation, especially in the morphology of the axillary bulbils and leaf morphology, and each probably encompasses a group of species, which need cultivation for analysis.

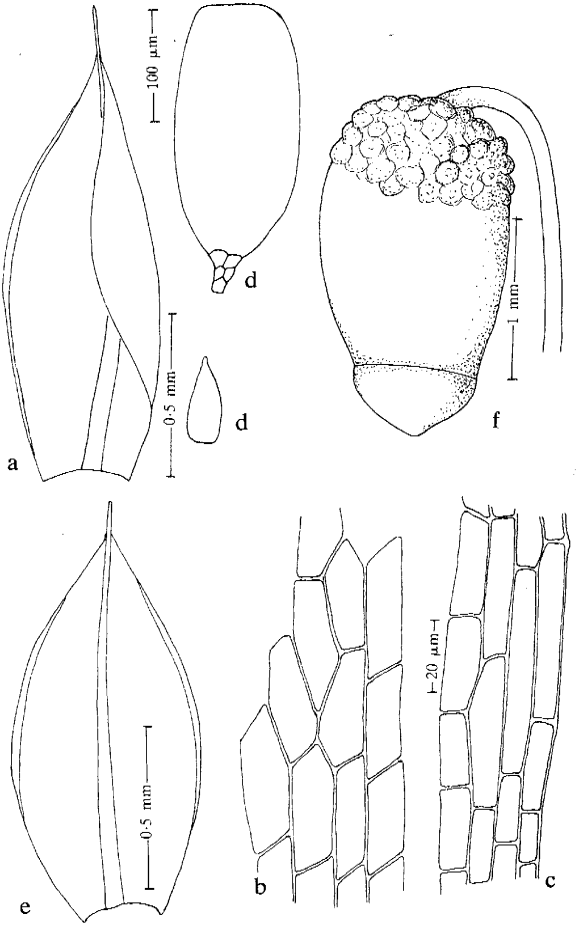


Fig. 155. *Bryum pachytheca*

Bryum pachytheca C.Müll, 1848, *Syn.* **1**:307.
Type: Australia

B.gambierense C.Müll. 1871, *Linnaea* **37**:148.
Type: South Australia, Mount Gambier.

B.cupulatum C.Müll. 1871, *Linnaea* **37**:149.
Type: Australia.

Fig. 155

Plants in mats or tufts, golden green to reddish green, the stems 0·5-1 cm tall. Leaves (a) elliptical to lanceolate, 0·6-1 × 0·3-0·4 mm concave, tapering to an acute apex, erect to patent, not much altered when dry; costa yellow or red, excurrent in a short arista, sometimes hyaline at the tip; margin plane; upper and middle cells (b) rhomboid to polygonal, 20-45 × 10-15 μm, walls fairly thin, cells narrower and rectangular. Oblong or obovate bulbils (d) about 150-250 × 100-125 μm, in the axils of leaves on sterile stems, without primordia of leaves. Perichaetial leaves (e) similar. Seta short, 0·5-2 cm tall, red; capsule purplish to crimson-brown (f) barrel-shaped to broadly ovate, pendent, the apophysis wider than the theca when moist, narrower when dry; apophysis rugose, abruptly expanded from the seta, not tapered, much darker than the theca; operculum shortly conical; or hemispherical; exostome teeth lanceolate, yellow, minutely papillose, apex hyaline, papillose; endostome membrane nearly two-thirds the height of the exostome, processes tapering with broad perforations, cilia 2 appendiculate; spores 8-10 μm smooth.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand, other areas uncertain. Common (6, 8, 17, 21) on sandy and loamy soils in many habitats, including urban environments such as gutters and crevices where soil collects.

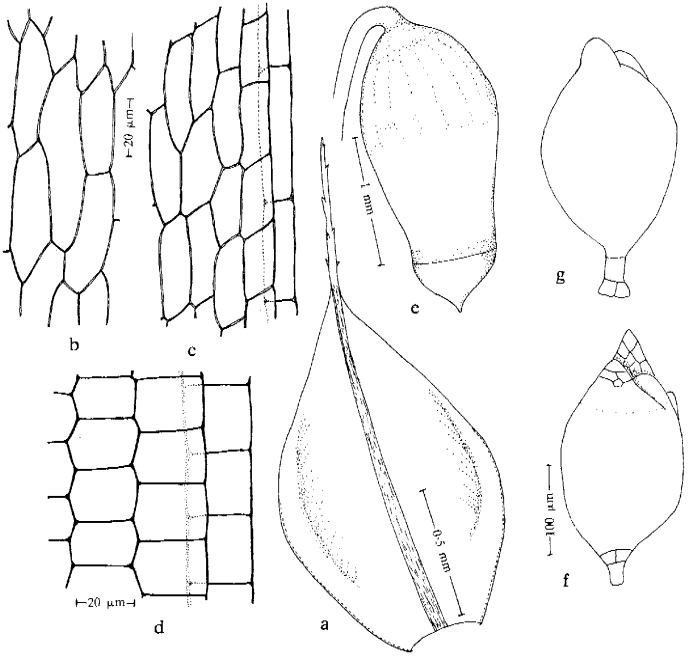


Fig. 156. *Bryum species C.*

Very variable, not always with bulbils. The following two seem fairly distinct, but may have to be included in *B.pachytheca;* they do not appear to fit any of the variants named by C. Müller.

Bryum species C

Fig. 156

Differing from *B.pachytheca* in the wider, broadly ovate, concave, acuminate leaf (a) with the margin revolute to at least mid leaf and with the costa excurrent in a long denticulate hyaline arista; upper cells (b), somewhat larger, wider at the margin (c); basal cells (d) hexagonal, becoming quadrate at the margin, tending to be wider than long. Bulbils (f, g) present in axils of leaves on sterile stems, one per axil, the bulbils broadly ellipsoid bearing minute rudiments of leaves at the apex. Capsule (e) ovate, brown, about 2 mm long, somewhat tapering into the seta, the apophysis scarcely grooved when moist, but wrinkled when dry; operculum dome shaped, apiculate; cilia appendiculate.

Distribution: Australia (S.A.). On sandy soil in arid areas (16)

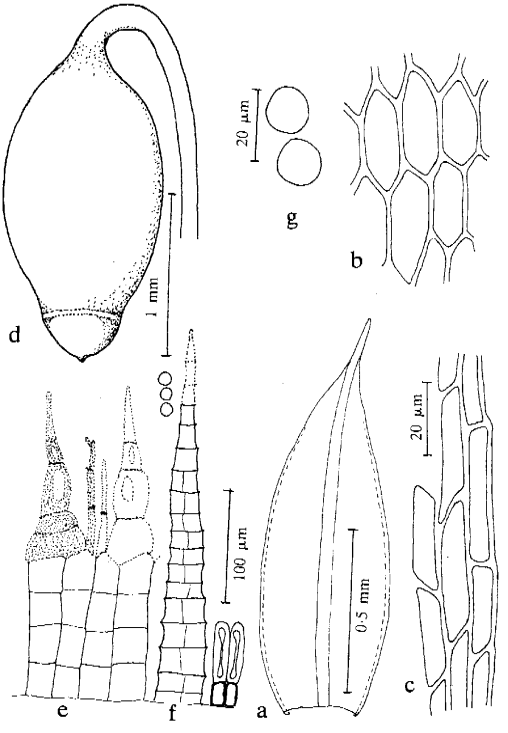


Fig. 157. *Bryum species D.*

Bryum species D

Fig. 157

Differing from *B.pachytheca* in the narrower, oblong-lanceolate leaf (a), acuminate, with the costa shortly excurrent in a reddish brown point and the margin revolute nearly to the apex; upper cells (b) hexagonal, shorter, incrassate, the marginal cells (c) narrowly rhomboid or rectangular. Seta about 1·5 cm tall, red, capsule (d) pendent, broadly ovoid, smooth when moist and shortly tapering into the seta; apophysis somewhat corrugated when dry, remaining broader and darker than the light-red theca; operculum dome-shaped apiculate; membrane of endostome (e) less than half the height of the exostome teeth (f), the cilia nodose; spores (g) 12-14 μm, smooth.

Distribution: Australia (S.A.). On sand dunes (10).

Bryum dichotomum Hedw. 1801, *Spec. Musc.* p.183.

Type: New Zealand.

Fig. 158

Dioecious. In tufts, 0·5(-2) cm tall, often rather glossy, brown to yellowish green. Leaves (a) imbricate, 0·75-1·5 mm long, erecto-patent, hardly altered when dry; ovate-lanceolate to lanceolate, acuminate, concave; margins plane or rarely recurved near the base; costa yellow, percurrent or usually excurrent in a rigid point; cells with firm to incrassate walls, hexagonal to rhomboid in mid-leaf (b) 35-50 μm long, 3-5 times as long as wide, becoming rhomboid and then narrowly rectangular to 80 μm long, at the margin (c) in the upper half of the leaf, but not forming a distinct border; basal cells quadrate or shortly rectangular. Axillary bulbils (d), bearing rudimentary leaves from shortly above base, present among the upper leaves, usually one in an axil. Seta 0·5-1·5 cm long, reddish, capsule (e), 1·5-2·5 mm long, cernuous to pendulous, light to dark brown, oblong elliptical, the apophysis tapering to the seta, sometimes faintly corrugated, its colour like the theca; operculum convex, mamillate; annulus persistent; exostome teeth yellow; basal membrane of endostome less than half the height of the exostome; the processes (f) with narrow splits; cilia (g) 1-3, usually 2, appendiculate; spores (h) 12-14 μm, faintly papillose.

Distribution: America, Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Fairly common (4, 6) on clayey and silty soils or on rock, in moist and sheltered areas; sometimes on disturbed soils in urban areas.

Bryum argenteum Hedw. 1801, *Spec. Musc.* p.181

Type: Europe

Fig. 159; Plate 9B

Dioecious. Plants small, in dense cushions or small tufts, pale green or silvery white, especially when dry, glossy when moist, scarious or hyaline when dry; stems up to 1·5 cm or more but usually much shorter with julaceous branches. Leaves (a) crowded, concave, usually broadly ovate, though sometimes almost

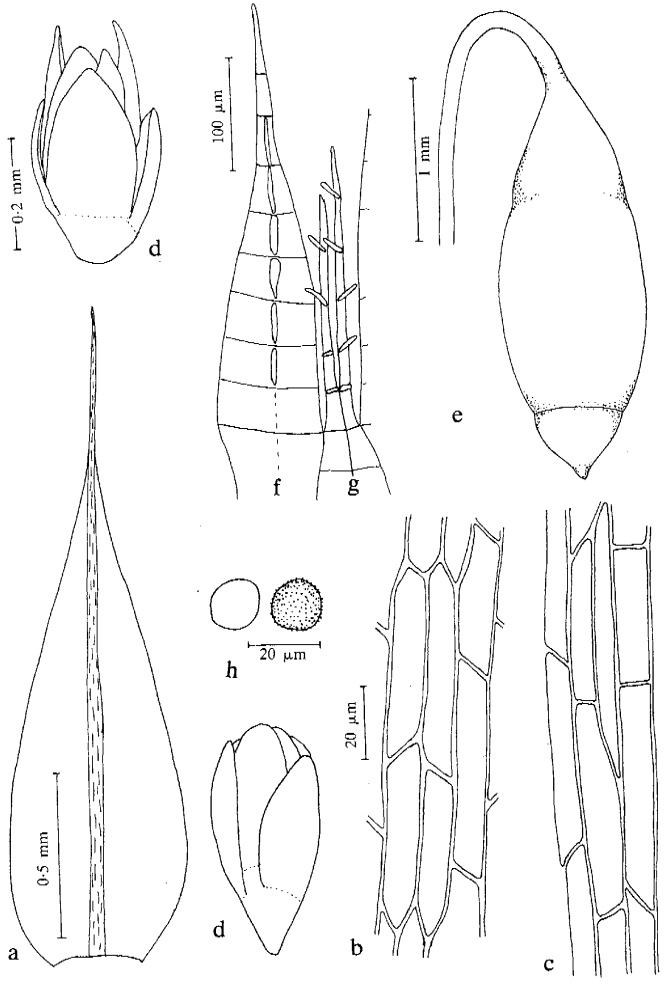


Fig. 158. *Bryum dichotomum*

rounded and obtuse, usually quickly tapered to a shorter or long point; apex of leaf and the point hyaline; costa slender, ceasing below the apex; margin plane, entire; middle and upper cells (b) elongate-hexagonal, tending to rhomboid, 40-70 × 12-14 µm with the walls strongly thickened at the angles to form thickened triangles at the upper and lower ends and a slightly sinuous or vermicular shape to the cell cavities; rhomboidal towards the margin (c), with one row rectangular at the margin, thickened over the cross walls; basal cells shorter, chlorophyllose,

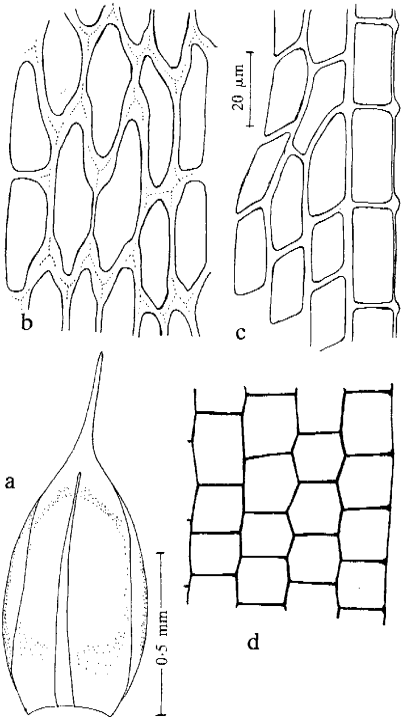


Fig. 159. *Bryum argenteum*

hexagonal to quadrate, the walls thin. Seta to 1 cm tall, reddish below, paler above, arcuate at the top; capsule pendulous, short and broad, ovoid, reddish brown, to 1·5 × 0·5 mm, contracted abruptly to the seta at the base; mouth orange, operculum convex, apiculate; exostome teeth brownish yellow, tapering, tip pale, with a narrow border, outer side of plates finely papillose; processes of endostome with narrow gaps, cilia appendiculate; spores 12-14 µm, smooth.

Distribution: Cosmopolitan, Australia (all States, N.T.), New Zealand. Very common (1, 4, 6-9, 14, 15, 21) in urban areas, on city pavements and walls, and on all soils and in rock crevices, even in very arid areas, probably preferring calcareous substrates and places that are rich in organic nitrogen.

Bryum erythrocarpoides C. Müll. et Hamp. 1853, *Linnaea* **26**:495.

Type: South Australia, Lofty Ranges near the third cataract, F. von Mueller.

B.subcurvicollum Broth. 1916, *Proc. Linn. Soc. N.S.W.* **41**:590.

Type: N.S.W., Apsley Falls, on slate, W. Forsyth No. 749, Oct. 1900.

Fig. 160

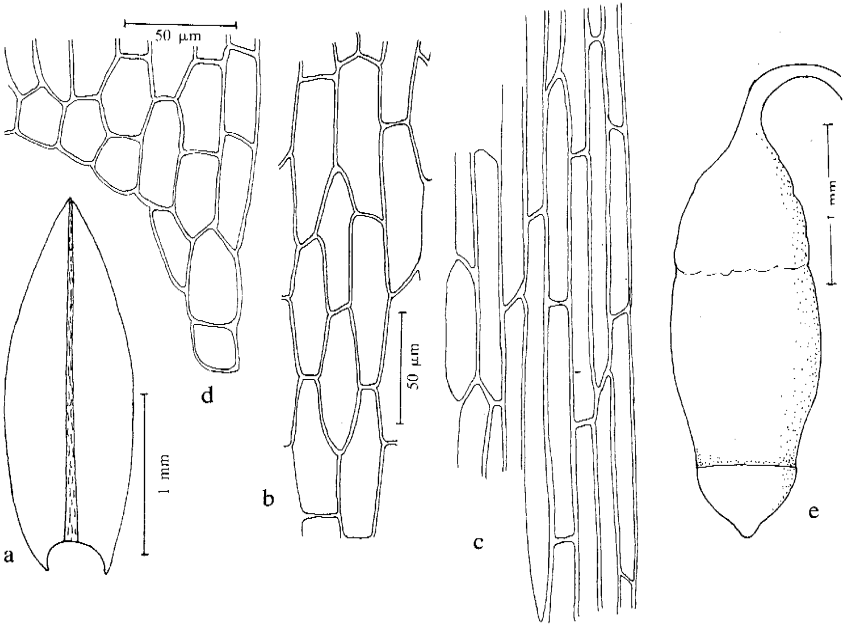


Fig. 160. *Bryum erythrocarpoides*

Dioecious. In large dense tufts around calcareous springs or on wet rocks, dull green to reddish brown; stems 1-4 cm tall, branching by innovations, sometimes very long when in water. Leaves (a) oblong-lanceolate, 2 mm, imbricate, rather rigid, erect or suberect dry or moist, costa percurrent or excurrent, apex denticulate. Upper cells (b) hexagonal or irregularly polygonal to rhomboid especially towards the margin (c), several marginal rows very long and narrow forming a distinct border; basal cells (d) shortly rectangular or quadrate, slightly decurrent. Seta 2-4 cm reddish, capsule (e) 2-4 cm long, brownish red, inclined to cernuous, oblong-pyriform, apophysis regulose; operculum shortly conical, concolorous; annulus broad; exostome teeth yellow to yellow-brown, lanceolate tapering to a long fine hyaline subula; processes broad, widely split, borne on a basal membrane about a quarter to a third of the height of the exostome teeth; the cilia usually 2, sometimes 1 or 0, nodose or appendiculate, nearly as long as the process; spores 12-16 µm, finely papillose.

Distribution: Australia (S.A., Vic., Tas., N.S.W., Qld), New Zealand, perhaps elsewhere. Uncommon in S. Australia, mostly in or near cataracts (6, 12, 14, 17). The bulbils described by Scott & Stone (1976, p.281) have not been seen.

Bryum species A.

Fig. 161

In tufts on rocks and in crevices, in or by streams, stems 2-3 cm tall, glossy when moist, dull when dry. Leaves (a) oval, concave, cymbiform, 1·5-2 mm long, margin plane, apex blunt, somewhat cucullate; costa thin, ceasing well below the obtuse apex; median cells (b) irregularly hexagonal, 50-85 μm long × 20-30 μm wide, more irregular towards the apex (d), narrower and longer near the margin (c) but not forming a distinct border; basal cells wider, irregular to rectangular. Rest unknown.

Distribution: Australia (S.A., A.C.T.). Rare, always in or close to running water (6, 14, 17).

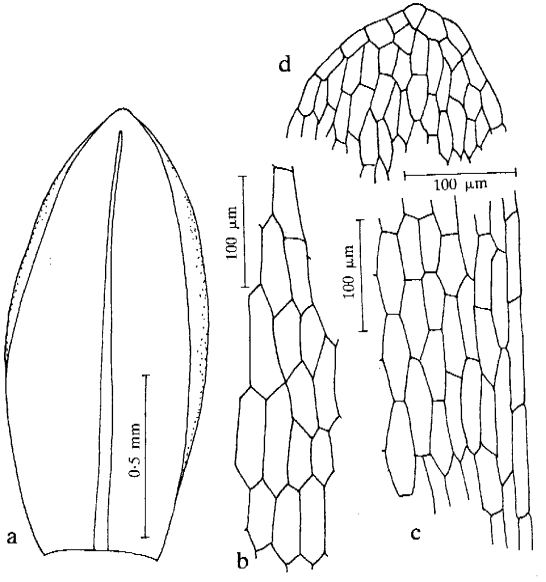


Fig. 161. *Bryum species A.*

Bryum chrysoneuron C. Müll. 1851, *Bot. Zeit.* **9**:549.

Type: Australia (?)

Fig. 162

In loose tufts, yellowish green to yellowish brown, often tinged red; stems 0·5-1·5 cm tall, slender, with the innovations densely leafy. Leaves (a, b) 1-1·25 mm long, erect or suberect whether moist or dry, ovate (a) to lanceolate, sometimes very narrow, somewhat concave; costa percurrent or shortly excurrent, golden

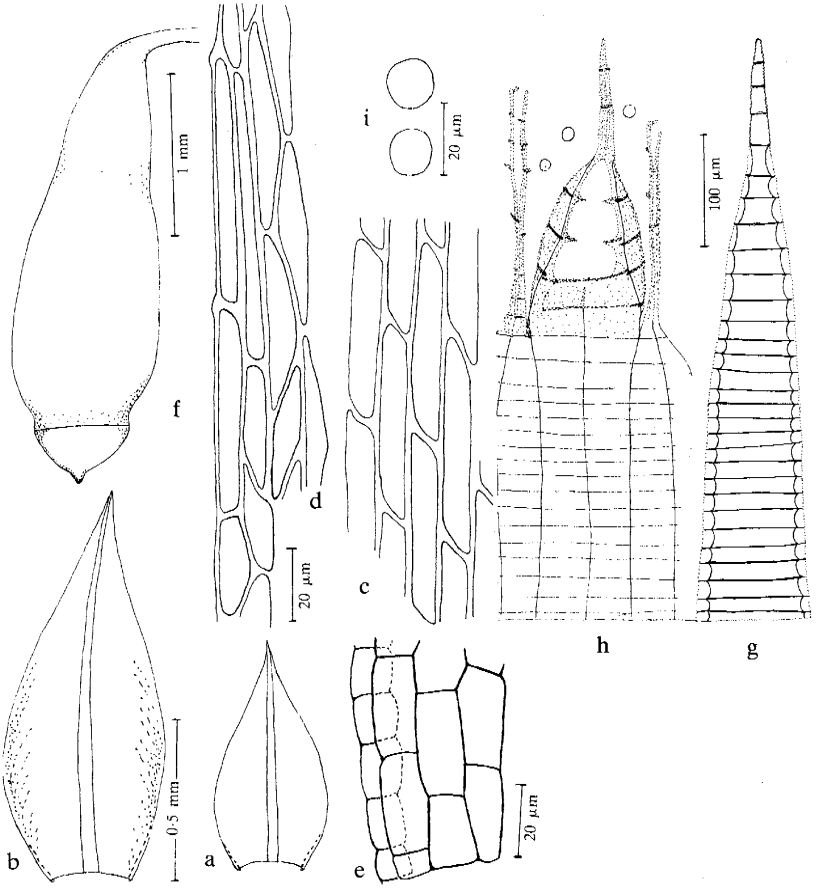


Fig. 162. *Bryum chrysoneuron*

yellow; margin plane or revolute basally; cells (c) rhomboid, 30-60 µm long, 4-6 times as long as wide, rather incrassate, irregular in shape and often very long at the margin (d), rectangular at the base (e) with the marginal cells quadrate. Perichaetial leaves with the costa more longly excurrent; seta 1·5-4 cm long, purple-red; capsule (f) 2-3 mm long, cernuous or pendulous, brown or reddish when mature, clavate, longly tapered at the base; operculum convex, apiculate; exostome teeth yellow, border hyaline, with numerous lamellae on the inner face (g); basal membrane of exostome high, the processes (h) gaping widely and reaching as high as the exostome teeth; cilia usually 2, sometimes joined, variably appendiculate; spores (i) 10-13 µm, smooth.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Fairly common (5, 6) on soil or rocks; regarded by Scott & Stone (1976, p.288) as *B.sauteri,* but the S. Australian specimens appear not to have rhizoid tubers.

Bryum species E

Fig. 163

Very small plants growing in groups or as scattered plants on acid soil; stems short, barely 0·5 mm tall, dark green, reddish below. Leaves (a) ovate, acuminate, barely 1 mm long, margin revolute; costa reddish excurrent; cells in mid leaf (b) hexagonal, incrassate, 25-40 μm long, 1·5-2·5 times as long as wide; a little larger at the margin, but not forming a border; basal cells (c) more nearly rectangular, broader, reddish. Tubers on rhizoids (d), ovoid or ellipsoid, red, about 150-160 × 90-120 μm, cells 15-25 μm across. Seta 0·5-1 cm tall, slender, red; capsule (e) pendent, deep red, broadly ovoid, quickly tapered to the seta

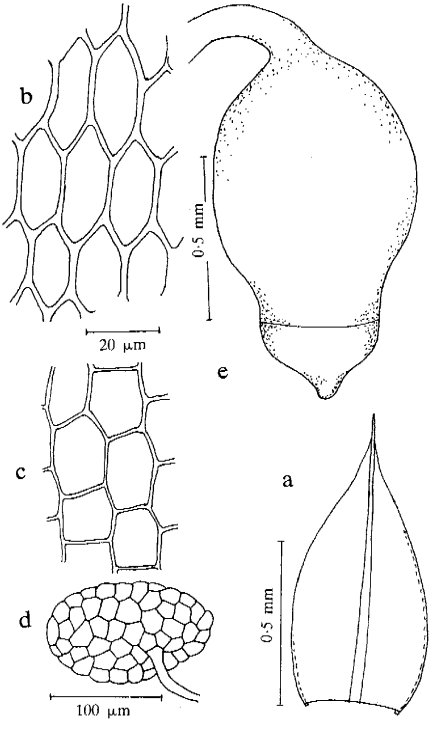


Fig. 163. *Bryum species E.*

and contracted to the mouth, about 1 mm long; apophysis wrinkled when dry; operculum yellowish, convex with a blunt apiculum; exostome teeth lanceolate, light yellow, hyaline at the apex, papillose, more coarsely at the apex; basal membrane of endostome at least half height of exostome, bearing rather narrow processes with a long point and with wide gaps below; cilia 2-4, nodose and appendiculate, nearly as long as processes; spores 10-12 μm, smooth.

Distribution: Australia (S.A.) on peaty soil, by acid swamps (6). This has the appearance of a minute *B. pachytheca,* but has no bulbils. It seems to belong to the group which Crundwell and Nyholm (1964) categorize as the *B. erythrocarpum* complex. Several of their species are known to occur in Australia and it seems likely that they occur in South Australia. The most reliable characters are in the tubers, generally borne on the rhizoids. The species share the following characters:

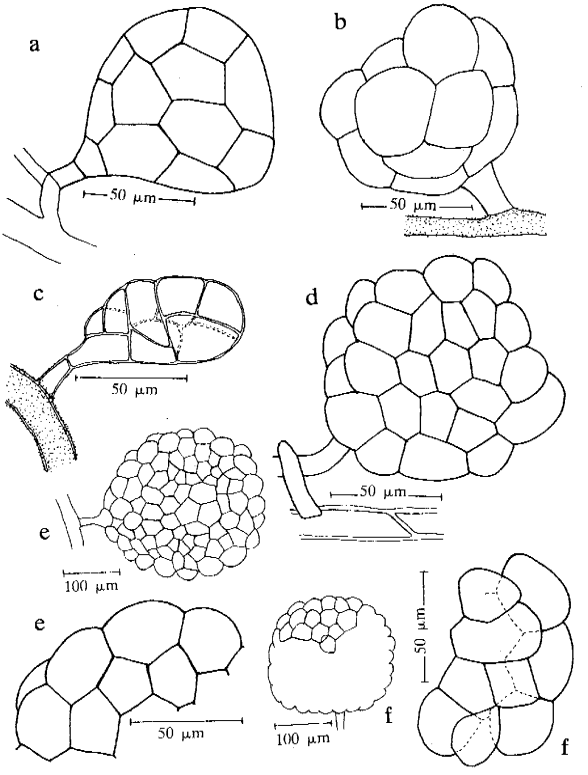


Fig. 164. Tubers of (a) *Bryum violaceum;* (b) *B.klingraeffii;* (c) *B.sauteri;* (d) *B.tenuisetum;* (e) *B.rubens;* (f) *B.micro-erythrocarpum.*

B. erythrocarpum Schwaegr. complex.

Usually dioecious. Plants 0·3-1·5 cm tall, somewhat tinged red, leaves ovate-lanceolate or lanceolate to triangular, erect or slightly spreading and somewhat shrunken when dry, erect to patent when moist, base reddish; margin recurved in upper leaves, denticulate at the apex, bordered or not; costa more or less excurrent; cells in mid leaf elongate-hexagonal, shorter and wider towards the base. Capsule cylindrical to avoid, symmetrical or slightly curved; cilia appendiculate.

A number of species may be distinguished by the following key, the tubers being illustrated in fig. 164.

1. Tubers small, mostly less than 100 μm 2
   Tubers large, mostly over 120 μm 4
2. Rhizoids usually deep violet; tubers paler, spherical, fig. 164a . *B. violaceum*
   Rhizoids brown, red brown or crimson; tubers not regularly spherical 3
3. Tubers crimson, irregularly spherical, mostly 60-100 μm across, the superficial cells protuberant; rhizoids pale. fig. 164b ..... *B. klinggraeffii*
   Tubers brown to reddish brown, pyriform, 40-60 x 60-100 μm, their cells not or slightly protuberant; rhizoids concolorous with tubers. fig. 164c *B. sauteri*
4. Tubers yellow, fig. 164d ..... *B. tenuisetum*
   Tubers red, rarely reddish orange or brown 5
5. Leaves distinctly bordered; cells 14-20 μm wide, rather thinly walled; tubers often in axils of leaves, fig. 164e ..... *B. rubens*
   Leaves scarcely bordered; cells 10-15 μm wide 6
6. Costa strong, longly excurrent, yellow; basal cells more or less quadrate; calcicolous. fig. 165 ..... *B. radiculosum*, p.277
   Costa thinner, less excurrent, reddish; basal cells rectangular; calcifuge. fig. 164f. ..... *B. micro-erythrocarpum*

Bryum radiculosum Brid. 1817, *Spec. Musc.* **3**:18

Type: Italy, Rome

Fig. 165

Plants densely tufted, 3-10 mm tall. Leaves (a) not or scarcely bordered; costa strong, excurrent, yellow or reddish when old; mid-leaf cells (b) 40-60 × 10-15 μm, longer and narrower at the margin (c); basal cells more or less quadrate (d). Rhizoids (f) yellowish to brown, coarsely papillose; tubers brown to bright red, spherical (e), 120-180 μm diameter, sometimes larger and irregular (f) in shape. Capsule narrowly ellipsoid; spores 10-14 μm. A calcicolous plant, on calcareous soils, limestone, etc.

Distribution: Europe, N. Africa, India, ?Australia (N.T., fruit not seen)

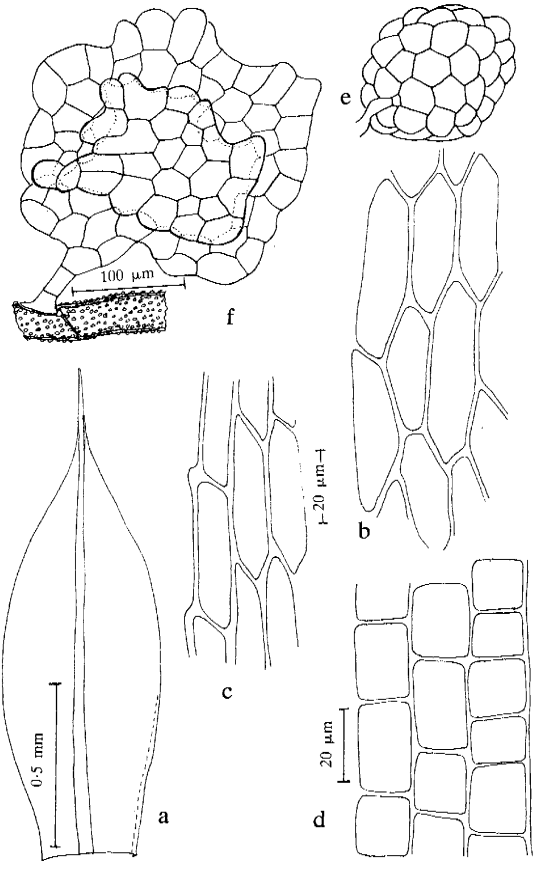


Fig. 165. *Bryum radiculosum*

Family: **BARTRAMIACEAE** Schwaegr. *in* Willd. 1830, *Sp. Pl.*, ed. 4, **5**(2):90.

Plants generally in tufts, the stems tomentose. Leaves ovate-lanceolate to linear-lanceolate, often subulate, the margin usually serrate; costa ceasing below the apex or excurrent; cells rectangular to roughly hexagonal, mamillose or papillose. Seta long, straight; capsule erect or inclined, globose, symmetrical or asymmetrical with the mouth oblique, usually furrowed longitudinally when dry; peristome double, single or none; if present the exostome teeth 16, the processes of the endostome divided and the cilia none or rudimentary; calyptra small, cucullate.

BARTRAMIA Hedw. 1801, *Spec. Musc.* p.164

Type species: *B. halleriana* Hedw.

Plants erect in loose or dense tufts, green, yellowish green or glaucous; stems branched, branches not in whorls, in section with an outer layer of small cells and a prominent central strand. Leaves linear, subulate; costa percurrent or excurrent, abaxial side often toothed above; margin toothed above, often in two rows; lamina more or less in two layers above, often only at the margin or adjacent to the costa; upper cells quadrate to rectangular, papillose at each end of lumen partly by projection of end of cell (prora or scindula) and partly by local thickening of the wall. Capsules globose to ovoid, with 16 longitudinal furrows when dry, due to alternating longitudinal bands of relatively more thickly and more thinly walled exothecial cells; spores verrucose. The projecting ends of the cells are characteristic of *Bartramia* and have been named *scindulae* (sing. scindula) by Weber and Simone (1977) and *prorae* by Argent (1973). Two subgenera occur in South Australia:

(i) VAGINELLA, leaves with a hyaline sheathing base abruptly contracted to a narrow subulate lamina;

(ii) STRICTIDIUM, leaves lanceolate, aristate, not sheathing.

Key to South Australian species:

1. Leaves with a sheathing base *(Vaginella)*. 2
   Leaves not sheathing 3
2. Peristome present; plants usually more than 1 cm high; leaves usually spreading; exothecial cells without prominent trigones *B. papillata*, p.279
   No peristome; plants short, less than 1 cm tall; leaves less spreading; exothecial cells with prominent trigones . . . . . *B. hampei*, p.281
3. Leaves with several longitudinal rows of quadrate cells at the base *B. species A, p.283*
   Leaves with a few, 2-4 (-5), longitudinal rows of quadrate cells at the base . 4
4. Leaves strictly erect and appressed to the stem when dry; spores 30-34 μm diameter . . . . . *B. stricta*, p.282
   Leaves spreading, more flexuous; spores 24-28 μm diameter *B. species B*, p.285

Bartramia papillata Hook. f. et Wils. 1854, *Fl. Nov. Zel.* **2**:89

Type: New Zealand

Fig. 166

Dioecious. In dense tufts, yellowish brown to yellowish green, very diverse in size; stems 1-3 cm tall, tomentose with matted rhizoids. Leaves (a) 3·5-4·5 mm long, suberect to spreading when moist, sometimes somewhat secund, strict and rigid or a little crisped when dry; lamina glaucous green, linear, contracting to a subula from a wide, sheathing, hyaline base; margins flat, occasionally a little reflexed below, serrulate above; costa poorly defined, 50-150 μm wide at the base, excurrent or percurrent, denticulate at the apex, papillose and sometimes serrulate abaxially. Cells of sheathing base (b, c) narrowly linear, 50-150 × 12-

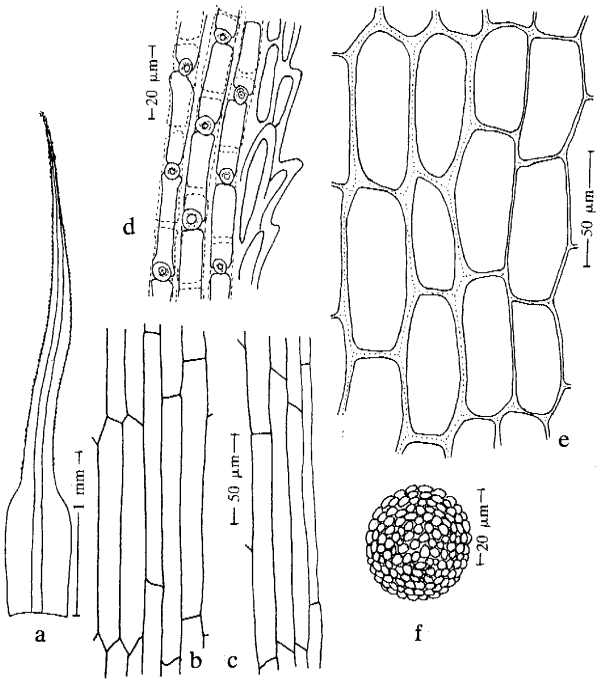


Fig. 166. *Bartramia papillata*

15 µm, pellucid, more elongate towards the margin (c), where very narrow; cells of lamina and subula (d) rectangular, 20-40 10-12 µm, opaque and obscure, incrassate, mamillose (prorate) on both surfaces at each end, the cells in two layers from the costa almost to the margin; margin with one to two rows of teeth, formed of projecting cells, the walls thickened at the ends. Perichaetial leaves similar; seta 1-3 cm, long reddish yellow; capsule 1-3 mm long, subglobose, somewhat asymmetrical, erect or inclined; exothecial cells (e) shortly rectangular to nearly quadrate, the walls nearly evenly thickened on the ridges, thinner in the furrows; operculum flat, mamillate. Exostome teeth orange, linear subulate from a broader base, margins sinuous, faintly papillose with transverse bars and a median line on the outer surface; inner surface trabeculate; endostome, if present, a low yellow membrane, more or less perforated, sometimes with rudimentary processes, but no cilia; spores (f) 28-32 µm, brown, coarsely and densely verrucose.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Uncommon in South Australia (6, 15), on soil or rock in moist valleys, usually near streams or runnels.

Bartramia hampei (Mitt.) comb. nov.

Basionym: *Bartramidula hampei* Mitt. 1882, *Trans. Proc. R. Soc. Vict.* **19**:68 based on *Glyphocarpa erecta* Hamp. 1876, *Linnaea* **40**:305.

Type: Victoria, Grampian Mountains.

Fig. 167; Plate 11A

Dioecious. Similar to *B. papillata,* but the stems much shorter, 0·5-1 cm. Leaves (a) less widely spreading and the lamina cells (b) relatively narrower. Capsule similar but usually smaller, without any peristome, except an occasional short membrane; exothecial cells (c) hexagonal, sometimes 5- or 7-sided, with prominent thickenings (trigones) at the angles.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W.). Uncommon (6), usually on moist earthy banks, always in small tufts.

Very difficult to separate with certainty from *B. papillata* in the absence of fruit. It may be identical with the South African *B. hampeana* C. Müll. (1858, *Bot. Zeit.* **16**:162), in which case the latter would be the correct name.

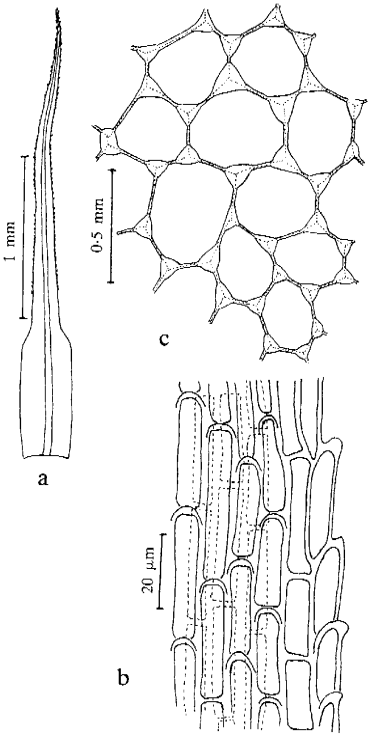


Fig. 167. *Bartramia hampei*

Bartramia stricta Brid. 1803, *Musc. Rec.* **2**(3):132

Type: North Africa

Fig. 168

Synoecious. In short dense tufts, 0·5-1·5 cm tall, glaucous green; stems straight, rigid, tomentose below. Leaves (a) almost erect, very closely appressed when dry, short, 1·5-2·5 mm long, narrowly lanceolate, subulate, margin narrowly recurved, finely denticulate in the upper third; costa strong, yellowish, excurrent in a serrulate point; cells narrow, the upper ones (b) rectangular, 20-40 × 8-10 μm, the ends protruding as prorae; basal cells larger, pellucid, a few marginal rows, usually 2 or 3 but up to 5, wider and quadrate, there being about 15-17 (-20) cells between costa and margin at the base. Seta erect, slender, pale, fairly angular above; capsule erect, symmetrical, small, oval to globose; exothecial cells (c) polygonal, mostly 5-6 sided, isodiametric, with the corners thickened (collenchymatous), more heavily on the ridges; operculum convex; exostome teeth short, blunt, yellow, finely papillose; endostome none or a short

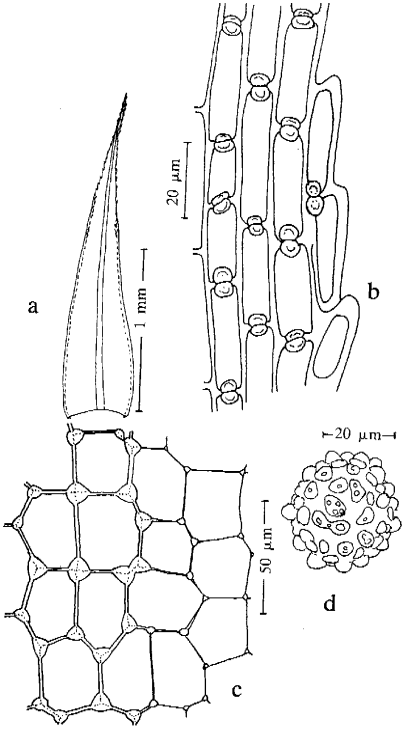


Fig. 168. *Bartramia stricta*

fragmentary membrane, spores (d) 30-35 μm, verrucose, the verrucae very coarse.

Distribution: Europe, S.W.Asia, North Africa, North America, South America, Australia (S.A., Vic.). Not uncommon (6, 7, 14) on soil of banks in sclerophyll forest and on banks of streams, usually in small colonies.

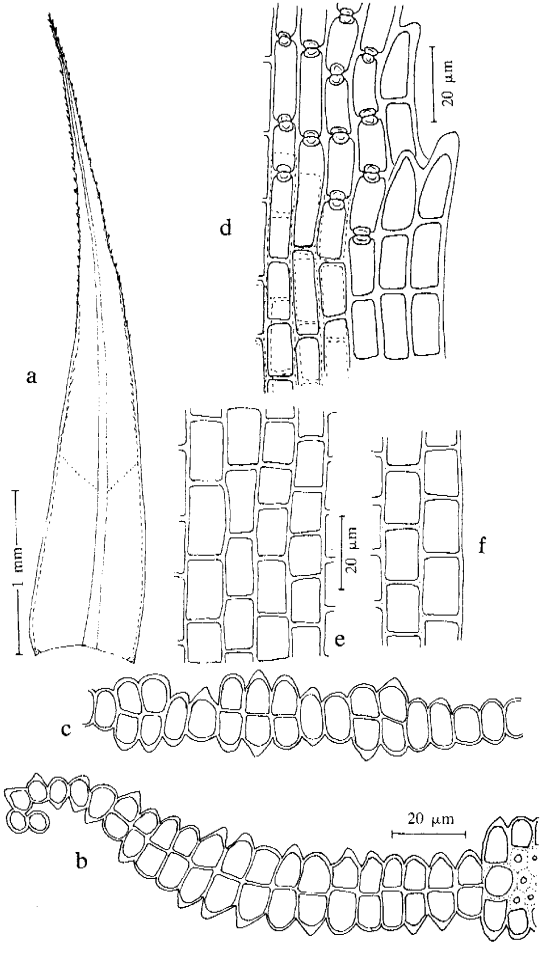


Fig. 169. *Bartramia species A.*

Bartramia species A

Fig. 169; Plate 11B

Similar to *B.stricta,* but more robust, stems 2·5-4 cm tall, green. Leaves (a) broader, erect, closely appressed when dry, narrowly lanceolate, 3·5-4·5 mm long, the lamina evident for most of the length, with two layers of cells in the upper two-thirds (b), extending from the costa to within 6 or 8 cells of the margin, patchily bistratose (c) in the lower part, the basal 1 mm unistratose; margin revolute from the base for two thirds of the length, dentate to denticulate in the upper half, the teeth in one to two rows (d). Upper cells rectangular, 16-25 × 8-10 μm, the two ends of the cells projecting as prorae, somewhat thickened locally (b,c); basal cells 30-45 between costa and margin, broader than upper cells, the innermost (e) rectangular, but shorter than in *B.stricta,* 9-12 marginal rows quadrate or shortly rectangular, those at the extreme base coloured. Rest unknown.

Distribution: Australia (?W.A., S.A., Vic.). Rather rare (5-7), on rocks in moist, sheltered gorges. Confused sometimes with *Breutelia affinis,* which has the lamina cells papillose over the lower end and the leaves ovate lanceolate.

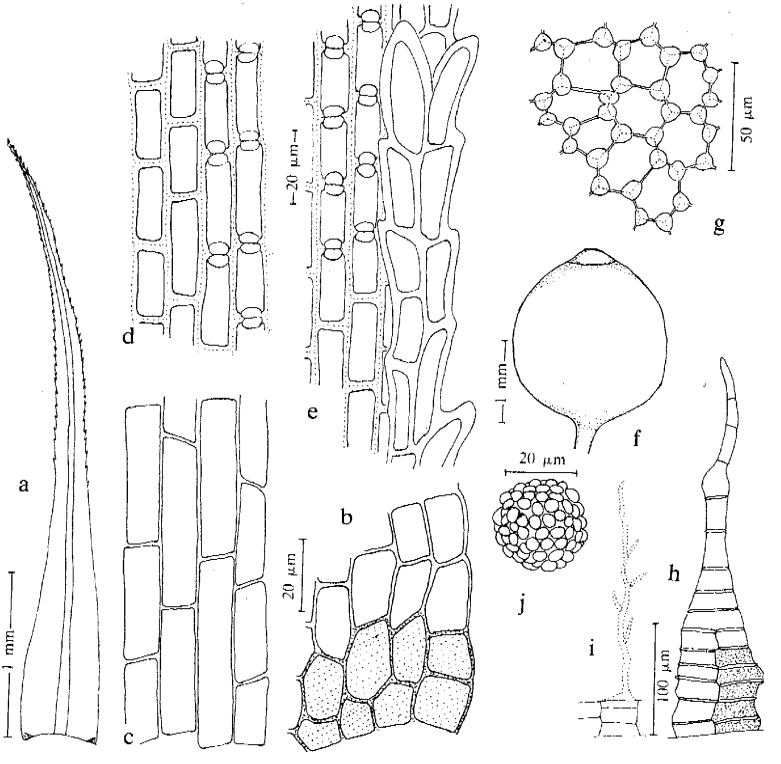


Fig. 170. *Bartramia species B.*

Bartramia species B

Fig. 170

Similar to *B.stricta* but tufts looser. Leaves (a) softer, spreading whether moist or dry, linear-lanceolate, flexuous, glaucous green, similar in width at the base, with 2-3(-4) rows of shortly rectangular cells (b) coloured at the base, and the inner cells (c) longer, 20-50 × 10 μm; upper cells (d) rectangular, the margin recurved with two rows of teeth (e), dentate for more than half of the leaf. Capsule (b) globular, about 2 mm diameter, erect; operculum small, convex; exothecial cells (g) polygonal with 5 or 6 sides usually, isodiametric, the angles much thickened; exostome teeth (h) long, slender, yellow, papillose, the edges somewhat sinous; endostome (i) a low membrane bearing tenuous appendiculate filaments; spores brown, 24-28 μm diameter, closely verrucose, the verrucae smaller than in *B.stricta*. Synoecious.

Distribution: Australia (S.A., ?W.A.). Not uncommon (6, 12) on the soil of banks of streams and by tracks in sclerophyll scrub, in small patches.

This seems to be similar in many respects to the Western Australian species described by Scott and Stone (1976, p.328-9) as related to *B.compacta* Hornsch., but as having no peristome.

BARTRAMIDULA B.S.G. 1846, *Bryol. Eur.* **4**:55 *nom. cons.*

Lectotype: *B.wilsonii* B.S.G. *fid.* Flowers *in* Grout 1935, *Moss Fl. N.Amer.* **2:**163.

Usually synoecious. Very slender plants with small shoots borne on a creeping stolonaceous stem. Leaves small, imbricate, ovate, lanceolate, margin plane, denticulate; cells in one layer in the lamina; costa usually ceasing below apex. Perichaetial leaves longer, the base partly sheathing; capsule globose, erect or pendulous; operculum convex; no peristome; calyptra small, cucullate.

Bartramidula pusilla (Hook.f.et Wils.) Par.1894, *Index Bryol.* p.116.

Type: Tasmania.

Basionym: *Glyphocarpa pusilla* Hook.f.et Wils. 1844, *London J. Bot.*, **3**:544.

Fig. 171

Small, caespitose, pale or glaucous green, with erect julaceous branches less than 0·5 cm long rising from a creeping stem. Leaves (a) small, about 0·5 mm. long, ovate-lanceolate or narrower, acuminate, bluntly denticulate, often only by projections over the walls between marginal cells (b); costa ceasing below the apex; cells (b) rectangular, 25-40 × 12-16 μm, more irregular in shape and size near the apex (c), rather incrassate. Seta slender, 0·5-1 cm tall, straight or arcuate; capsule (d) globose, about 1-1·5 mm across, pendulous or erect; operculum convex with an umbo; no peristome; spores large, usually 50-60 μm diameter, but up to 80 μm, papillose.

The variety **weymouthii** Rodway (1914, *Pap.Proc.R.Soc.Tas.* for **1913**:194), characterised by the erect capsule, nodulose at the base and with a wider mouth, appears worthless, as all the variations may appear within the same colony in all combinations.

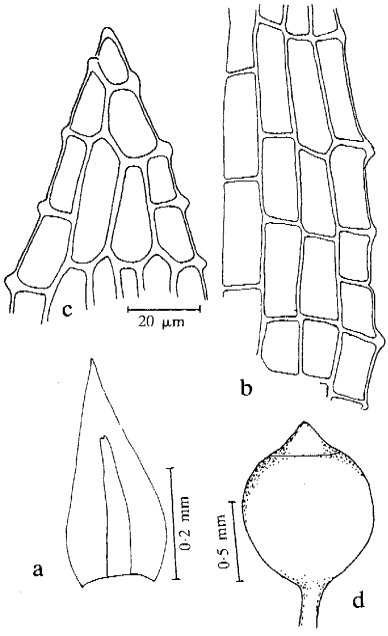


Fig. 171. *Bartramidula pusilla*

Distribution: Australia (W.A., S.A, Vic., Tas., N.S.W.) endemic. Not uncommon on intermittently moist soil in sheltered situations (1, 6, 10).

BREUTELIA (B.S.G.) Schimper 1856, *Coroll. Bryol. Eur.* p.85

Bartramia sect. *Breutelia* B.S.G. 1851, *Bryol. Eur.* **4**:1.

Type: *B.arcuata* (Sw.) Schimp. = *B.chrysocoma* (Hedw.) Lindb.

Dioecious. Robust plants with erect or procumbent stems, simple or branched, frequently with whorls of branches below the inflorescences. Rhizoids finely papillose. Leaves lanceolate, subulate, from a partly sheathing base, the lamina plicate, glossy, denticulate; costa narrow, excurrent; upper cells linear, incrassate, strongly papillose over the lower end of each cell or between cells; marginal cells at the base shortly rectangular or quadrate. Seta fairly long, flexuous, arcuate; capsule cernuous to pendulous, ovate to oblong, sulcate when dry; operculum conical; peristome double or, rarely, none; cilia of endostome rudimentary. Perigonium discoid.

Breutelia affinis (Hook.) Mitt. 1856, *Kew J. Bot.* **8**:261.

Basionym: *Bartramia affinis* Hook. 1820, *Musc. Exot.* **2**:16, plate 176.

Type: New Zealand.

Fig. 172; Plate 12A, B

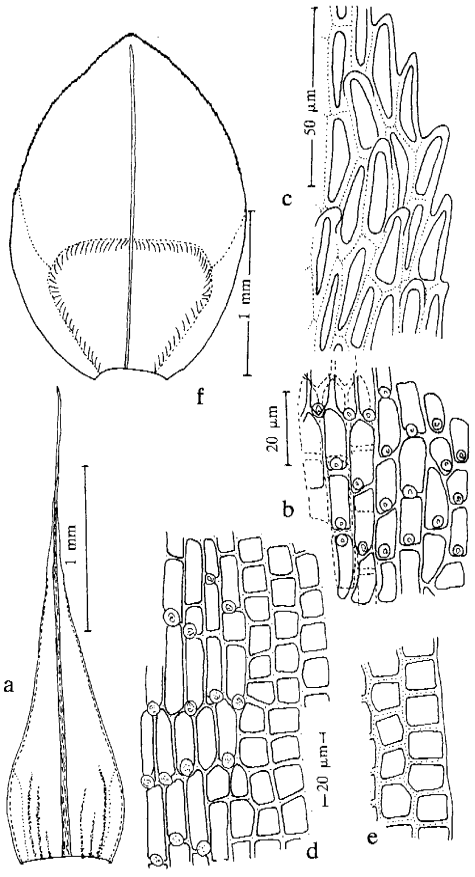


Fig. 172. *Breutelia affinis*

Dull brownish or yellowish to green plants growing in laxly cohering tufts or as tightly adherent mats on rocks. Stems 1-6 cm long, erect or recumbent, richly branched by subfloral innovations, with dense brown tomentum below. Leaves (a) crowded, erect, appressed with flexuous points when dry, erect to spreading when moist, ovate-lanceolate, about 3 mm long, plicate at the base, aristate from the excurrent costa; margin revolute to the base of the acumen, irregularly denticulate below, sharply serrulate near the apex; costa rough abaxially, longly excurrent as a yellow denticulate arista. Upper leaf cells (b) oval to oblong, 12-20 × 7-9 µm, incrassate, sharply papillose over the lower end of the lumen, more elongate towards the apex, to 30 µm long, usually in two layers (b); marginal cells (c) narrower and longer, projecting as teeth, some of the lamina cells projecting as teeth; basal cells (d) narrowly rectangular to linear towards

the costa, becoming quadrate and rather opaque in 6-8 or more rows towards the margin (d, e), papillose almost or quite to the base, reddish brown at the very base. Seta erect, reddish, pendulous, cylindrical and sulcate when dry; operculum low conical. Perigonial leaves (f) widely ovate, concave and brown at the base.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Very common (1, 6-8, 10, 12, 17) on banks and rocks in the moister areas, chiefly in sclerophyll forest.

PHILONOTIS Brid. 1827, *Bryol. Univ.* **2**:15.

Lectotype: *P.fontana* (Hedw.) Brid. *fid.* Grout 1935, *Moss Fl. N.Amer.* **2**:164.

Usually hygrophilous plants, in tufts on wet rock or earth or around springs and in flushes. Stems erect, with subfloral whorls of branches; outer layer of large cells. Leaves lanceolate, acuminate, dentate; costa generally excurrent; cells rectangular, most papillose. Seta long; capsule subglobose, inclined to horizontal, sulcate, the mouth small; operculum convex to conical; annulus not differentiated; calyptra cucullate. Peristome double (fig. 174 e-h) exostome teeth (fig. 174 e, f) lanceolate, finely papillose, with strong transverse bars on the outer face (fig. 174 e) and trabeculate on the inner face (fig. 174 f) with the lamellae projecting laterally in the upper part of the tooth; endostome (fig. 174 g, h) a low basal membrane bearing processes (fig. 174 g) as long as the exostome teeth, each split down the middle into two lobes which diverge, with short blunt cilia (fig. 174 h) between the neighbouring halves of adjacent processes; this structure gives the appearance of processes standing behind instead of alternating with the exostome teeth. Vegetative propagula in the form of numerous rudimentary branches (surculigerae) clustered near the top of the stem occur in several species; they spring from the stem between leaves, not from the axils. Perigonia terminal, discoid.

Philonotis tenuis (Tayl.) Reichdt. 1870, *Reise Oest. Freg.Novara Bot.***1**(1):178

Basionym: *Bartramia tenuis* Tayl. 1844, *Phytologist* **1**:1095.

Type: Norfolk Island, A. Cunningham; New Zealand, R. Cunningham.

Fig. 173

Dioecious. Slender plants in dense tufts, pale green to yellowish green or light brown; stems 1-3 cm tall, green or reddish, matted with brown tomentum below; rhizoids smooth. Leaves (a) 0·75-1·75 mm long, dense, subfalcate and secund or straight and evenly arranged, erect to spreading, scarcely altered when dry, narrowly lanceolate, subulate, finely acuminate; margins plane or recurved, singly or doubly dentate (c); costa usually excurrent in a long fine arista, denticulate abaxially above. Cells in mid leaf (b) 20-40 μm long, oblong, with the upper end projecting and papillate; basal cells wider, but usually not longer; marginal teeth usually in pairs (c). Perichaetial leaves wider at the base, with the costa longly excurrent; seta 1-2·5 cm long, reddish; capsule 1·25-2·5 mm long; operculum acutely conical; exostome teeth red, joined to the rim

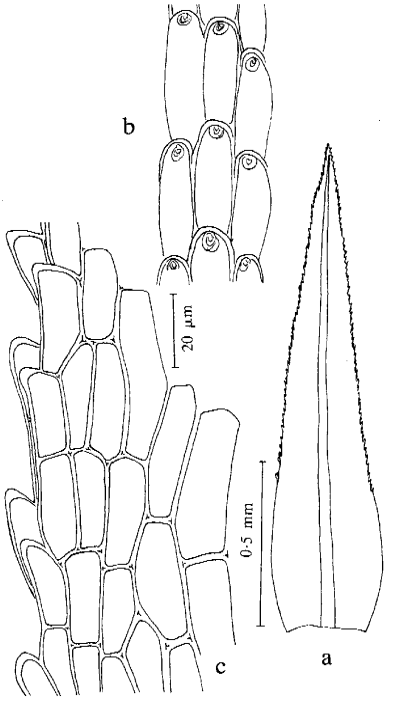


Fig. 173. *Philonotis tenuis*

of the urn by a broad band of hyaline tissue, nearly smooth; endostome yellow brown, papillose, the basal membrane about a third of the height of the exostome; spores 20-24 µm brown, densely papillose. Perigonium small.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld, N.T.), New Zealand. Norfolk Island, Subantarctic Islands, Africa. Fairly common (6, 7, 12) in damp or wet sheltered places, on soil or rock, but always in small patches.

Philonotis scabrifolia (Hook.f.et Wils.) Braithw. 1893, *Brit.Moss.Fl.* **2**:215

Basionym: *Hypnum scabrifolium* Hook.f.et Wils.1844 *London J. Bot.*, **3**:552

Type: New Zealand, Auckland Is., coll. J. D. Hooker.

Fig. 174

Dioecious. Very slender glaucous green plants growing in dense tufts; stems very thin, 1-3 cm tall, the vegetative stems commonly dendroid with a pinnately branched upper part; the fruiting shoots less dendroid with whorls of slender innovations below the inflorescence; stems tomentose below, with papillose rhizoids. Leaves (a) small usually less than 1 mm long on the branches; those on

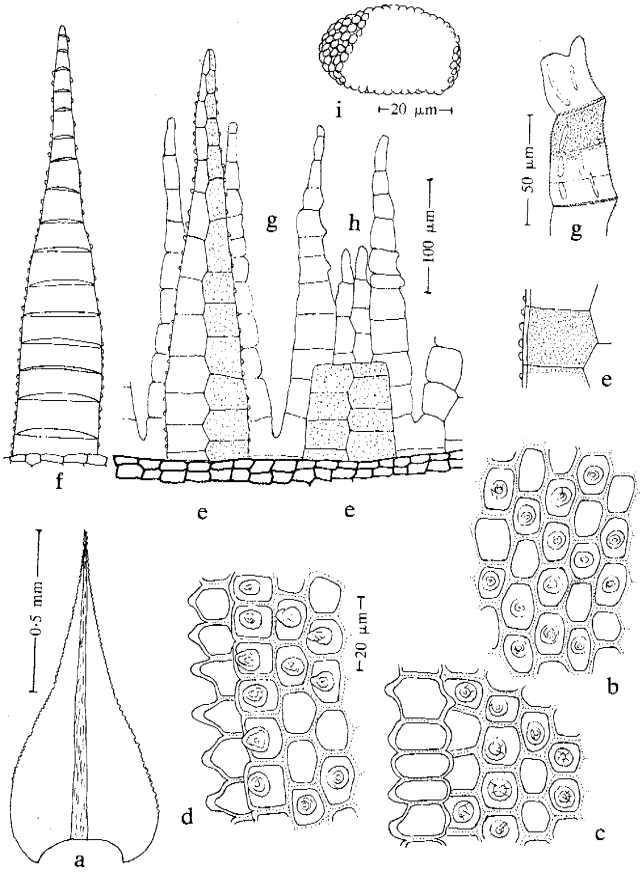


Fig. 174. *Philonotis scabrifolia*

vegetative stems (a) spreading, broadly lanceolate, acuminate; those on fertile stems erect and appressed with incurved apices when dry, erecto-patent when moist; margins plane or narrowly recurved (c,d) serrulate for most of length, from domed papillae; costa strong, excurrent, papillose abaxially above; cells uniform, shortly oblong or subquadrate, incrassate, with a large hollow papilla (mamilla) on one or other surface, about half of the cells having adaxial mamillae (b, c), the other half abaxial ones (d). Perichaetial leaves much longer, narrowly subulate, setaceous, the costa longly excurrent and the cells large, smooth with thin walls; seta 1-2·5 cm long, orange, stout; capsule 2-3 mm long, widely oval oblong, somewhat asymmetrical; operculum low convex. Peristome similar to that of *P.tenuis,* but exostome teeth (e, f) orange and very finely papillose; endostome (g) yellow and smooth, cilia (h) short; spores (i) 24-32 µm

long, brown, reniform, papillose. Perigonium large, conspicuous, the spreading perigonial leaves wide, long (ca.3 mm) and golden.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, C.America, S.America, Subantarctic Islands. Uncommon (6) on damp shaded soil or on wet rocks, in gorges and by streams.

Order **ISOBRYALES**

Family **RHACOPILACEAE** Kindb. 1898, *Bot.Centralbl.* **76**:85.

A small family mainly tropical, containing two genera, the one not occurring in South Australia being *Powellia*. The family has the stems prostrate and creeping, pinnately branched and somewhat complanate, bearing four rows of leaves, two lateral and two on the upper (antical) side usually smaller, densely tomentose on the under side, with tufts of rhizoids sprouting from near the base of each lateral leaf; cells hexagonal to quadrate, smooth or with a papilla; costa excurrent or not reaching the apex. Seta long; capsule cylindrical; annulus broad, separating; operculum conical, rostrate; peristome double, hypnoid; calyptra hairy. Apparently usually dioecious with dwarf male plants.

RHACOPILUM P.Beauv. 1805, *Prodr.* p.36

Lectotype: *R.mnioides* P.Beauv. *fid.* Brid. *in* Leman 1826, *Dict. Sci. Nat.* **44**:341.

Leaves without a border of distinct cells; costa strong, more or less excurrent. Capsule downwardly curved and deeply grooved; exostome teeth with transverse striolae on the outer side; processes broad, cilia present.

Rhacopilum convolutaceum (C. Müll) Reichdt. 1870, *Reise Oest. Freg. Novara Bot.* **1**(3):194.

Basionym: *Hypopterygium convolutaceum* C. Müll. 1850, *Syn.* **2**:13.

Type: Australia, coll. Preiss.

Fig. 175; Plate 14B

Plants densely matted, dark green to yellow-green; stems 1-5 cm long, creeping, flattened, densely tomentose with brown rhizoids, irregularly subpinnate, the branches short and straight or curved. Leaves 0·75-2 mm long, crisped when dry with the lower part spreading and the upper part incurved; costa excurrent; lateral leaves (a) oblong-lanceolate to oblong-ovate, somewhat asymmetrical, the margins plane and serrulate (d); antical leaves (b) rather smaller, ovate to ovate cordate, the margins entire. Upper cells (c) 8-15 μm, hexagonal, rather incrassate, with a central papilla, the marginal cells (d) more irregular; lower cells (e) longer, more nearly rectangular. Perichaetial leaves ovate, acuminate, costa very longly excurrent, the cells hexagonal, longer and laxer than vegetative leaves. Seta 1·5-2·5 cm, yellowish red; capsule 2·5-5 mm long, cylindrical, horizontal to cernuous, curved downwards, deeply grooved, usually with a struma at the base; operculum conical and rostrate, half the length of the capsule; calyptra hairy. Exostome teeth about 0·4 mm long, with a

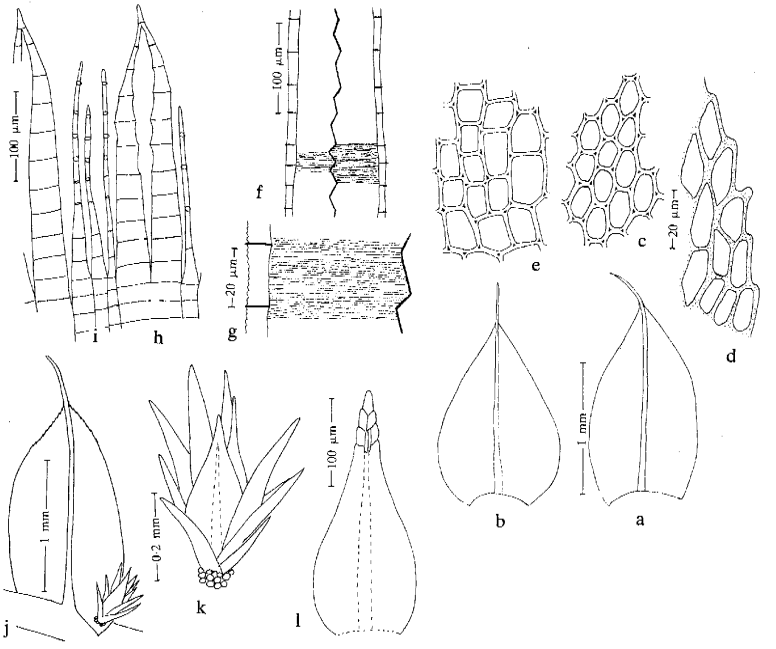


Fig. 175. *Rhacopilum convolutaceum*

median zigzag ridge (f), edge hyaline, finely and densely cross striolate (g) below on the outer face, about 25 lamellae on the inner face projecting laterally above, hyaline and papillose towards the slender tips which are split; basal membrane of endostome smooth, about half the height of the exostome teeth, bearing divided processes (h) which are faintly papillose; three long, nodose cilia (i) stand between each pair of processes; spores 10-12 µm, green, surface very finely wrinkled. Dioecious with small male plants nestling in the tomentum or attached to the leaves (j), sometimes described as pseudautoecious; male plants (k) small, barely 0·5 mm tall; leaves (l) ovate-lanceolate, costa ceasing below the apex.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Common (1, 6, 7, 9, 10, 12, 17) on bark, rock or soil in damp situations, but rarely in fruit.

It is somewhat variable in the relative sizes of the lateral and antical leaves and their shapes, in the size of the struma and the hairiness of the calyptra. *R.strumiferum* (C. Müll.) Mitt. and *R.cristatum* Hook.f.et Wils., as well as others, have been separated but cannot be sustained as distinct. Moreover, it may be the same as the widespread *R.tomentosum* (Hedw.) Brid. 1827, *Bryol. Univ.* **2**:719, basionym *Hypnum tomentosum* Hedw. 1801, *Spec. Musc.* p.240, though the illustration in Brotherus (1925, **2**:53, Fig. 470) shows a plant that has very small antical leaves.

Family **CRYPHAEACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.97

Autoecious. Primary stems, creeping, stoloniform, bearing erect or pendulous secondary stems which are leafy and have pseudoparaphyllia but not paraphyllia. Leaves imbricate when dry, spreading when moist, ovate or ovate-lanceolate, acute to acuminate; costa single; cells smooth or slightly papillose, with oval lumina, elongated and porose near the costa. Perichaetial leaves erect; seta short; capsule immersed with a few superficial stomata; peristome double, single or none; basal membrane of endostome very short if present; calyptra small, mitriform, papillose.

CRYPHAEA Mohr. *in* Web. 1814, *Tab. Syn. Musc.*

Capsules immersed to emergent, borne unilaterally, ellipsoid to cylindrical; operculum conical; peristome double; exostome of 16 narrow, papillose teeth, the endostome of 16 filiform processes.

Cryphaea dilatata Hook.f. et Wils. 1854, *Fl.Nov.Zel.* **2**:102.

Type: New Zealand.

Fig. 176

Plants slender to robust, brownish green in colour; secondary stems 4-8 cm tall, rather slender and rigid, erect or pendulous, branched pinnately, the branches in one plane or secund. Leaves (a, b) 1-1·8 × 0·5-1·2 mm, erect and appressed when dry, spreading when moist, widely ovate, obtuse or subacute, base somewhat decurrent, sometimes a little plicate; leaves (b) on main secondary stems larger and relatively wider, those on branches smaller and narrower; margins plane or reflexed below, entire, sometimes vaguely serrulate at the apex; costa strong, ceasing just below the apex or reaching it. Cells in mid leaf (c) 12-15 μm long, hexagonal, the lumen oval or rhomboid, walls very thick, smooth; marginal cells (d) subquadrate; basal cells near the costa longer, those at the basal margin subquadrate. Perichaetia numerous, the leaves much longer, with the costa longly excurrent as a stout arista, entire or denticulate; cells narrow, somewhat vermicular. Seta short, barely 2 mm long; capsule 1·3-1·6 mm long, oval oblong, light brown with a thick reddish rim; no annulus; operculum conical, acute; calyptra small, just covering the operculum, split on one side and laciniate at the base, slightly papillose above. Exostome teeth deeply inserted, about 200 μm long, narrowly lanceolate, the outline irregular, pale yellow, outer face smooth below and papillose above, the median line cracked, the inner face weakly lamellate below; basal membrane very short, the processes filiform, as long as the exostome teeth, irregularly nodose and slightly papillose; no cilia. Perigonia numerous, axillary, gemmiform.

Distribution: Australia (S.A., Vic., Tas., N.S.W., Qld), New Zealand. Rare (6) in South Australia, on shrubs or trees by rivers, sometimes on roots and intermittently submerged.

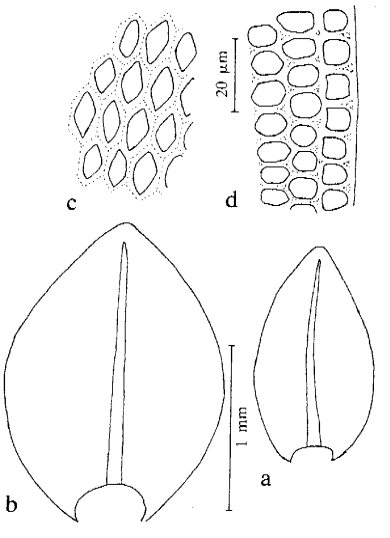


Fig. 176. *Cryphaea dilatata*

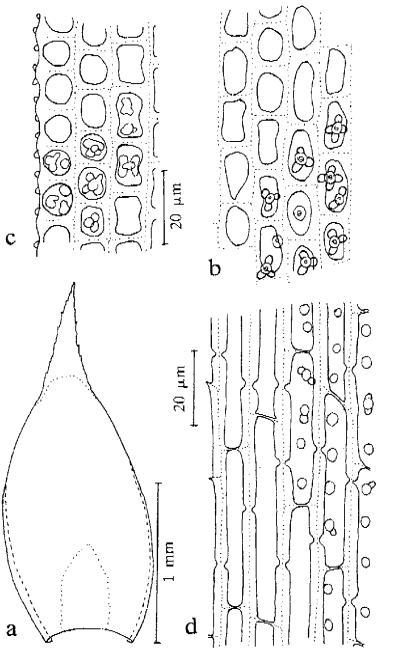


Fig. 177. *Hedwigia ciliata*

Family **HEDWIGIACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.52

Stem without a central strand, branching irregularly to pinnately. Leaves imbricate when dry, spreading when moist, ovate to ovate-lanceolate, concave, sometimes plicate; no costa; cells papillose. Perichaetia terminal on main or lateral branches; perichaetial leaves long; seta very short, vaginula hairy; capsule immersed to exserted, erect, asymmetrical with superficial stomata; with or without a peristome; calyptra small or larger.

HEDWIGIA P.Beauv. 1804, *Mag. Enc.* 5:304 *nom.cons.*

Type: H.ciliata (Hedw.) P.Beauv.

Leaves in 8 rows, broad and firm; cells incrassate papillose; cells at basal angles quadrate. Capsule with a peristome. Autoecious, perigonia gemmiform and axillary.

Key to species:

1. Leaves with hyaline apices, spinously toothed; cells with branched papillae; perichaetial leaves with long, hyaline cilia ..... *H.ciliata*, p.295
   Stem and perichaetial leaves entire, without hyaline apices, cells with simple papillae ..... *H.integrifolia*, p.295

Hedwigia ciliata (Hedw.) Ehrh *ex* P.Beauv. 1805, *Prodr.* p.15.

Basionym: *Anictangium ciliatum* Hedw. 1801, *Spec.Musc.* p.40.

Type: Leipzig, E. Germany.

Fig. 177

In loose mats on acidic rocks, yellowish green to glaucous green, hoary. Stems 3-6 cm long, procumbent, rigid and bare below, branched dichotomously with long branches and irregularly with short ones. Leaves (a) 1·5-2 mm long, erect, closely imbricate and with reflexed tips when dry, spreading when moist, concave, ovate to ovate-lanceolate, acuminate with the apex hyaline and dentate; no costa; margins revolute below. Upper cells (b) oblong, 14-20 μm long, very incrassate, the lumen oval or irregular to reniform, each cell in mid-leaf with a papilla over the centre of the cell, the abaxial ones larger; the papillae compound, branched with several heads; marginal cells (c) quadrate, the lumen rounded and the outer edge with several small simple papillae; central cells at the base in a large patch (a) linear and yellow, the longitudinal walls incrassate and porose, the transverse wall thin, the elongated cells with a row of papillae, most simple, some a little branched. Perichaetial leaves larger than the vegetative ones, their upper margins with along flexuous cilia; seta very short, less than 0·5 mm; capsule subglobose, 1-1·5 mm long, immersed, the rim of the theca red; no annulus and no peristome; operculum convex, often mamillate; calyptra small, conical, soon lost; spores 28-32 μm, ornamented with sinuous lines.

Distribution: widespread in N. & S. Hemispheres, Australia (W.A., S.A., Vic., Tas., N.S.W., Qld, A.C.T.), New Zealand. Common on dry, acid rocks in South Australia (6).

Hedwigia integrifolia P.Beauv. 1805, *Prodr.* p.60.

Type: Europe.

Fig. 178

In loose mats on acidic rocks, green to yellowish brown, darker below. Stems procumbent, occasionally forked, mostly branched subpinnately with short branches, also with fairly long, slender, flagelliform branches. Leaves (a) broadly ovate-lanceolate, shortly acuminate or apiculate, 1·25-1·75 mm long, spreading when moist, erect and closely imbricate and weakly plicate when dry; margins revolute to near apex; no costa. Upper cells (b) oblong, incrassate, the lumen somewhat sinuous, each cell with several simple papillae; marginal cells (c) quadrate, with heavily thickened walls; basal cells linear, incrassate, with a linear row of papillae. Leaves (e, f) on stolons very small, oval, suddenly narrowed to a long squarrose hair point. Perichaetial leaves much larger than the foliage leaves, not ciliate, with long cells, nearly similar throughout. Seta 0·5-1 mm long; capsule widely oval, 1·5 mm long, immersed, light brown with a red rim, slightly grooved when dry; operculum conical rostellate; calyptra small, cucullate, reddish brown, smooth; spores about 30 μm diameter, with sinuous lines.

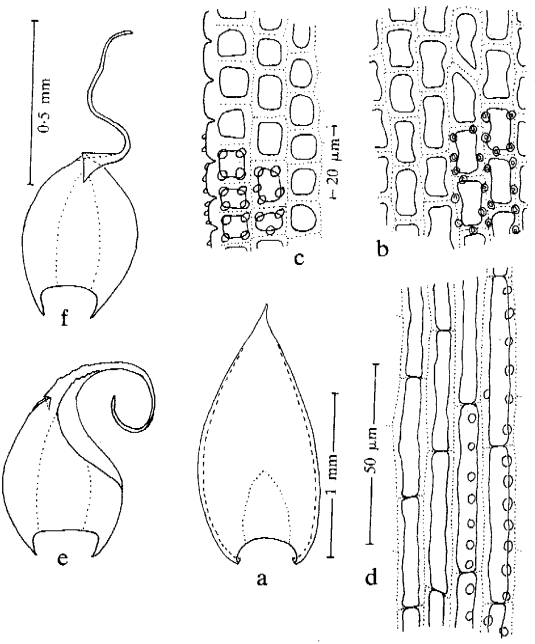


Fig. 178. *Hedwigia integrifolia*

Distribution: Europe, Central & S. Africa, S.E. Asia, Central and S. America, Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Common on acidic rocks (6, 7, 12).

Family **PTYCHOMNIACEAE** Fleisch. 1908, *Musci Fl.Buitenzorg* **3**:656.

Plants robust or slender with creeping primary stems which are densely rhizinous but mostly leafless, bearing crowded secondary stems. Leaves often plicate, ovate-lanceolate or oval, acuminate or rounded, no border, usually toothed above; either no costa or very short and single or double; cells linear or elliptical. Seta long; capsule with eight ribs; peristome double; operculum conical, rostrate; calyptra cucullate.

PTYCHOMNION (Hook.f.et. Wils.) Mitt. 1869, *J.Linn.Soc.Bot.* **12**:536.

Hypnum section. Hook.f. et Wils. 1854, *Fl.Nov.Zel.* **2**:110.

Type species: *P.aciculare.*

Robust glossy plants, leaves spreading squarrosely, concave, somewhat plicate, subulately acuminate; cells linear, not differentiated at the angles. Capsule oblong-cylindrical, horizontal or pendulous; annulus broad, separating; operculum with a long fine beak; spores small.

Ptychomnion aciculare (Brid.) Mitt. 1869, *J.Linn.Soc.Bot.* **12**:536.
Basionym: *Hypnum aciculare* Brid. 1801, *Musc.Rec.* **2**(2):58.
Type:

Fig. 179

Robust plants, growing in dense mats, green to brownish green, glossy; the secondary stems rigid, to 10 cm tall. Leaves (a) 4-4·5 mm long, rigidly and squarrosely spreading, rather crowded, somewhat rugose when dry, similar when moist, ovate with a narrow plicate base, rather abruptly and longly acuminate, the acumen twisted; margins (c) plane, denticulate above and coarsely serrate in the acumen; no costa. Cells (b) linear, 30-50 × 7-10 μm, very incrassate, porose; several marginal rows in lower part of lamina wider, coloured and shorter at the base. Perichaetial leaves convolute, abruptly contracted to a long slender point; seta 2·5-4 cm, thin, dark brown, arcuate at top; capsule 3-4 mm long, more or less cernuous, subcylindrical, very thick walled and deeply grooved; annulus of several rows of cells; operculum conical, with a long fine beak. Exostome teeth dark yellow-brown, narrowly lanceolate, subulate, the median line transparent, the plates either side on the outer face transversely striolate, papillose above; lamellae on inner face of exostome much

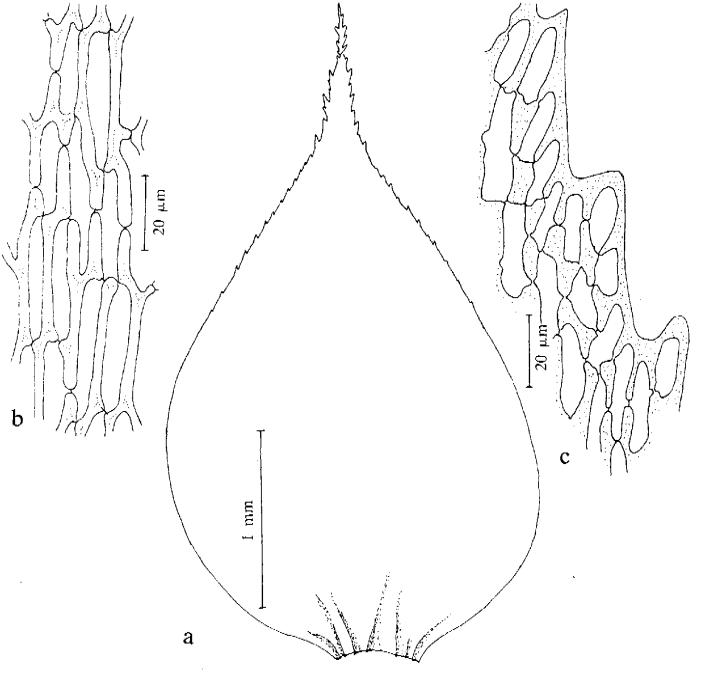


Fig. 179. *Ptychomnion aciculare*

projecting; basal membrane of endostome about half the height of the exostome, bearing pale papillose processes, keeled but not cleft, to nearly the height of the exostome; cilia 2-3, long, appendiculate; spores 8-12 μm, pale, smooth. Dioecious: antheridia axillary.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, S.America, Subantarctic Islands. Very rare in South Australia (1), on soil or on rotting logs.

Family **LEMBOPHYLLACEAE** Broth. 1906, *Nat.Pfl.* **1**(3):863.

Robust tufted plants, rigid and glossy, mostly growing on bark; primary stems creeping; secondary stems erect to pendulous, sometimes elongated and rhizinous at the apex. Leaves concave, oval or oblong; costa none or short and single or double; cells differentiated at the angles. Seta long; capsule ovoid; operculum conical, rostrate; calyptra cucullate; peristome double.

LEMBOPHYLLUM Lindb. 1872, *Act.Soc.Sc.Fenn.* **10**:277.

Shoots and branches julaceous; lower leaves small, upper larger, concave, cochleariform, suborbicular; costa single; angular cells small, subquadrate forming rather distinct dark auricles. Seta long; capsule cernuous.

Lembophyllum divulsum (Hook.f.et Wils.) Lindb. 1872, *Act.Soc.Sc.Fenn.* **10**:277.

Basionym: *Hypnum divulsum* Hook.f.et Wils. 1844, *London J. Bot.*, 3:556.

Type: Terra Van Diemen, coll. J. D. Hooker.

Fig. 180

In dense green to brownish green tufts on bark or rock; primary stems short, creeping, bearing suberect secondary stems to 4 cm long, with short curved branches; shoots distinctly julaceous. Leaves (a) crowded, closely imbricate, unaltered when dry, suborbicular and cochleariform, 0·75-1·25 mm long, usually rounded and obtuse at the apex; margins plane, entire; costa reaching at least half way. Upper cells (b) rhomboid, 9-16 μm long, walls sinuously thickened, the margin (c) vaguely crenate dentate; lower cells (d) longer, more sinuous, the marginal ones (e) quadrate; those at the angles small, incrassate forming auricles. Sporophytes lateral; inner perichaetial leaves long, sheathing, oblong, obtuse with a short denticulate apiculum, the outer leaves short and divergent; seta long, reddish; capsule 1·5-2 mm, inclined to horizontal, brown, oblong-ovoid; annulus narrow; operculum high, conical. Exostome teeth joined at the base, transversely striolate below on outer face, papillose apically; basal membrane of endostome about two-fifths the height of the exostome, bearing processes to the height of the exostome, the processes split; cilia generally two, slender, nodulose, as long as the processes. Spores 12-16 μm smooth. Dioecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Very rare in South Australia (6,7) on bark of trees and shrubs by rivers, in sheltered places.

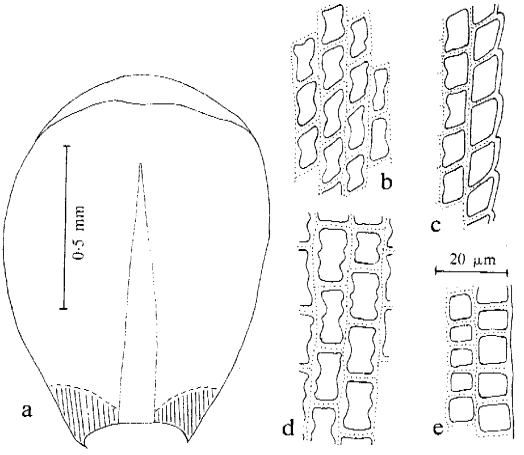


Fig. 180. *Lembophyllum divulsum*

Order **HOOKERIALES**

Family **HOOKERIACEAE** Schimp. 1855, *Coroll.Bryol.Eur.* p.101.

Plants with soft stems, the epidermal cells large and thinly walled; shoots often complanate with the leaves dimorphous in some species. Leaves somewhat asymmetrical, often bordered; the cells large with thin walls. Sporophyte lateral, rather robust; exothecial cells of capsule rectangular below, quadrate to hexagonal above and collenchymatous; exostome teeth often widely furrowed, usually horizontally striate; endostome with a high basal membrane bearing keeled, finely papillose split processes, but no cilia. Calyptra mitriform, smooth or hairy at the apex, the base fringed. A large family, mostly tropical.

Key to genera:

1. Costa none or short and usually double ..... *Eriopus,* p.301
   Costa long, single or forked at the top 2
2. Costa single; leaves all similar, bordered or not .... *Distichophyllum,* p.299
   Costa forked at the apex; leaves dimorphous, the upper and under smaller; no border ..... *Pterygophyllum,* p.302

DISTICHOPHYLLUM Dozy et Molk. 1846, *Musci Fl.Ined. Archip.Indici.* 4:99.

Shoots mostly complanate; the leaves in 6 to 8 rows, mostly symmetrical, oblong to obovate from a narrow base, the apex rounded or shortly pointed; costa single, ceasing below apex of leaf. Inner perichaetial leaves acuminate, without a costa; exostome teeth furrowed on the median line; calyptra rather fleshy, with a frilled base.

1. Leaves without a border, apex rounded ..... *D.microcarpum*, p. 301
   Leaves with a border, usually with a small apiculus ... *D.pulchellum*, p.300

Distichophyllum pulchellum (Hamp.) Mitt.1882, *Trans.R.Soc.Vict.* **19**:77

Basionym: *Mniadelphus pulchellus* Hamp. *in* C.Müll. 1850, *Syn.***2**:23.

Type: Auckland I., J. D. Hooker.

Fig. 181

Plants yellowish green, in soft, very dense flat patches on soil or rotting vegetation in damp to wet habitats; stems 1-5 cm long. Leaves (a) 1·25-1·75 mm long, obovate or broadly spathulate, undulate, flaccid, densely imbricate, obtuse or rounded at the apex, usually shortly apiculate (d), bordered; margins plane or reflexed, especially at the apex, entire; costa at least two-thirds of the length of the leaf. Upper cells (b) hexagonal, 12-20 μm across, larger below; marginal cells (c) elongate and narrow in two rows, forming a thin pale border.

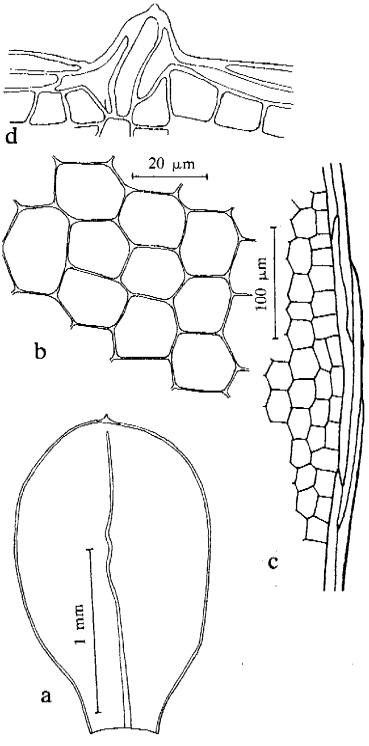


Fig. 181. *Distichophyllum pulchellum*

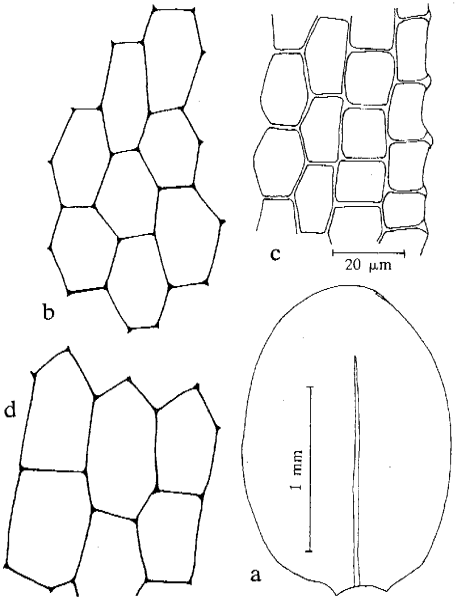


Fig. 182. *Distichophyllum microcarpum*

Perichaetial leaves short, truncate or obtuse, no costa, cells large; seta red, 1-3 cm long; capsule 1·5-2 mm long, cernuous, oblong, reddish brown; operculum highly conical with an erect beak; annulus narrow, adhering to operculum. Exostome teeth yellow, deeply furrowed, striolate; membrane of endostome about one third of the height of the exostome, bearing smooth lanceolate processes as long as the teeth, split between the articulations; spores 12-14 μm, smooth. Dioecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Very rare in moist gorges in the Mount Lofty Ranges (6).

Distichophyllum microcarpum (Hedw.) Mitt.1882, *Trans.R.Soc.Vict.* **19**:77.

Basionym: *Hypnum microcarpum* Hedw. 1801, *Spec.Musc.* p.244.

Type: Insulae Australes.

Fig. 182

Small to robust in dull green to yellowish green patches; stems 2-10 cm long. Leaves (a) 2-4 mm long, widely elliptical to obovate from a narrow decurrent base, very obtuse, no border; margins plane, entire; costa single, fairly long. Upper cells (b) 12-22 μm long, irregularly hexagonal, walls firm, shorter and rectangular at the margin (c); lower cells similar, but those (d) near the costa larger, more thinly walled forming a distinct patch. Seta 0·3-1 cm long, stout, purplish red; capsule small, 0·5-1 mm long, usually inclined, ovoid, dark purplish brown, with the upper exothecial cells often turgidly mamillose; operculum conical, beak erect. Peristome as in *D.pulchellum*.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Rare (1, 6) in gorges in the Mount Lofty Ranges and the South-East.

ERIOPUS Brid. 1827, *Bryol. Univ.* **2**:78.

Type: *E.cristatus* (Hedw.) Brid.

Complanate plants with six rows of bordered leaves, the upper and under ones symmetrical and appressed, the lateral leaves somewhat asymmetrical; costa short, often forked unequally, or none. Seta thick, hairy or papillose.

Eriopus apiculatus (Hook.f.et Wils.) Mitt.1869, *J.Linn.Soc.Bot.* **12**:393.

Basionym: *Hookeria apiculata* Hook.f.et Wils.1844, *London J. Bot.*, **3**:549.

Type: Cape Horn, J. D. Hooker; Tasmania, coll. Gunn.

Fig. 183

Slender plants in dense patches on damp soil or rock in shade, yellowish green to dark green; stems 1-2·5 cm tall, erect or ascending, densely tomentose. Leaves 1·5 mm long, undulate, not shrinking much when dry; upper and under leaves orbicular to ovate; lateral leaves (a) oblong-orbicular; all leaves widely bordered, apiculate, the margin entire or slightly crenulate below and denticulate above; costa short. Upper cells (b) hexagonal, 25-40 μm across; lower cells longer and wider, oblong hexagonal; five to seven rows of marginal cells (c) narrow, elongate, porose. Perichaetial leaves ovate-lanceolate, acuminate; seta 5-7 mm long, straight, slightly papillose from some protruding

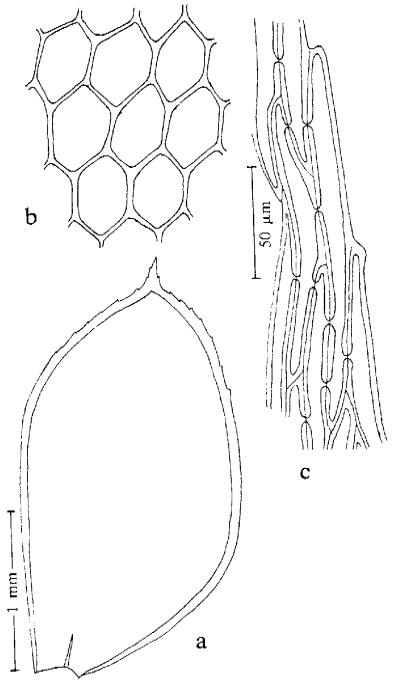


Fig. 183. *Eriopus apiculatus*

epidermal cells; capsule 1-1·5 cm long, usually inclined, brown; operculum conical with an erect beak; calyptra smooth, but fringed with long hairs at base. Exostome teeth furrowed narrowly, orange below, yellow above, transversely striolate; membrane of endostome half the height of the teeth, the processes reaching nearly as high as the teeth, split between the articulations; cilia rudimentary; spores 16-24 µm, smooth, green. Dioecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand, Chile, Tierra del Fuego. Rare in South Australia (6), only in sheltered valleys of Mount Lofty Ranges.

PTERYGOPHYLLUM Brid. 1827, *Bryol. Univ.* **2**:347.

Type: *P.quadrifarium* (Hook.) Brid.

Plants complanate, with the leaves in 6 to 8 rows, the upper and under smaller and appressed, the lateral larger and asymmetrical, variably toothed above; no border; costa strong, forked at mid leaf. Seta long, smooth. Exostome teeth with a wide median furrow. Dioecious. The name *Achrophyllum* Vitt et Crosby 1972 (*Bryologist* **75**:174) has been proposed instead of *Pterygophyllum*, which is

illegitimate, though used in the present sense for a long time and may later be conserved.

Pterygophyllum dentatum (Hook.f.et Wils.) Dix.1912, *J. Linn.Soc.Bot.* **40**:455.

Achrophyllum dentatum (Hook.f.et Wils.) Vitt & Crosby 1972, *Bryologist* **75**:175.

Basionym: *Hookeria dentata* Hook.f.et Wils. 1844, *London J. Bot.*, **3**:550.

Type: Fuegia and Falkland Is.

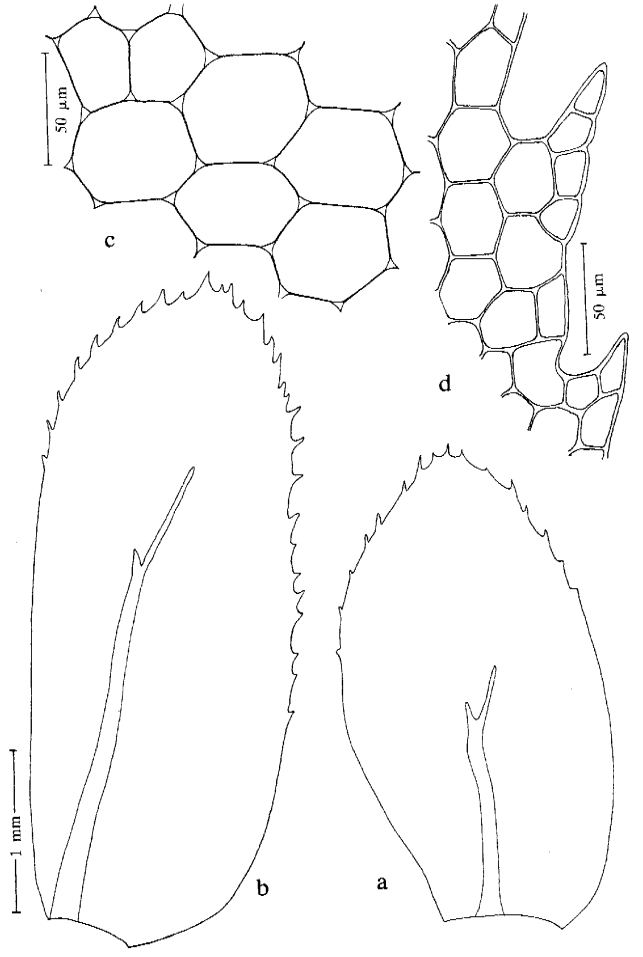


Fig. 184. *Pterygophyllum dentatum*

Fig. 184

Fairly robust plants, green and fleshy when moist, black and shrivelled when dry, in tufts on wet soil or rocks, usually in shade: stems 0·5-5 cm tall, suberect. Leaves 2-4 mm long; the upper and lower leaves (a) almost symmetrical and widely oval; the lateral leaves (b) oblong obovate, asymmetrical at the base. Upper cells (c) hexagonal, 40-60 μm across, the walls thin, thickened at the angles; marginal cells smaller, their tips projecting to make the margin erose denticulate, but also grouped to form coarse teeth above (d). Pale green gemmae frequent in a zone just inside the margin; each gemma a filament of about six cells with 1 to 3 short branches, each of 1-3 cells, at the base. Perichaetial leaves ovate-lanceolate; seta 1·25-2 cm long, dark red, the apex arcuate; capsule cernuous, obovoid, 1-2 mm long, dark brown tuberculate on the apophysis; operculum conical with an erect beak; calyptra black at the tip, white at the base where it is shallowly lobed. Exostome teeth yellow, lanceolate subulate with a filiform apex, the median zone broadly furrowed, pale yellow and not ornamented, the middle section of the plates transversely striolate and the margins hyaline; the lamellae on the outer face projected considerably and extending beyond the margin, lamellae on the inner face also well developed; basal membrane of endostome about half as high as the exostome, the processes reaching as high as the teeth, keeled but not split; cilia none or rudimentary; spores 12-18 μm, smooth.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, Chile, Tierra del Fuego. Rather rare in South Australia (6), only in wet shady places in the gorges of the Lofty Ranges.

Family **HYPOPTERYGIACEAE** Mitt. 1859, *Jour.Proc.Linn.Soc., Bot.Suppl.* **1**:147.

Plants with rhizomatous, tomentose primary stems bearing erect secondary stems which are usually dendroid or branched pinnately. Branches complanate, with the leaves in four rows, two lateral and two underneath (underleaves) almost appearing as one row; leaves mostly bordered and dentate with a single costa. Mainly tropical.

HYPOPTERYGIUM Brid. 1827, *Bryol. Univ.* **2**:709

Secondary stems with distant stipe leaves, branched pinnately above and so dendroid or frondose. Lateral leaves asymmetrical, bordered, serrate above; underleaves smaller symmetrical, in the form of subulate bristles in some species.

Hypopterygium rotulatum (Hedw.) Brid. 1827, *Bryol. Univ.* **2**:713.

Basionym: *Leskea rotulata* Hedw. 1801, *Spec. Musc.* p.213.

Type: Insulae Meridionales.

Fig. 185

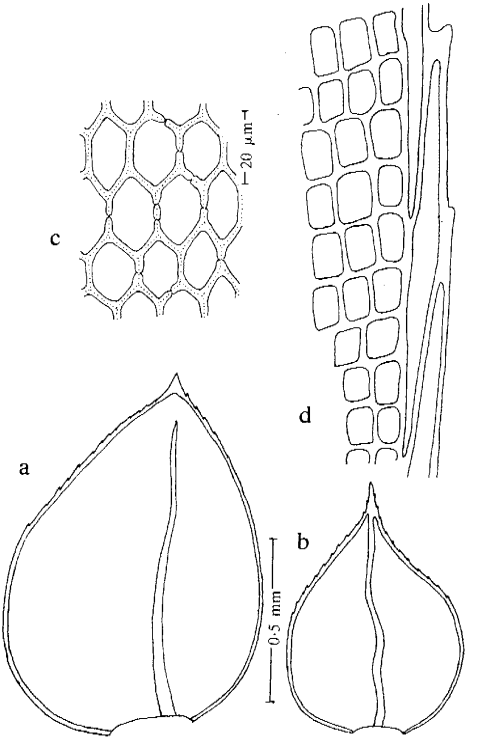


Fig. 185. *Hypopterygium rotulatum*

Small plants in loose tufts, dull green, sometimes glaucous; secondary stems 1·5-3 cm tall, black, tomentose only at the base, bearing distant stipe leaves, which are widely triangular ovate, acute, no costa. Branches in a terminal fan-shaped frond, sometimes branched again. Lateral leaves (a) spreading in one plane, 1-1·5 mm long, lax and undulate when dry, asymmetrical, widely ovate to orbicular-ovate, subacute, apiculate, costa reaching mid leaf or higher; margins plane, bordered, denticulate above; cells (c) hexagonal 20-40 µm long, not much bigger below, walls rather thick, porose, surface finely wrinkled to roughened, cells more rhomboid near margin (d) where 1-3 rows are much elongated. Underleaves (b) smaller, broadly oval to suborbicular, longly apiculate; costa weak, sometimes none. Inner perichaetial leaves sheathing, broadly ovate, cuspidate, no costa; seta to 1 cm tall, red; capsule 1-2 mm long, ovoid, horizontal to pendulous, light brown; operculum conical, rostrate; calyptra fleshy, blunt and smooth. Exostome teeth lanceolate, subulate with a zigzag median line, the lower plates transversely striolate on the outer face, the upper ones coarsely papillose, the inner face with wide lamellae; basal

membrane about a third of the height of the exostome, the processes reaching three quarters of the height of the teeth; cilia 2-3, shorter than the processes, jointed; spores 12-14 μm, smooth. Dioecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, S.America, Pacific Islands. Collected by F. von Mueller at Mount Gambier (1), but not seen since. It should be sought in shady dolines and cave entrances.

Order **HYPNOBRYALES**

Family **THUIDIACEAE** Schimp. 1860, *Syn.Musc.Eur.* p.493

Primary stems creeping, secondary stems procumbent to erect, irregularly branched or once to thrice pinnate, somtimes with stolons; paraphyllia often present. Leaves of branches often differing from those of stems; costa usually well developed; cells usually short, especially near the margin, sometimes elongated or linear towards the costa, papillose on one or both sides. Capsule and peristome typically hypnoid.

THUIDIUM B.S.G. 1852, *Bryol. Eur.* **5**:157

Stiff plants, with the secondary stems usually arcuate and once to thrice pinnate, with numerous paraphyllia. Leaves dimorphous; the stem leaves ovate to triangular lanceolate, acuminate, plicate basally, cells short papillose, usually one per cell; costa single, long.

Our species have been placed in the weakly defined genus *Thuidiopsis* Fleisch., the differential characters of which are stem once or twice pinnate and branch leaves inarched and catenulate when dry (see below)

Thuidium furfurosum (Hook.f.et Wils.) Reichdt. 1870, *Reise Oest.Freg. Novara Bot.* **1**(3):187.

Basionym: *Hypnum furfurosum* Hook.f. & Wils. 1854, *Fl.Nov.Zel.* **2**:10

Type: New Zealand.

T.hastatum (Mitt.)Reichdt.1870, *Reise Oest.Freg.Novara Bot.* **1**(3):187

Basionym: *Leskea hastata* Mitt. 1859, *J. Linn Soc. Bot.* **4**:93.

Fig. 186; Plate 13B

Plants loosely tufted or in mats, orange, yellow-green or dull brownish green; secondary stems to 10 cm long, decumbent or suberect, pinnate to bipinnate. Stem leaves (a) 1·5-2 mm long, more or less spreading when dry, reflexed with squarrose tips, broadly triangular-ovate, finely acuminate, somewhat plicate near the base; margins entire or vaguely crenate to denticulate above; costa ceasing below the apex, smooth abaxially. Branch leaves (b) imbricate and catenulate when dry, the basal part patent and the upper part strongly incurved towards the stem; erect when moist; ovate-lanceolate, acuminate, margins variably recurved, crenulate to entire. Leaves of branchlets smaller, more shortly pointed, costa shorter, margins denticulate. Cells of stem leaves (c) 10μm, rounded, each with one or two spicate papillae; lower cells (d) with

thinner walls; apical cell truncate and appearing bifid due to a pair of papillae (e); cells a little smaller in branch leaves and with more papillae (f, g, h). Paraphyllia (i) very numerous ranging from short filaments to leaf-like structures up to 0·25 mm long, but without a costa. Perichaetial leaves long, ovate-lanceolate, finely acuminate or piliferous, sometimes ciliate, with narrow rhomboid cells. Seta 2-3 cm long, slender, red; capsule 2-2·5 mm, cylindrical, cernuous, slightly curved, pale brown; operculum red, conical with an oblique beak; peristome double, perfect; spores 10-12 μm, smooth. Dioecious; perigonia small, gemmiform.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, Central and South America. Very common (1, 6-10, 12, 17) on rocks, shrubs, the bases of trees and amongst grass, tolerating full exposure to sunlight.

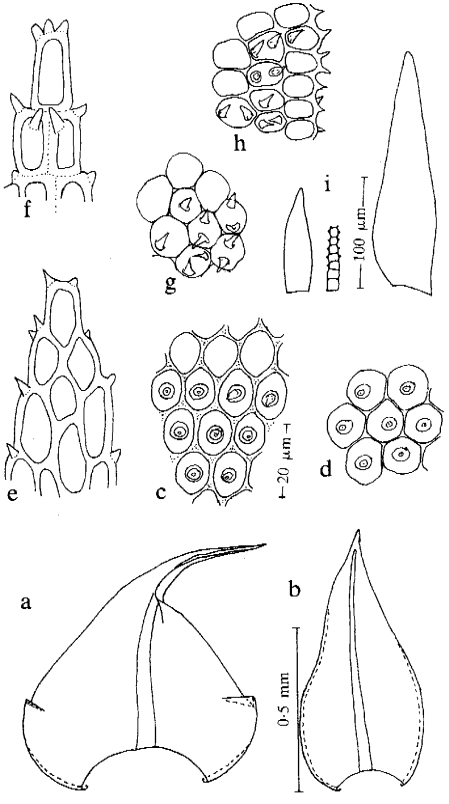


Fig. 186. *Thuidium furfurosum*

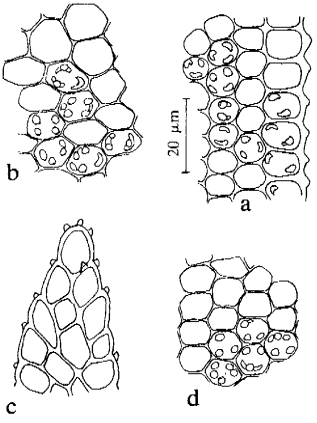


Fig. 187. *Thuidium species A.*

Very variable especially in cell size and papillation. Some (fig. 187) in South Australia (1, 6, 10) have the cells (a, b) of the stem leaves 7-8 μm across with several rounded or c-shaped papillae on each cell, the apex with smaller papillae (c) and the cells of branch leaves (d) still smaller. They scarcely fit in *T.laeviusculum* (Mitt.) Jaeg. (1878, *Ber. S.Gall, Naturw. Ges.* **1876-7**:258), whose other characters do not show in these specimens, except for being less catenulate in the branches. The features of *T.laeviusculum* are shoots bi-to tri-pinnate, with the end of the year's growth bare of branches and arching down to root at the tip; the branch leaves, when dry, less inarched and the upper part lying parallel to the stem; the costa of the leaves of branchlets cristate and often ending in a spicule; the seta rather thick and the perichaetial leaves always ciliate; the cells 7-8 μm across, each with several low papillae; the paraphyllia taller. Generally darker green and a plant of damp, shaded forest soils. Fruit is rather rare in both species. Incidentally, Dixon (1929, *N.Z. Inst. Bull.* No.3, pp. 302-3) has *T.furfurosum* with several papillae per cell and *T.laeviusculum* with one.

ANOMODON Hook. & Tayl. 1818, *Musc.Brit.* p.79.

The primary stems stoloniform bearing very small leaves, different in shape from those of the secondary stems and branches; secondary stems erect or ascending, branching irregularly. Leaves ovate or lanceolate, costa single; cells more or less rounded, highly papillose on both sides; no paraphyllia. Perichaetia on erect secondary stems, the perichaetial leaves with a sheathing base and reflexed apex; capsule erect, symmetrical, peristome double, the cilia of the endostome rudimentary or none; calyptra cucullate.

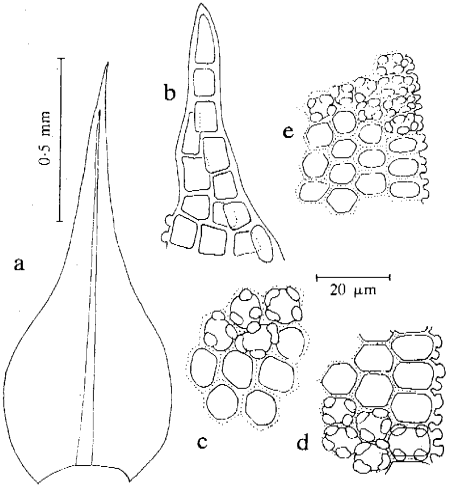


Fig. 188. *Anomodon tasmanicus*

Anomodon tasmanicus Broth. 1899, *Oefv. Finsk. Vet. Soc. Foerh.* **42**:121

Type: Tasmania, Hobart, Knocklofty. W.A. Weymouth No. 1571.

Triquetrella curvifolia Dix. & Sainsb. 1933, *J.Bot. Lond.* **71**:217.

Type: New Zealand.

Fig. 188; Plate 14A

Plants in tufts or mats, yellow-green to glaucous green, on soil or rock. Secondary stems 2-4 cm high, slender, rather rigid and irregularly branched, bearing anchoring rhizoids; stems and branches subcatenulate when dry, the leaves being more or less spirally curved around the stem; leaves borne in three rows, though not very obviously; widely spreading when moist. Leaves *(a)* 1-1·5 mm long, widely ovate-lanceolate or ovate-cordate, decurrent at the base, acuminate or acute, the apex distinctly hyaline, with a long apical cell *(b)*; margins variably revolute in lower half of leaf; costa fairly strong, but ceasing well below the apex; cells *(c)* irregularly hexagonal to subquadrate, papillose, with several large papillae per cell; marginal cells *(d, e)* similar. Fruit unknown.

Distribution: Australia (S.A., Vic., Tas., A.C.T.), New Zealand. Rare (6, 10, 12), only in sheltered places. The plant is known only from a very few, widely separated, localities.

The taxonomic position is uncertain in the absence of fruit. Placing it in *Anomodon* is based on general similarity to other species in the genus. Its description as a *Triquetrella* was due to the leaves being in three ranks.

Family **LESKEACEAE** Schimp. 1856, *Coroll. Bryol. Eur.* p.109.

Primary stems generally stoloniform, the secondary stems erect or procumbent, the branching pinnate or irregular; some with paraphyllia; leaves concave, ovate to lanceolate, the cells often longer than wide, but quadrate at the basal angles.

PSEUDOLESKEA B.S.G. 1852, *Bryol. Eur.* **5**:147.

Rigid plants with the branches julaceous, curved and elongate; no paraphyllia; leaves closely imbricate, the costa strong; cells smooth, incrassate; inner peristome with well developed cilia.

Pseudoleskea imbricata (Hook. f. & Wils.) Broth. 1907, *Nat.Pfl.* **1**(3):1000.

Leskea imbricata Hook. f. & Wils. 1859, *Fl. Tasm.* **2**:202.

Type: Tasmania.

Fig. 189; Plate 13A

Slender wiry plants in dense tufts on wet rocks, usually by streams, brown to dull green; primary stems rigid, to 4 cm long, creeping; the secondary stems 5-10 mm long, crowded, curved, terete and julaceous, simple or sparsely branched. Leaves *(a)* to 0·8 × 0·6 mm, closely imbricate when dry, spreading when moist, broadly ovate, shortly and bluntly acuminate; margins plane or slightly recurved basally *(d)*, entire or finely crenate apically *(c)*; costa robust, ceasing below the apex. Cells *(b)* 12-18 μm long × 8-10 μm wide, oval to rounded hexagonal or rounded rhomboidal, smaller towards the margins *(c)* and the base; basal cells near margin *(d)* subquadrate, rectangular or transversely

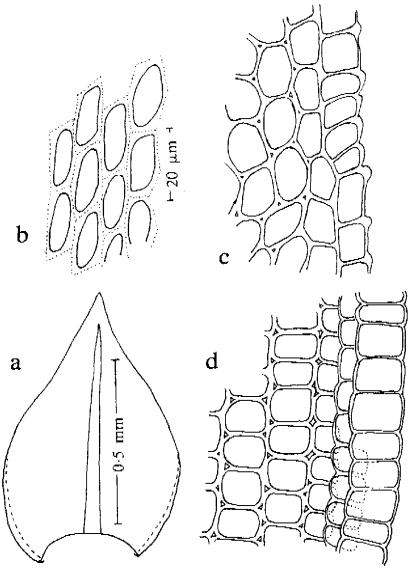


Fig. 189. *Pseudoleskea imbricata*

oval, the angular ones rather opaque. Perichaetial leaves large, colourless, 2 mm long, oblong-lanceolate, acuminate, rather finely attenuate, with a costa; cells long, rhomboid. Seta 0·3-1 cm, red; capsule about 2 mm long, erect, shortly cylindrical, slightly curved; operculum conical, acute; exostome teeth triangular-lanceolate, blunt, border hyaline, plates transversely striolate, median line zigzag; endostome papillose, the basal membrane half the height of the teeth; processes as high as the teeth, cracked medianly; cilia one in each space, about half as high as the processes. Autoecious; perigonia small, gemmiform, on the main stem.

Distribution: Australia (S.A., Vic., N.S.W., A.C.T.), New Zealand. Fairly common (6, 7, 12) on rocks by streams, apparently favouring basic rocks.

Family **AMBLYSTEGIACEAE** G. Roth 1899, *Hedwigia* **38**:(6)

Slender or robust plants, of moist to aquatic habitats, irregularly to pinnately branched, without stolons and ususally without paraphyllia. Leaves symmetrical, with a distinct single costa or sometimes costa double and faint or none; cells prosenchymatous and hexagonal to long and narrow, smooth, the angular cells often differentiated. Autoecious to dioecious, the inflorescences in dwarf gemmiform branches laterally on the mainstem. Capsules generally slender and curved, the exostome teeth yellowish brown.

CRATONEUROPSIS (Broth.) Fleisch. 1923, *Musci Fl. Buitenzorg* **43**:535

Campylium sect. *Cratoneuropsis* Broth. 1908, *Nat.Pfl.* **1**(3):1043.

Leaves more or less squarrose, not plicate, with relatively short cells no more than 3-5 times as long as wide; abundant filamentous paraphyllia present especially in the axils. Australasian and S.African; perhaps only one species in the genus.

Cratoneuropsis relaxa (Hook.f. & Wils.) Fleisch. in Broth. 1925, *Nat. Pfl.* ed 2, **11**:335.

Basionym: *Hypnum relaxum* Hook.f. & Wils. 1854, *Fl.Nov.Zel.* **2**:110

Type: New Zealand.

Fig. 190

Plants in dense tufts or mats in moist or wet habitats, green to yellowish brown, dull; variable in size, the stems to 10 cm long, irregularly subpinnate to pinnate, procumbent, stout. Leaves (a) 1-3 mm long, widely spreading to squarrose, unaltered when dry, sometimes a little secund, lanceolate from a cordate or ovate base, acuminate, the acumen usually reflexed and oblique;

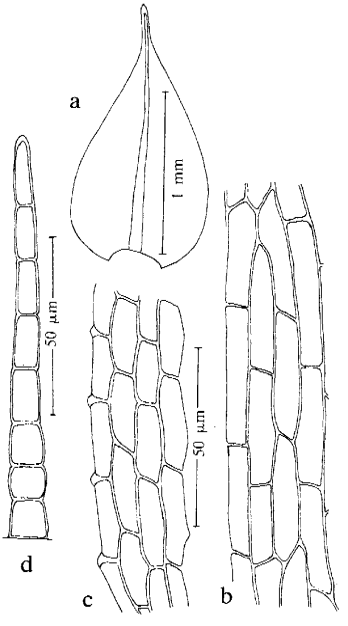


Fig. 190. *Cratoneuropsis relaxa*

costa generally reaching nearly to the apex; margin entire or serrulate. Cells (b) 20-50 μm long, 3 to 5 times as long as wide, linear rhomboid, smooth, walls firm, shorter towards the margin (c). Paraphyllia (d) usually abundant, filamentous, of 6-8 cells or longer to 15 cells with two rows of cells at the base. Perichaetial leaves sheathing, narrowly lanceolate, acuminate, no costa; seta 2-5 cm long, red; capsule 2-3·5 mm, long, cylindrical, slightly curved, brown; operculum conical, apiculate. Exostome teeth yellow, joined at the base striolate; basal membrane of endostome half as high as the teeth; the processes as high as the teeth, keeled and cracked; cilia 2-3, shorter; spores 12-16 μm, smooth. Dioecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand, S.Africa.

Uncommon (6) and apparently restricted to very moist situations, in and by streams and on waterfalls.

C.decussata (Hook.f. & Wils.) Fleisch. is smaller in size, has smaller more reflexed leaves and somewhat smaller cells; it occurs in relatively drier situations and is probably just a habitat modification.

AMBLYSTEGIUM B.S.G. 1852, *Bryol. Eur.* **6**:45.

Lectotype: *A.serpens* (Hedw.) B.S.G. *fid.* Braithw. 1896, *Brit. Moss Fl.* **3**:17.

Mostly small plants with small leaves, generally ovate acuminate, usually imbricated all round the stem, not complanate; costa single or none; cells parenchymatous, short, usually less than five times as long as wide, rhomboid hexagonal; no paraphyllia.

Amblystegium serpens (Hedw.) B.S.G. 1853, *Bryol. Eur.* **6**:53

Basionym: *Hypnum serpens* Hedw. 1801, *Spec.Musc.* p.268

Type: Europe.

Fig. 191

Stems prostrate, radiculose, slender, with numerous erect or spreading, slender, sometimes filiform branches, forming very low soft tufts of a dull or yellowish green, not shining. Leaves crowded, spreading when moist, usually appressed and imbricated when dry, but sometimes erecto-patent; ovate lanceolate (a), acuminate, tapering to a long point, small, usually 0·5-1 mm long, the branch leaves smaller and relatively narrower; leaves narrowed at the base and slightly decurrent; margin denticulate (c); costa rather faint, reaching mid leaf or a little higher; cells (b) hexagonal rhomboid, irregular, variable in size, usually 3-5 times as long as wide, broader and subrectangular towards the base; marginal cells at base near angles short, subquadrate. Seta slender, red 1·2-2 cm long; capsule cylindrical, strongly curved, constricted below the wide mouth when empty; operculum conical, obtusely apiculate; calyptra whitish; spores 10-14 μm. Autoecious.

Distribution: Europe, Asia, N.Africa, N. and S.America, Australia (S.A., Tas.), New Zealand. On soil, stones and decaying wood in moist, shady places. Rare (8); in situations such as conservatories, which suggest introduction.

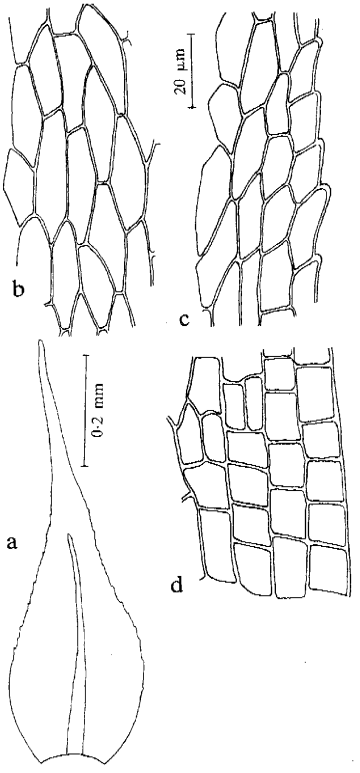


Fig. 191. *Amblystegium serpens*

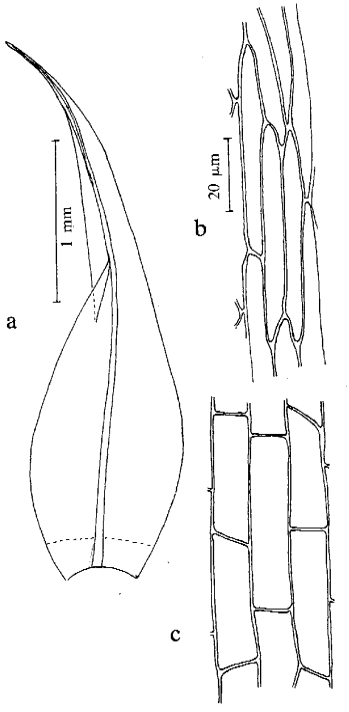


Fig. 192. *Leptodictyum riparium*

LEPTODICTYUM (Schimp.) Warnst. 1906, *Krypt. Fl. Brandenb.* **2**:840, 867.

Amblystegium subgen. *Leptodictyum* Schimp. 1860.

Plants slender to robust; no paraphyllia. Leaves spreading, costa thin reaching at least to mid leaf; cells prosenchymatous, with thin walls, narrow and elongated in mid leaf; no auricles at the basal angles.

Leptodictyum riparium (Hedw.) Warnst. 1906, *Krypt. Fl. Brandenb.* **2**:278

Basionym: *Hypnum riparium* Hedw. 1801, *Spec Musc.* p.241

Type: Europe.

Fig. 192

Plants in soft tangled tufts on stones or roots or near water, especially swamps, pools and stream sides. Stems to 10 cm or more long, but often shorter, branched distinctly and subpinnately, with the branches spreading, often flattened, sometimes the tips cuspidate and secund. Stem leaves (a) spreading or

erect, silky, little changed when dry, 2-4 mm long, widely or narrowly ovate lanceolate; narrow and rounded at the base, tapered gradually to a long, fine flat subula; margins plane, entire; costa single, narrow, usually attaining at least to three-quarters of the length of the leaf; cells (b) with thin walls, narrowly linear-rhomboid with pointed ends, 60-100 × 7-10 μm; laxer below and rectangular at the base (c), but no distinct auricles; branch leaves similar but smaller. Perichaetial leaves sheathing; seta 1-1·5 cm orange; capsule about 2 mm, long, cylindrical, curved; operculum lowly conical. Peristome hypnoid, with 1 or 2 cilia; spores 10-16 μm, green, smooth. Autoecious.

Distribution: Northern Hemisphere, Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Uncommon (6) usually by streams or in swamps.

DREPANOCLADUS (C. Müll) Roth. 1899, *Hedwigia* **38**(Beibl):6.

Hypnum subsect. *Drepanocladus* C. Müll. 1851, *Syn.* **2**:321

Lectotype: *D.aduncus* (Hedw.) Warnst. *fid.* Grout 1931, *Moss Fl. N. Amer.* **3**:103.

Plants of aquatic or moist terrestrial habitats with erect, creeping or floating stems, branched pinnately or fastigiately, with the tips of leaves and branches more or less secund. Leaves ovate or lanceolate, acuminate; costa single; cells very long and narrow, linear, prosenchymatous; alar cells more or less differentiated, quadrate or inflated, hyaline or somewhat coloured. Seta long, flexuous; capsule suberect to horizontal, subcylindrical, curved; operculum conical, apiculate; peristome perfect, hypnoid, the cilia nodulose. There appear to be three species in South Australia none found fruiting. They seem to correspond to species of the Northern Hemisphere which are notoriously variable. A fourth species probably does not belong in *Drepanocladus.*

Key to species:

1. Costa excurrent ..... *D. species A,* p.317
   Costa not excurrent 2
2. Leaves entire or at most slightly sinuous 3
   Leaves denticulate, at least near the apex ..... *D. fluitans,* p.316
3. Angular cells enlarged, hyaline; costa extending half-way to three-quarter way up leaf, 40-60 μm wide near base ..... *D.aduncus,* p.314
   Angular cells not much enlarged, yellowish to orange brown; costa extending into acumen, 60-120 μm wide near base ... *D.sendtneri,* p.315

Drepanocladus aduncus (Hedw.) Warnst 1903, *Beih. Bot. Centralbl.* **13**:400.

Basionym: *Hypnum aduncum* Hedw. 1801, *Spec.Musc.* p.295.

Type: Europe.

Fig. 193

Dioecious. Plants of medium size, to 10 cm long or more, soft in texture, usually dull green to yellowish green; stems irregularly to pinnately branched. Leaves (a) patent, 2-5 mm long, straight to falcate or falcate secund, not plicate, ovate to ovate lanceolate, tapering to a long acuminate apex, the base cordate and slightly decurrent; margin entire; costa extending ½-¾ up the leaf, rather

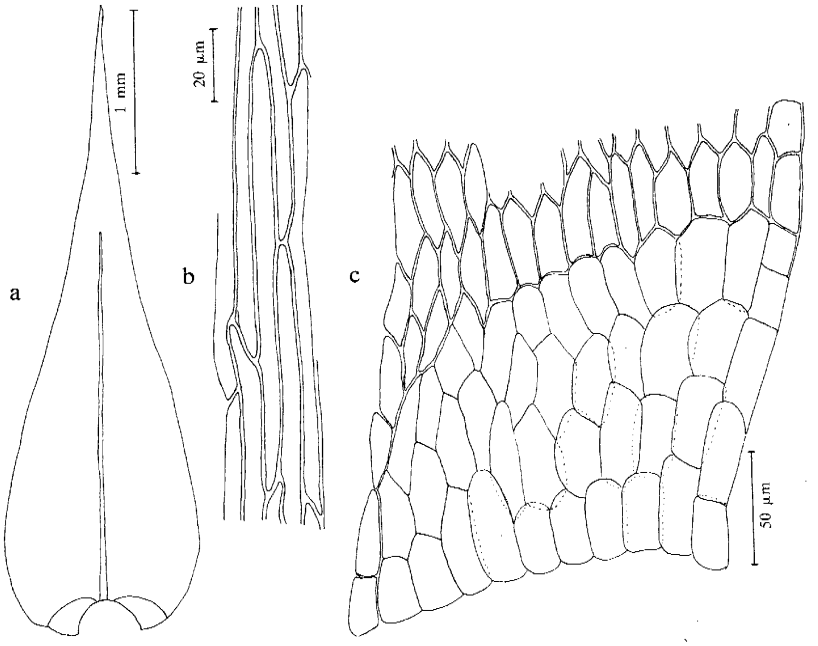


Fig. 193. *Drepanocladus aduncus*

slender, 40-60 µm wide near the base. Upper cells (b) linear or linearly rhomboid, 40-100 × 5-10 µm in mid leaf, generally porose, the angular cells (e) much inflated, hyaline or pale yellow, forming auricles not usually reaching to the costa.

Distribution: Widely spread in N.Hemisphere, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Rare (1, 6), in gorges of the Mount Lofty Ranges and in freshwater swamps.

Drepanocladus sendtneri (Schimp. *ex* H.Müll.) Warnst. 1903, *Beih.Bot.Centralbl.* **13**:400.

Basionym: *Hypnum sendtneri* Schimp. *ex* H.Müll. 1864. *Verh.Naturh. Ver.Rheinl.* **21**:117.

Type: Germany.

Fig. 194

Dioecious. Similar in habit to *D.aduncus*, green to reddish or golden brown. Leaves (a) secund to falcate-secund, 2·5-4·5 mm long, ovate-lanceolate to lanceolate, tapering to a long acuminate apex, base not decurrent; margin entire; costa strong, 60-100 µm wide near base. Upper cells (b) linear, 55-90 × 5-8 µm, 10-15 times as long as wide; basal cells shorter and wider, irregularly

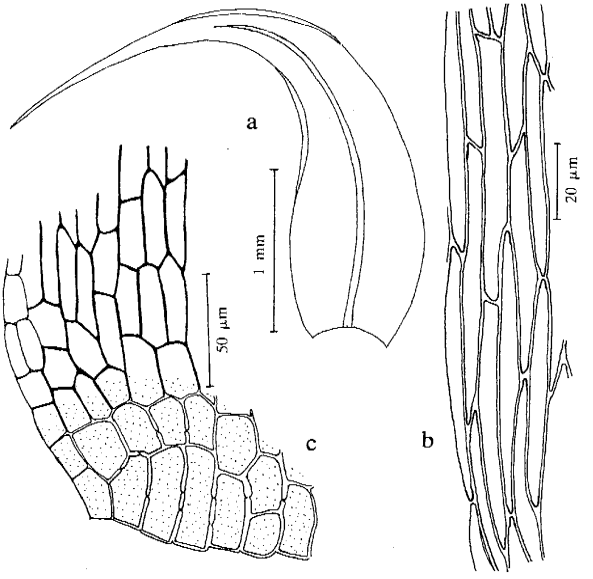


Fig. 194. *Drepanocladus sendtneri*

hexagonal to rhomboid, the angular ones (c) incrassate, orange to brown, porose, forming a small auricle not extending to the costa.

Distribution: Europe, N.Asia, N.America, Australia (S.A.). Rare, only in gorges of the Mount Lofty Ranges (6), but apparently commoner than *D.aduncus.*

Drepanocladus fluitans (Hedw.) Warnst 1903, *Beih Bot. Centralbl.* **13**:404.

Basionym: *Hypnum fluitans* Hedw. 1801, *Spec.Musc.* p.296.

Type: Europe.

Fig. 195

Autoecious. Plants of moderate size, to 15 cm long, usually soft in texture, branched irregularly, rarely pinnate, dull green to brownish. Leaves (a) straight to falcate, narrowly lanceolate to ovate-lanceolate; tapering to an acuminate or longly acuminate apex; margin denticulate (c); costa extending ½-¾ of the way up to the leaf, 40-70 µm wide near the base. Upper cells (b) 80-140 × 5-10 µm, linear, 10-20 times as long as wide; angular cells (d) enlarged and differentiated from the basal cells, but not forming very distinct auricles, mostly about 50 µm long, extending almost to the costa.

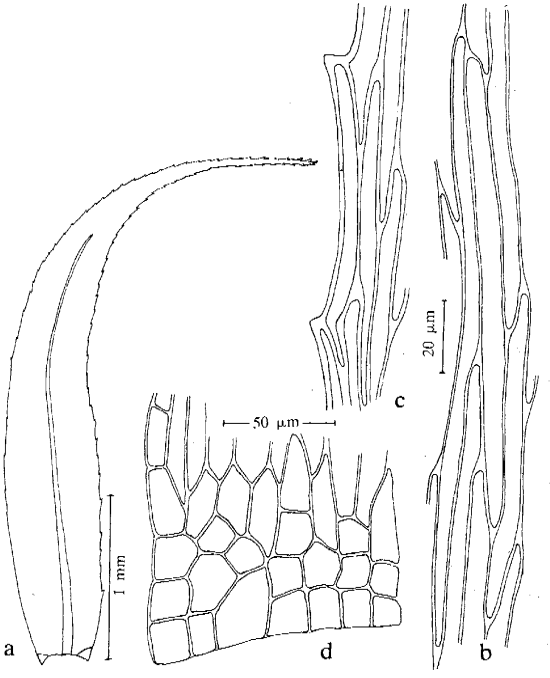


Fig. 195. *Drepanocladus fluitans*

Distribution: Northern Hemisphere, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Rare (6), known only in aquatic habitats in gorges of the Mount Lofty Ranges.

Drepanocladus species A.

Fig. 196

Plants dull green, irregularly branched, 3 to 4 cm tall, on wet rock in cascades. Leaves (a) to 1·5 mm long, broadly ovate lanceolate, acuminate, somewhat falcate; costa narrow, 45-50 µm wide near the base, extending into the apex and excurrent; margin plane, virtually entire (c); mid-leaf cells (b) 40-50 x 7-8 µm, elongated hexagonal, prosenchymatous; basal cells shorter, those at extreme base (d) larger, but not forming distinct auricles.

Very rare (6) in or near cascades.

The identity of this plant, superficially like a small *D.aduncus,* is obscure. The excurrent costa is unusual in this genus and it may be an *Amblystegium.*

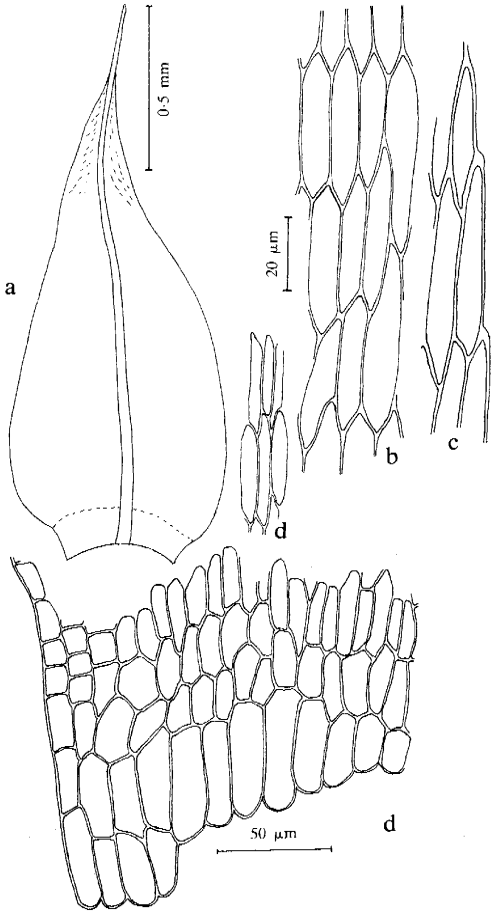


Fig. 196. *Drepanocladus species A.*

ACROCLADIUM Mitt. 1869, *J.Linn.Soc.Bot.* **12**:531

Lectotype: *A.auriculatum* (Mont.) Mitt. *fid* Broth. 1908, *Nat.Pfl.* **1**(3):1038.

Robust aquatic or semiaquatic plants in tufts; stems branched irregularly or pinnately. Leaves concave, apex rounded, sometimes apiculate, not falcate nor secund; no costa or very short and faint or double; cells linear, the basal ones forming well-defined auricles. Seta smooth; capsule oblong; peristome perfect, hypnoid. Sometimes placed in the Lembophyllaceae.

Acrocladium chlamydophyllum (Hook.f. & Wils.)C. Müll.& Broth. 1900, *Abh. Naturw. Ver. Bremen* **16**(3):507.

Basionym: *Hypnum chlamydophyllum* Hook.f. & Wils. 1844, *London J. Bot.*, **3**:552.

Type: Campbell Is., J. D. Hooker.

Fig. 197

Robust, in tufts on soil or logs, yellow to green, glossy; stems 3-6 cm long, procumbent, irregularly branched with convolute cuspidate tips. Leaves (a) 1·25-1·5 mm long, wider than long, loosely imbricated on the stems, densely so on the branches, erect to patent, concave, orbicular, rounded to obtuse, decurrent at the base; costa short and faint, or double or none, sometimes with very short basal branches; cells in mid leaf (b) narrowly linear, 50-80 x 4-6 μm, prosenchymatous, incrassate, porose; basal cells shorter and wider, angular cells (c) large, hyaline, thinly walled, forming a conspicuous alar group. Perichaetial leaves erect, oblong, apex rounded, entire or denticulate; seta 2-4 cm, slender, red; capsule 1·5-2 mm long, horizontal, oblong, curved, pale brown; operculum conical. Autoecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Rare (1).

The S.American *A.auriculatum* (Mont.) Mitt., to which our plant has been referred previously, differs (Karczmarz, 1966) in the cordate deltoid leaf shape tapering to a blunt apex and the distinct auricles above the angular cells. Andrews (1949) first drew attention to these and other differences.

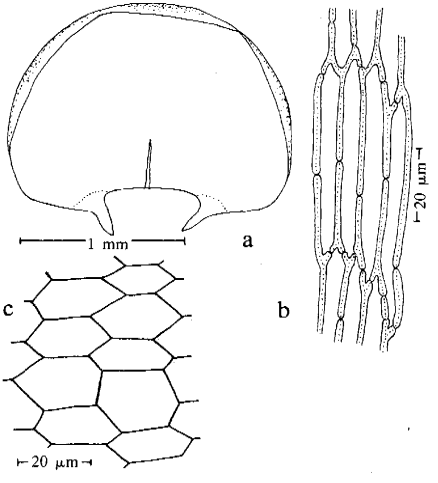


Fig. 197. *Acrocladium chlamydophyllum*

Family **BRACHYTHECIACEAE** G. Roth. 1899, *Hedwigia* **38**:(5)

Slender to robust plants, usually of relatively dry habitats, irregularly to pinnately branched, usually no paraphyllia. Leaves appressed to spreading, often plicate, with a single costa ending below the apex, sometimes projecting at the tip as an abaxial spine; cells prosenchymatous, elongate, rhomboid to linear, the basal laxer and often porose and the angular cells sometimes differentiated. Capsules usually inclined to horizontal, rather short with a conical operculum; exostome teeth reddish brown.

Key to genera:

1. Apical cells of branch leaves short and rhomboid hexagonal, distinct from the median cells; costa often ending in a spicule projecting abaxially *Eurhynchium*, p.321
   Apical cells of branch leaves elongate, hardly different from the median cells; end of costa not projecting 2
2. Operculum obliquely longly rostrate; leaves smooth, ovate or ovate-lanceolate, usually somewhat complanate . . . . . *Rhynchostegium*, p.324
   Operculum blunt or acute to apiculate; leaves often more or less plicate, ovate-lanceolate to lanceolate, not complanate . . . *Brachythecium*, p.320

BRACHYTHECIUM B.S.G. 1853, *Bryol. Eur.* **6**:5.

Leaves ovate to lanceolate, sometimes plicate; upper cells linear, basal cells shorter and wider, porose, often subquadrate at the angles. Seta smooth or papillose; capsule short, ovoid, curved and usually gibbous at the back; operculum conical; peristome double, hypnoid.

Brachythecium rutabulum (Hedw.) B.S.G. 1853, *Bryol. Eur.* **6**:15.

Basionym: *Hypnum rutabulum* Hedw. 1801, *Spec. Musc.* p.276.

Type: Europe.

Fig. 198

In large, loose tufts of a bright or deep green to yellowish green, glossy, usually on soil amongst grass. Stems creeping, usually branched irregularly, the branches erect or ascending, robust, usually with some rhizoids. Leaves (a) large, 2·5-3·5 mm long, cordate-ovate or ovate-laneolate, acuminate, somewhat divergent whether dry or moist, usually a little concave; base more or less decurrent (c), faintly plicate especially when dry; margin plane or slightly reflexed especially basally (c), finely denticulate; costa thin, narrow, but widened at the base, reaching mid way or more. Cells (b) linear rhomboid, 55-100 × 6-10 μm, usually 8-15 times as long as wide, becoming shorter and wider basally and oblong to hexagonal, porose; angular cells decurrent, not forming distinct auricles. Perichaetial leaves longly and finely acuminate, squarrose, no costa; seta 2·5-3 cm, robust, strongly papillose throughout; capsule rather large, oval to subcylindrical, gibbous at the back, arcuate, dark reddish brown; operculum conical. Dioecious.

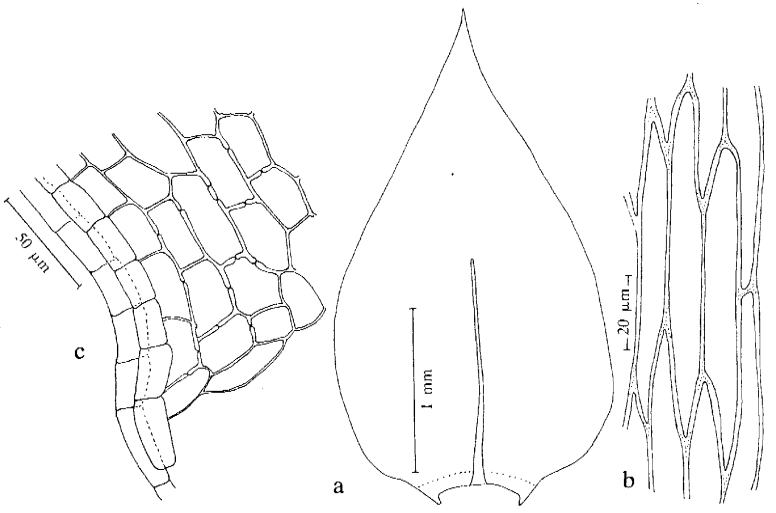


Fig. 198. *Brachythecium rutabulum*

Distribution: Europe, Asia, N.Africa, N. & S.America, Australia (S.A., Vic., Tas., N.S.W., A.C.T.), New Zealand. Fairly common (6, 8), in sheltered woodlands among grass and on the bases of trees and especially in lawns; perhaps introduced, at least to garden sites.

Brachythecium salebrosum (Web. & Mohr.) B.S.G. 1853, *Bryol.Eur.* **6**:20, is similar in habitat, colouration and habit of branching. It differs in the more silky appearance, the leaves strongly plicate and longly pointed, in being autoecious, and the seta quite smooth. The two species are readily confused unless in fruit. Similar in world distribution, but not found in S.America. In Australia known in Tas., Vic., N.S.W. and A.C.T.

EURHYNCHIUM B.S.G. 1854. *Bryol.Eur.* **5**:217.

Stem and branch leaves either similar or different in shape, cordate-triangular or ovate to lanceolate; costa single often ending in an abaxial spicule. Cells linear, rhomboid or hexagonal rhomboid, rarely less than 5 times as long as wide, but short at the apex of the branch leaves. Capsule inclined to horizontal, ovoid to shortly cylindrical, usually curved or gibbous; operculum usually with a long subulate beak. Usually dioecious.

Key to species:

1. Stem leaves cordate-triangular, longly decurrent; branch leaves ovate to lanceolate. ..... *E.praelongum*, p.323
   Stem and branch leaves similar in shape, but may differ in size
   E.pumilum, p.322

Eurhynchium pumilum (Wils.) Schimp. 1856, *Coroll. Bryol. Eur.* p.119.
Basionym: *Hypnum pumilum* Wils. 1843, *Engl. Bot.*Suppl. plate 1942.
Type: England, Winwick Stone Quarry, near Warrington.

Fig. 199

Plants very slender, the stems branched irregularly, the branches filiform; in dense, dull green mats on soil on shady places in woods and banks. Leaves (a) spreading, often somewhat complanate, the stem and branch leaves of similar shape, ovate to ovate-lanceolate, acute, slightly asymmetrical with the base slightly decurrent on one side (d); margin plane, denticulate (c); costa extending ½-⅘ of the way up the leaf, in branch leaves projecting abaxially as a small tooth; cells (b) rhomboid to hexagonal, 16-35 × 7-9 μm, rhomboid at the margin (c), much shorter towards the apex, more nearly rectangular at the base near the margin. Seta papillose; capsule horizontal, ovoid to ellipsoid; operculum with a subulate beak; fruit rare.

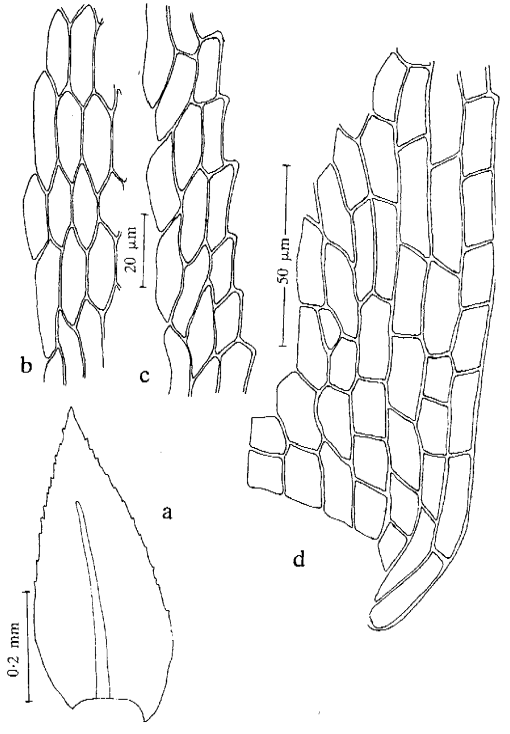


Fig. 199. *Eurhynchium pumilum*

Distribution: Europe, N.Africa, Australia (S.A.). Rare (6) on soil in Mount Lofty Ranges garden, in shade; introduced.

Differs from *Amblystegium serpens* in the shorter leaf, the papillose seta, the shorter broader capsule and in being dioecious.

Eurhynchium praelongum (Hedw.) B.S.G. 1854, *Bryol. Eur.* **5**:224.

Basionym: *Hypnum praelongum* Hedw. 1801, *Spec. Musc.* p.258.

Type: Europe.

Fig. 200

Plants slender, straggling, in dull green to yellow-green mats or wefts; stems procumbent, pinnate, to 8 cm long, branches to 1·5 cm long, spreading somewhat curved, subcomplanate. Leaves dimorphous; stem leaves (a) patent to spreading or squarrose when moist, somewhat shrunken when dry, 1-1·5 mm long, widely triangular cordate to ovate triangular, base excavate and longly decurrent, rapidly narrowed above to a long acumen, which is recurved and folded to one side; costa to middle leaf or higher; margin plane, denticulate (d).

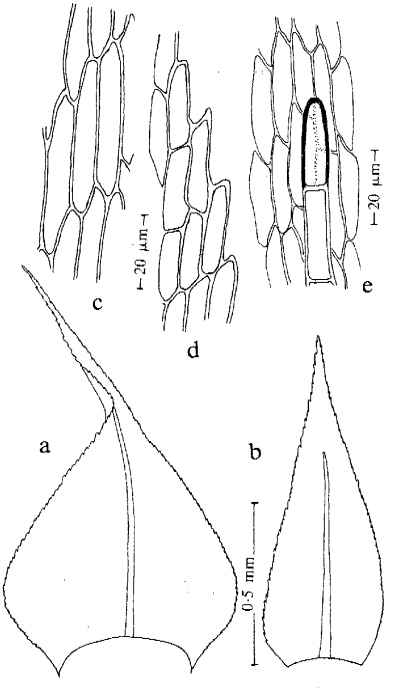


Fig. 200. *Eurhynchium praelongum*

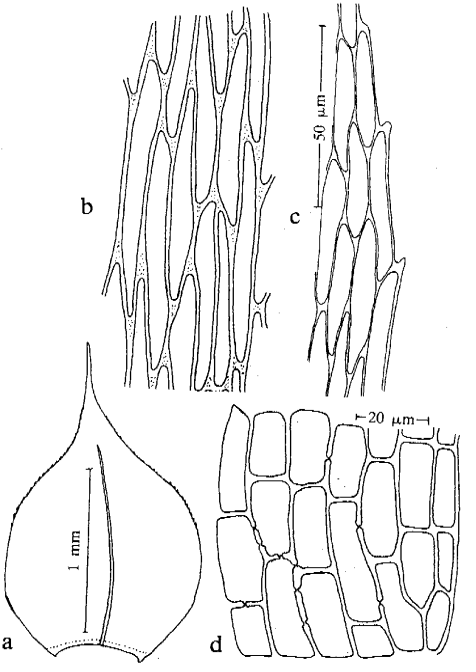


Fig. 201. *Rhynchostegium tenuifolium*

Branch leaves (b) much narrow, 0·75-1·25 × 0·3-0·5 mm, patent, lanceolate to ovate-lanceolate, gradually tapered, denticulate, costa reaching to three quarters of the way up the leaf, excurrent abaxially in a tooth (e). Cells (c) 25-60 × 6-9 μm, narrowly rhomboidal, those at the basal angles rectangular; apical cells of branch leaves short. Seta papillose, reddish; capsule broadly ellipsoid, about 1·5 mm long, curved, green with small black blotches when mature; operculum with a long subulate beak.

Distribution: Widespread in the Northern Hemisphere, Australia (S.A., Tas., Vic.), New Zealand. Rare (6), on damp soil in grasslands or on rocks or logs, in some shade; probably introduced.

RHYNCHOSTEGIUM B.S.G. 1852, *Bryol. Eur.* **5**:197.

Type: *R.confertum* (Dicks) B.S.G.

Autoecious. Plants slender to robust, with procumbent, rather irregularly branched stems; no paraphyllia. Stem and branch leaves similar, usually concave, broadly ovate to ovate lanceolate, acuminate and acute to obtuse, margin entire or denticulate; costa fairly long, not projecting abaxially at the terminus; cells narrowly rhomboidal to linear. Seta smooth, reddish; capsule like *Eurhynchium* with a rostrate operculum.

Rhynchostegium tenuifolium (Hedw.) Reichdt. 1870, *Reise Oest. Freg. Novara Bot.* **1**(3):191.

Basionym: *Hypnum tenuifolium* Hedw. 1801, *Spec. Musc.* p.283.

Type: Insulae Australes.

Fig. 201

Soft, rather slender plants, in lax and straggling wefts or in dense, flattened mats, pale or dark green or yellowish green, glossy; stems to 8 cm long, decumbent, irregularly pinnately branched, the branches 1-1·5 cm long, usually somewhat flattened. Leaves (a) 1·5-3 mm long by 0·5-1·5 mm wide, spreading, somewhat shrunken when dry, ovate-cordate, concave, acuminate, the tip sometimes slender and half twisted; margins plane, usually serrulate (c); costa thin, reaching more than half way. Branch leaves smaller and narrower. Cells (b) 60-120 x 7-10 μm, linear fusiform; basal cells (d) shorter and wider, rectangular, porose; no distinct auricles. Seta 1-1·5 cm long, reddish; capsule 2-2·5 cm long, horizontal to cernuous, ovoid oblong to cylindrical oblong, asymmetrical and curved, dark brown; operculum with a long slender, curved beak.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand, S.America. Not uncommon (1, 6, 7, 10), in humid valleys on rock, soil, humus or logs.

Vegetatively and in habit it resembles *Brachythecium rutabulum* and *B.salebrosum*, but differs from both in the base of the leaf not being decurrent. Forms with a long leaf point are particularly easy to confuse with *B.salebrosum;* the presence of fruit with opercula is decisive.

Family **FABRONIACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.102.

Small soft plants, growing on bark or rocks, often silkily glossy, the stems creeping and irregularly branched. Leaves appressed, concave, ovate to lanceolate, acuminate, sometimes ciliate-dentate; costa single, short; leaf cells rhomboid, a large patch at the basal angles quadrate, the quadrate cells usually covering the base of the costa. Seta short; capsule erect, ovoid to oblong; exostome teeth in pairs, rather short, sometimes none; endostome, if present, without cilia. Mainly tropical. Two genera in South Australia. For a detailed account of the peristome structure see Catcheside and Stone (1980).

Key to genera and species:

1. Basal quadrate cells extending 8-10 cells up costa and 22-30 cells up margin; margin entire; cells in mid-leaf 50-100 μm long
Ischyrodon lepturus, p.328

Basal quadrate cells extending only 2-4 cells up costa and 10-14 cells up margin; margin dentate; cells in mid-leaf 30-40 μm long
Fabronia australis, p.325

FABRONIA Raddi 1908, *Atti Acc. Sc. Siena* **9**:230.

Type: *F.pusilla* Raddi.

Slender glossy plants in dense mats, the branches commonly erect. Leaves oval to ovate-lanceolate, acuminate to subulate; margins entire, denticulate or ciliate. Operculum conical, apiculate; exothecial cells usually with undulate walls; peristome single or none, no endostome; exostome teeth ornamented on both surfaces with rows of papillae and longitudinal, oblique or transverse ridges, entire or formed of close rows of papillae; no lamellae on inner face.

Fabronia australis Hook. 1819, *Musc. Exot.* **2**:plate 160.

Type: W.Australia, King George Sound, D.Menzies.

Fig. 202

Small plants in dense patches on bark, pale to olive green; stems 1-2 cm long, creeping, branched irregularly, the branches erect and simple or with a few branchlets. Leaves (a) 0·4-0·75 mm, crowded, imbricate, straight or subsecund, appressed and with the tips spreading slightly when dry, erect when moist, concave, ovate to ovate-lanceolate, acuminate to piliferous; margin plane, entire or serrate (c), sometimes ciliate; costa to mid leaf. Cells (b) 25-50 × 10-12 μm, rhomboid, smooth; basal cells (d) 12-15 μm wide, abruptly distinct from upper cells, very shortly rhomboid rectangular to almost quadrate, forming a distinct area crossing the costa and extending 2-4 cells up it, extending obliquely to the margins and 8-12 cells upwards there. Perichaetial leaves larger, widely ovate, acuminate with hyaline cells; seta 3-4 mm, yellow; capsule 0·4-1 mm, ovoid to oblong, tapered at the neck; exothecial cells transversely rectangular at the rim of the theca (e), lower cells (f) roughly rectangular with undulate walls; operculum conical, apiculate. Peristome teeth short, about 120 μm long, in pairs, the plates (g) ornamented on both surfaces with rows of papillae and

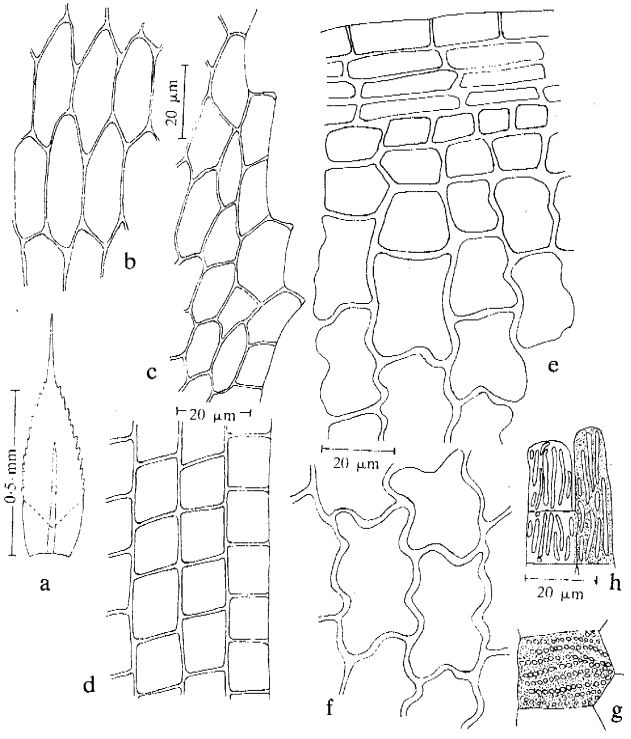


Fig. 202. *Fabronia australis*

ridges, transverse on the lower plates, oblique and then longitudinal on the upper ones (h); inner surface of teeth quite without lamellae; spores 15-18 µm, papillose. Autoecious.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., A.C.T., Qld), New Zealand. Rather rare (6, 7, 12) on trees and shrubs with rough bark, in sheltered valleys and gorges.

ISCHYRODON C.Müll. 1875, *Linnaea* **39:443.**

Type: *I.seriolus* C.Müll 1875, *Linnaea* **39**:444.

A small genus of rather stout plants with only a few species. The type from S.Africa is rather similar to ours. Distinct from *Fabronia* in the larger size and in the ornamentation of the exostome being in the form of anastomosing bars, sometimes bearing papillae, restricted to the outer surface, with the inner surface smooth but for projecting lamellae.

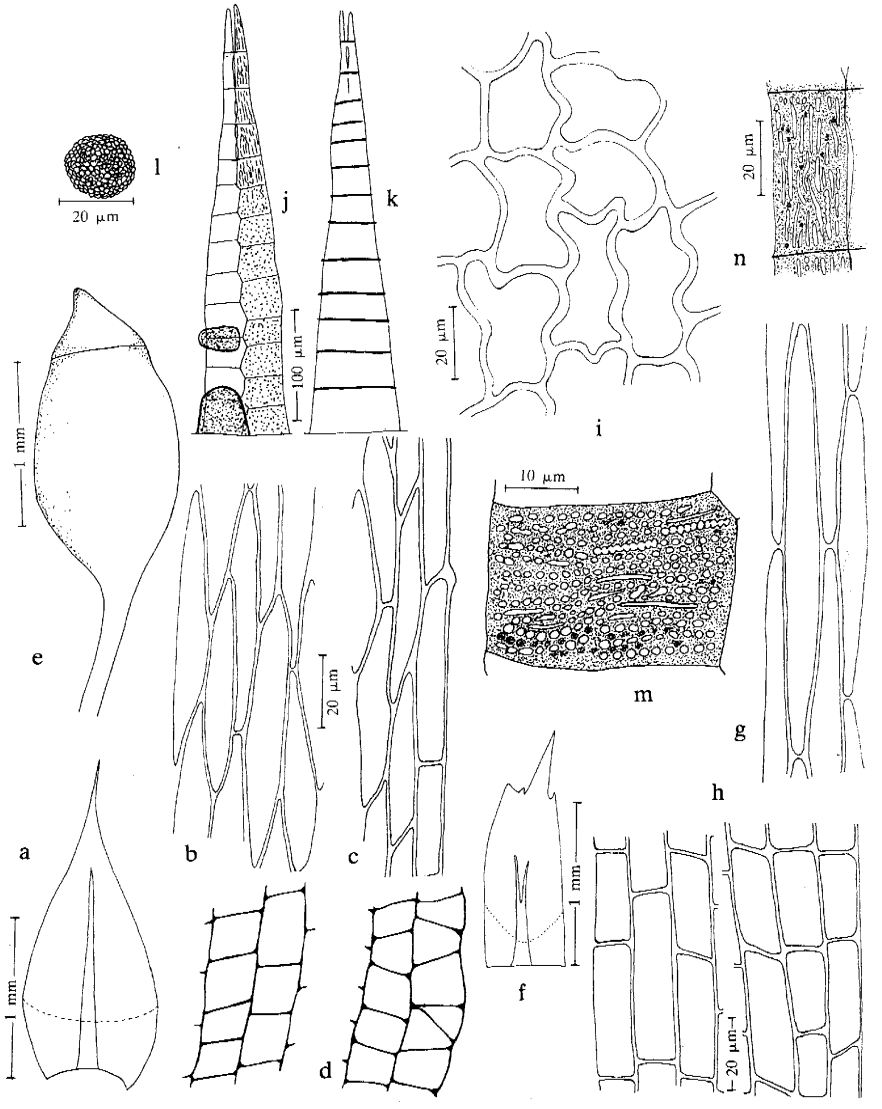


Fig. 203. *Ischyrodon lepturus*

Ischyrodon lepturus (Tayl.) Schelpe 1970, *Contr. Bolus Herb.* **2**:49.

Basionym: *Hypnum lepturum* Tayl. 1946, *London J. Bot.*, **5**:64

Type: Western Australia, Swan River, J.Drummond.

Fig. 203; Plate 15A, B

Dioecious. Rather robust, soft plants, with thick, golden-green branches having a silky lustre. Stems elongated, creeping, beset with rhizoids and densely branched; branches erect, short, flexuous, densely leafy, blunt and scarcely branched again. Leaves (a) 1·25-1·75 mm long, appressed when dry, patent when moist, concave ovate-lanceolate, acuminate, with a long and narrow point; margin plane, entire (c); costa strong, reaching beyond mid leaf. Cells (b) elongatedly rhomboid, 55-80 × 8-10 μm, somewhat shorter towards the margin, where rhomboid to rectangular (c); basal cells (d) subquadrate or slightly rhomboid, usually 10-20 μm long, and 12-20 μm across, in a large, sharply distinct, patch, extending 8-10 or more cells up the costa and 30-35 cells up the margin. Fruit erect (e) borne on a very short lateral branch, very rare. Perichaetial leaves (f) delicate, with an obscure double or single and forked costa, oblong, shouldered near the apex, with one or two teeth on the shoulder and narrowed to a sharp point; upper cells (g) very long and narrow, lower cells (h) rectangular in a sharply differentiated area. Capsule (e) brown, broadly oval, on a short, thick seta, 6-7 mm long; operculum conical, very shortly beaked; exothecial cells (i) with undulate walls. Peristome (j, k) of lanceolate brown teeth, sometimes shorter and blunt, due to breakage; no endostome. Exostome teeth erect when dry, conjoined in pairs, sometimes with patches of preperistome attached to the lower half of the outer face (j); ornamentation of outside of teeth a meshwork of curved ridges with numerous perforations, predominantly transverse in the lower plates (m), but predominantly longitudinal and with vertically elongated slits in the upper segments (n); papillae may be present on the ridges or be scattered on the main meshwork; inner surface of teeth (k) smooth and with weakly developed transverse lamellae. Spores (l) 14-18 μm diameter, chlorophyllose, green in mass, the wall brown and finely verrucose.

Distribution: Australia (W.A., S.A., Vic., N.S.W.), New Zealand. Fairly common (6, 10-12, 17) on rocks in the Mount Lofty and Southern Flinders Ranges, usually in sheltered gorges. Nearly always sterile and growing as a thin silky mat.

Family **SEMATOPHYLLACEAE** Broth. 1908, *Nat.Pfl.* **1**(3):1098.

Plants slender to robust, with stems creeping, procumbent or ascending, irregularly to pinnately branched, usually without paraphyllia. Stem and branch leaves usually similar, sometimes secund or complanate, usually symmetrical, ovate to lanceolate, acute to acuminate; costa none or short and double; upper cells linear or linear rhomboid, prosenchymatous, lower cells shorter, the alar cells enlarged or inflated. Seta long, smooth or papillose; capsule usually inclined to pendulous, ovoid to cylindrical, straight or curved; operculum rostrate; peristome usually double; calyptra cucullate usually.

SEMATOPHYLLUM Mitt. 1864, *J. Linn. Soc. Bot.* **8**:5.

Type: *S.demissum* Mitt.

Rather slender, often glossy, plants in dense tufts. Capsule horizontal to pendulous; peristome double, usually with one rather wide cilium between each pair of processes.

Key to species:

1. Leaves, particularly of branches, falcate and curved down towards the substrate ..... *S.amoenum*, p.330
   Leaves straight or curved up away from the substrate 2
2. Leaves pale yellowish green, tapering to long slender points *S.contiguum*, p.330
   Leaves dark green to bronze, the apices short ..... *S.homomallum*, p.331

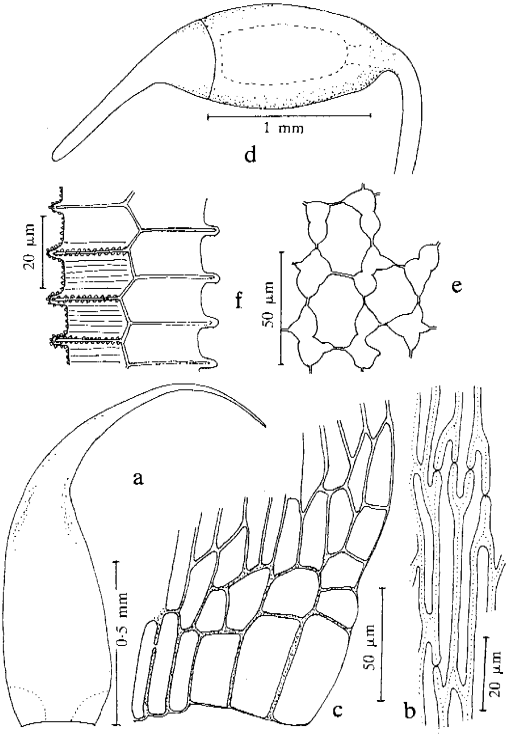


Fig. 204. *Sematophyllum amoenum*

Sematophyllum amoenum (Hedw.) Mitt. 1869, *J. Linn. Soc. Bot.* **12**:487.
Basionym: *Hypnum amoenum* Hedw. 1801, *Spec. Musc.* p.292.
Type: New Zealand.

Fig. 204

Slender, in dense mats on logs, stumps and bases of trees, yellow-brown to yellow-green, glossy. Stems 2-5 cm long, with dense tufts of brown rhizoids on the under side, densely pinnately branched; branches 0·5-1 cm long, obtuse. Leaves (a) 1-1·5 × 0·3-0·4 mm, crowded, decurved falcate, circinate or secund with the base somewhat spreading, hardly altered when dry, ovate-lanceolate to lanceolate, acuminate to a very slender apex; margins plane, entire or denticualte apically; no costa. Upper cells (b) linear, 60-90 × 5-8 μm, incrassate, porose; basal cells (c) shorter, wider and yellowish, the few at the angles large inflated, hyaline, some supra alar cells being quadrate. Perichaetial leaves widely ovate, acuminate, almost piliferous, denticulate above; seta 0·5-1·8 cm long, red and smooth; capsule (d) 1-1·25 mm long without the operculum, orange-brown, horizontal to subpendulous, broadly ovoid, base shortly tapered; no annulus; exothecial cells hexagonal, with large trigones (e); operculum with a long subulate slightly curved beak. Exostome teeth widely lanceolate below and contiguous, narrowed rather abruptly above to a slender, papillose apex; outer surface (f) striolate with a rather indistinct mid line and transverse papillose trabeculae projecting laterally, border hyaline; inner surface with lamellae which project very much in the upper part of the tooth; basal membrane of endostome half the height of the exostome, the processes entire and equal to the teeth, with a short wide cilium between each pair; spores 10-14 μm smooth. Autoecious.

Distribution: Australia (S.A., Vic., Tas., N.S.W.), New Zealand. Rather rare (6), usually on logs and branches in the mountains in sheltered ravines and moist forests.

Sematophyllum contiguum (Mitt.) Mitt. *in* Seem. 1873, *Fl. Vit.* p.398.
Basionym: *Stereodon contiguus* Mitt. 1859, *J. Linn. Soc. Bot.* **4**:87.
Type: Tasmania.

Fig. 205

Slender plants in close mats on rocks, stones or logs; pale whitish or yellowish green, rarely green. Stems 2-4 cm long, irregularly subpinnate, the branches short, incurved and rather cuspidate. Leaves (a) 1-1·5 × 0·3-0·4 mm, loosely imbricate, patent, spreading more when moist, nearly straight or slightly curved, often secund, ovate-lanceolate to lanceolate, finely acuminate, very concave; no costa. Cells (b) above 60-90 × 6-9 μm, narrowly linear rhomboid, with pointed ends, incrassate; basal cells (c) shorter and wider, a few at the angle inflated, oblong, hyaline or pale yellowish, with a few supra basal cells quadrate or irregular in shape. Fruit similar to that of *S.amoenum*. Autoecious.

Distribution: Australia (S.A., Tas., Vic., N.S.W., A.C.T.), New Zealand, S.Africa, Oceania. Rather rare (6), similar in occurrence to *S.amoenum*.

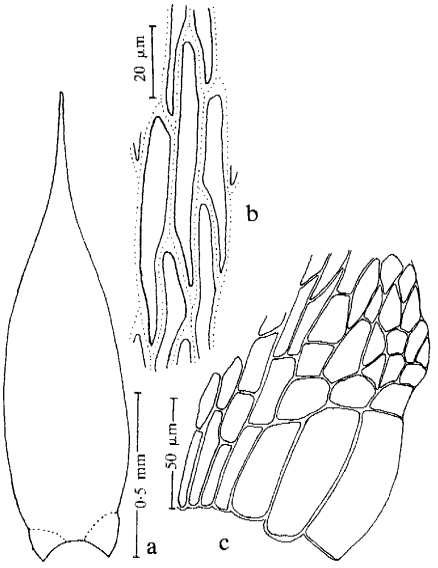


Fig. 205. *Sematophyllum contiguum*

Sematophyllum homomallum (Hamp.) Broth. 1925, *Nat.Pfl.* ed.2, **11**:433.
Basionym: *Leskea homomalla* Hamp. 1844, *Icon. Musc.* pl.6.
Type: Western Australia, on *Banksia menziesii* near Perth, Preiss no. 2465.
Fig. 206; Plate 15C

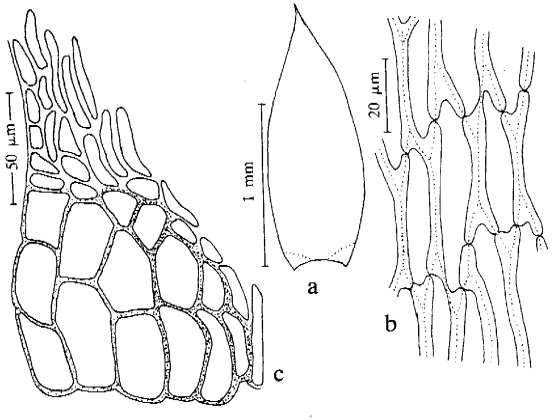


Fig. 206. *Sematophyllum homomallum*

Robust, in dense mats on rocks, logs and bases of trees, glossy, golden brown to golden green. Stems to 3 cm long, flexuous, creeping, branched irregularly, the branches being somewhat cuspidate. Leaves (a) 1·25-1·75 × 0·5-0·7 mm, strongly secund, ovate or oblong, concave, shortly obliquely and bluntly acuminate; margins entire, plane or slightly recurved. Cells (b) 40-80 × 8-9 μm, very incrassate, porose; alar cells (c) numerous in about four rows, orange or yellow, incrassate, the lower ones roughly oblong, the upper polygonal or quadrate, not inflated. Perichaetial leaves erect, lanceolate, entire; seta to 1 cm long; capsule 1·5-1·75 mm long, almost erect, ovate or oblong with a short tapered neck; operculum with a slender beak. Peristome like that of *S.amoenum*, but with a shorter basal membrane to the endostome; spores green, 24-27 μm, finely granular or papillose. Dioecious.

Distribution: Australia (W.A., S.A., Vic., Tas., N.S.W., ?Qld), New Zealand, S.E.Asia, Oceania. Very common (1, 6 -10, 17) on rock, shrubs and the bases and branches of trees in coastal dunes and wet and dry sclerophyll forest.

Family: **HYPNACEAE** Schimp. 1855, *Coroll. Bryol. Eur.* p.113.

Autoecious or dioecious; slender to robust, in mats, tufts or lax coarse wefts. Stems procumbent to erect, usually forked, frequently pinnately branched with the branches in one plane (complanate); paraphyllia and pseudoparaphyllia present or absent. Leaves frequently falcate and secund, smooth or plicate, the stem leaves larger than the branch leaves and usually similar in shape, lanceolate to cordate-triangular, abruptly to gradually tapering to the apex, usually acuminate; margin usually denticulate, at least near the apex; costa double or none, rarely single; basal cells often porose; angular cells generally differentiated, sometimes enlarged, forming auricles; upper cells linear to narrowly ellipsoid. Seta long, usually smooth; capsule erect to horizontal, ovoid to cylindrical, symmetrical or curved; annulus separating usually; operculum conical to mamillate or with a rostellate or subulate beak; peristome double, outer side of exostome teeth transversely striate below, then finely papillose in transverse rows near middle and randomly coarsely papillose above, sometimes with a pale border; endostome with a tall basal membrane, keeled processes and nodose cilia; calyptra usually cucullate.

HYPNUM Hedw. 1801, *Spec.Musc.* p.236, *nom. cons.*

Lectotype: *H.cupressiforme* Hedw.

Slender to robust, tufted, glossy plants; stems irregularly pinnate, the branches hooked at their tips. Leaves falcate, secund, concave, shortly or longly acuminate; costa none or short and double; alar cells distinct. Capsule oblong-cylindrical, curved.

Hypnum cupressiforme Hedw. 1801, *Spec.Musc.* p.291.

Type: Europe.

Figs. 207-209; Plate 16A, B

Extremely variable, growing in tufts or mats on soil, rocks or bark; typically fairly robust, golden brown to yellowish green or green to pale green, usually glossy. Stems 5-10 cm long, procumbent, irregularly pinnate, with the branches usually curved and divergent; stems greenish with very few rhizoids and with a few narrow, lanceolate, subulate pseudoparaphyllia. Leaves (a) to 2·75 mm long, closely imbricate, falcate and secund or circinate, decurved, concave and smooth; ovate-lanceolate or oblong-lanceolate, narrowed to a fine acumen of variable length; base somewhat narrowed and slightly excavate; margin plane, but often slightly recurved basally, entire or denticulate towards the apex; costa none or very short, faint and double. Upper cells (b) linear, 45-90 x 4-9 μm, shorter towards the margins and the apex and base; median basal cells (c) more incrassate and porose, wider, narrowly rhomboid with rounded ends; angular cells (d) numerous, thickly walled to strongly incrassate, quadrate to trapezoid or polygonal or irregular in shape, usually yellowish or hyaline, forming a group about twice as long as wide, not inflated. Perichaetial leaves sheathing, smooth, the outer ones short with divergent apices, the inner ones long, narrowly lanceolate and subulate to piliferous, denticulate. Seta 2-3 cm long, reddish; capsule (e) 2 mm, erect or inclined, obloid or cylindrical, curved especially in the upper part; operculum conical with a rostellate to rostrate or subulate beak; longitudinal walls of exothecial cells thicker than transverse walls; exostome teeth usually reddish brown, pale brown above, transversely striolate below and papillose above. Dioecious; fruit rather rare.

Distribution: Cosmopolitan; Australia (all States, but not N.T.), New Zealand.

Very common and variable. A large number of varieties have been named and in Europe it has been possible to distinguish three species at least. The variations in South Australia appear to group into three main types, with habitat preferences, easily separated by macroscopic appearance. The main difficulty is to find microscopic and anatomical differences that are reliable and not subject to the allegation of intergrading. The following key and short descriptions summarise present views—

1. Median cells of leaf 45-90 μm long; plants rather slender to very robust; operculum rostellate to rostrate 2
   Median cells of leaf 30-55 μm long; plants filiform to slender, the branches parallel to the main stem; operculum shortly rostellate
   var. *filiforme*, p.336
2. Plants green; leaves gradually tapered to the apex .. *H.cupressiforme*, p.332
   Plants yellowish green to bronze; leaves rather abruptly narrowed to the apex ..... var. *lacunosum*, p.335

H.cupressiforme Hedw.

Fig. 207

Plants rather slender to medium sized, green or pale green, growing in rather flat mats, usually on acidic substrates. Leaves (a) ovate-lanceolate, gradually narrowed to a long slender acumen; margin usually plane; angular cells (d) very incrassate. Common (6, 10).

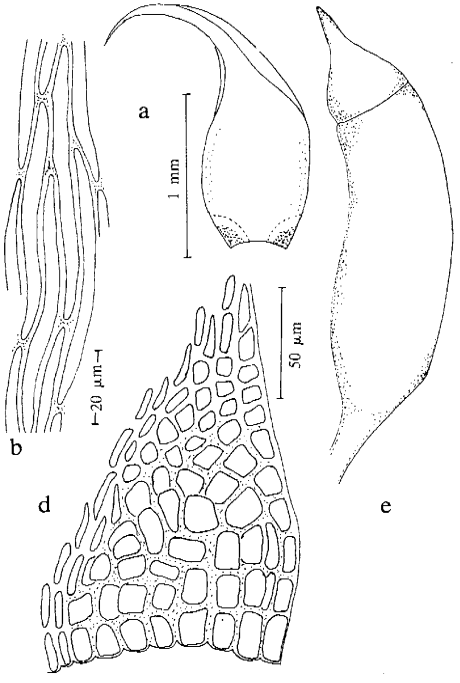


Fig. 207. *Hypnum cupressiforme*

H.cupressiforme var. **lacunosum** Brid. 1801, *Musc. Rec.* **2**:136.

Fig. 208; Plate 16A, B

Plants robust to very robust, dull green to glossy yellowish green or bronze, sometimes in extensive patches, growing in deep, dense carpets, usually on basic substrates. Branches somewhat curved, turgid and julaceous. Leaves (b) large to 3 mm long, broadly ovate to ovate oblong, rather abruptly narrowed to a flat or channelled apex; margin recurved below, denticulate towards the apex; angular cells (d) less incrassate.

Very common (1, 6, 7, 8, 12, 17), especially on the ground in sheltered places. This moss is the one chiefly subject to depredation for horticultural purposes.

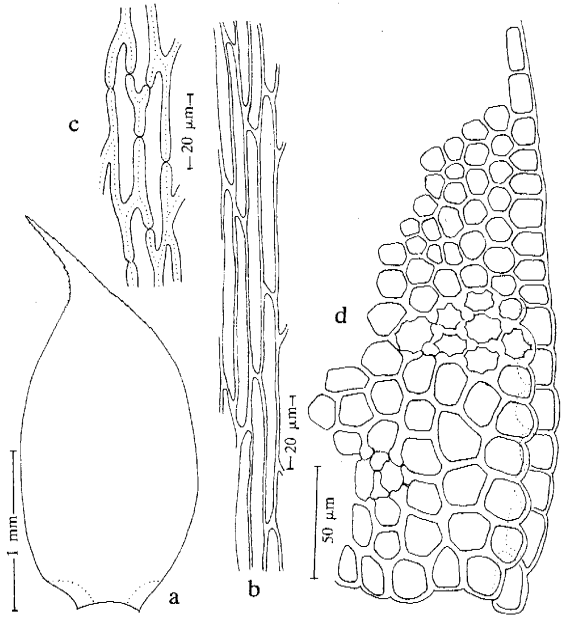


Fig. 208. *Hypnum cupressiforme* var. *lacunosum*

H.cupressiforme var. **filiforme** Brid. 1801, *Musc. Rec.* **2**:138.

Fig. 209

Plants filiform, in green to yellowish green mats, chiefly on twigs, bark and logs, rarely on rock. Stems long, creeping, procumbent or pendent, distantly pinnate with the branches long and parallel to the stem. Leaves (a) small, about 1 mm long, narrowly lanceolate, falcate, secund and decurved, gradually tapered to a long channelled acumen; margin entire or faintly denticulate; cells (b) 30-55 x 5-7 μm, shorter towards the margin, apex and base; angular cells (d) irregular in shape, hyaline, the walls coloured, few in number but forming a distinct group. Capsule (e) slightly curved, oblong ellipsoid; operculum shortly rostellate; exostome teeth light yellow, paler or hyaline apically.

Common (6, 7). This plant may fall into the range of variation of *H.mammillatum* (Brid.) Loeske, but has a rostellate rather than mamillate operculum.

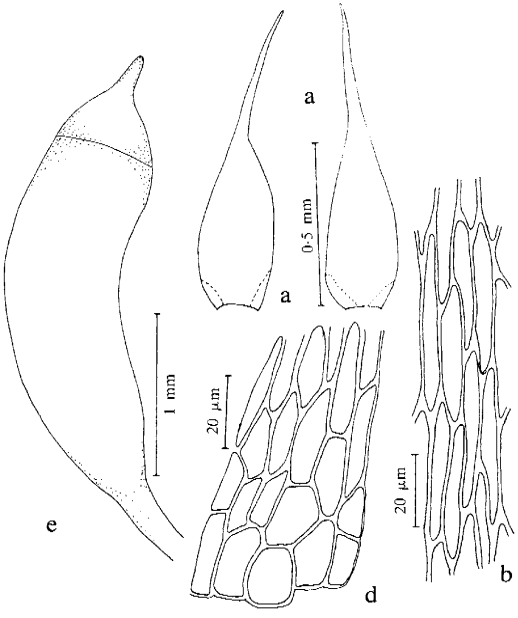


Fig. 209. *Hypnum cupressiforme* var. *filiforme*

GLOSSARY

The earliest works on mosses, as on other plants, were written in botanical Latin (Stearn 1973), which has a vocabulary of words each with a precise meaning. When botanical literature came to be written in English it was customary to anglicise the Latin words rather than translate to words that may have less precise or more diverse meanings. The following glossary defines the technical terms used in this book as applied to mosses and includes other words likely to occur in related literature.

Abaxial: away from the stem or axis, the converse of *adaxial;* see also *dorsal.*

Acrocarpous: with the sporophyte produced at the end of the stem or of a main branch.

Acumen: a long tapering apex; adj., *acuminate* tapered gradually.

Acute: with a sharp point, less than 90°.

Adaxial: toward the stem or axis, the converse of *abaxial*; see also *ventral.*

Adnate: fused with or attached to another organ.

Aerenchyma: tissue with large air spaces between the cells.

Alar cells: cells at the basal angle of a leaf, often distinctive in shape, size or colour.

Alveolate: with depressions of the surface, e.g. of spores.

Amphithecium: the outer embryonic tissue of a capsule, surrounding the central *endothecium.*

Annular: shaped like a ring.

Annulus: the ring or rings of differentiated cells between the mouth of the capsule and the operculum, aiding in dehiscence.

Antheridium (pl. *antheridia*): the male reproductive organ, stalked and globose to ellipsoid or clavate, producing the spermatozoids.

Apex (pl. *apices*): the tip or pointed end; adj., *apical* at or belonging to the apex.

Apiculus: a short abrupt point; adj., *apiculate* with an abrupt short point, longer than *mucronate* and shorter and thinner than *cuspidate.*

Apophysis: the sterile base of a capsule, sometimes swollen or expanded; often called the *neck* when slender or not swollen.

Appendiculate: with short transverse projections, as on the cilia of the endostome.

Appressed: closely applied to the stem.

Approximate: close together.

Archegonium (pl. *archegonia*): the female reproductive organ, flask shaped with a long *neck* and a swollen base (the *venter*) containing the *egg.*

Archesporium: the tissue precursury to the spore mother cells.

Arcuate: curved like a bow.

Areolate: with small angular areas forming a network; the cellular network of a leaf is often called the *areolation.*

Arista: the awn or bristle terminating a leaf, usually formed by an excurrent costa; adj., *aristate* with a bristle.

Articulate: jointed, with thickened joints, as in the peristome.

Ascending: directed upwards obliquely.
Attenuate: tapered very gradually and narrowly.
Auricle: a small bulge or lobe at the basal margin of a leaf; adj., *auriculate* with auricles.
Autoecious (or *autoicous*): with male and female inflorescences separate on the same plant (*monoecious*); differing relations are distinguished as: *cladautoecious*, with the male inflorescence on a separate branch; *gonioautoecious*, with the male inflorescence an axillary bud on the same branch as the female; *pseudautoecious*, with dwarf male plants epiphytic on the female (strictly this is *dioecious*); *rhizautoecious*, with the male inflorescence on a short branch attached to the female by rhizoids and so appearing as a separate plant.
Awn: arista, or bristle point, usually formed of an excurrent costa and frequently hyaline.
Axil: the angle between leaf and stem; adj., *axillary*, in the leaf axil.

Basal membrane: the delicate or robust membrane at the base of the *endostome*, often bearing *processes* and *cilia*.
Bi-: a prefix meaning two; *bicostate*, with two costae; *bifid*, divided into two parts, forked; *bilobed*, with two lobes; *bipinnate*, twice pinnately branched; *biseriate*, in two rows; *bistratose*, in two layers.
Border: a margin differentiated in shape, size, colour or thickness, applicable to the marginal cells of leaves and the edges of peristome teeth; adj., *bordered*.

Bract: one of the specialised leaves surrounding archegonia and/or antheridia.
Brood bodies: structures serving in vegetative reproduction, such as reduced buds (*bulbils*), leaves or branches (*surculi*) or small globose, ellipsoid, clavate or filamentous, septate *gemmae* if aerial, or *tubers*, if subterranean.
Bulbil: a small bud, shaped like a bulb; adj., *bulbiform* shaped like a bulb.

Caespitose: tufted, growing in cushions.
Calciphil: a plant preferring calcareous habitats, as opposed to a *calcifuge* (or *calciphobe*); also *calcicolous*, growing in calcareous habitats.
Calyptra (pl. *calyptrae*): the membranous hood covering a maturing capsule, developed from the archegonium and ruptured near the base, leaving the *vaginula*.
Campanulate: shaped like a bell.
Canaliculate: channelled.
Capitulum: head composed of crowded branches at the apex of the stem of *Sphagnum*.
Capsule: the spore case of the sporophyte, as distinct from *seta* and *foot*, usually differentiated into an *urn*, bearing the spores, a sterile base, the *apophysis* (or *neck*) and an *operculum* (or *lid*) covering the urn.
Carinate: with a keel.
Cartilaginous: thick and tough, used of a border of incrassate elongated cells.
Catenulate: like a chain.
Central strand: the column of narrow elongated cells, sometimes with thicker walls, in the centre of the stem.

Cernuous: nodding or drooping.
Channelled: of a leaf with a groove formed by upturned margins.
Cilium (pl. *cilia*): one of the delicate narrow segments between the processes of the endostome; one of the hair-like teeth fringing leaves or calyptrae; adj. *ciliate.*
Circinate: very strongly curved circularly.
Cirrate or *cirrose:* curled.
Clavate: shaped like a club; slender, elongate and thicker upwards.
Cleistocarpous: without an operculum and therefore not regularly dehiscent, as opposed to *stegocarpous.*
Cochleariform: round and deeply concave, like the bowl of a spoon (Latin, *cochleare*, a spoon).
Collenchymatous: with the cell walls thickened at the corners, the thickened corners being *trigones.*
Colliculate: covered with small, rounded elevations.
Columella: the sterile centre of the capsule, within the spore sac.
Comose: hairy; with leaves, larger and more crowded in tufts (*comae*) at the stem tips; cf. *rosulate.*
Complanate: more or less flattened into one plane or parallel planes.
Complicate: folded lengthwise.
Compressed: flattened.
Conduplicate: strongly folded along the middle.
Conical: shaped as a cone.
Connate: joined together.
Contorted: irregularly twisted and bent.
Convolute: rolled together to form a sheath.
Cordate: heart shape.
Cortex: outer layers of a stem, often differentiated from the central cylinder: adj. *corticate, cortical.*
Corticolous: growing on bark.
Cosmopolitan: inhabiting all floristic regions of the world.
Costa: the rib or *nerve* of a leaf, single or double; adj., *costate*, with a costa; adj., *ecostate*, without a costa.
Crenate: with rounded teeth; *crenulate*, with minute rounded teeth formed from bulging cell walls.
Cribrose: finely perforate, used of peristome teeth.
Crisped (or *crispate*): wavy; often used loosely to include curled, twisted and contorted.
Cristate: crested; with a pale margin.
Cucullate: hooded or the shape of a hood, applied to leaves concave at the tips and to calyptrae which are conical and split up one side; cf. *mitrate.*
Cushion: more or less hemispherical colony, with stems generally erect but radiating somewhat to form a tuft.
Cuspidate: ending in a stout, rigid point, like a tooth.
Cuticle: the outside coating of cells, in contact with the environment, often variously roughened or ornamented.

Cygneous: curved down in the upper part like the neck of a swan.
Cylinder: central strand; adj., *cylindrical.*
Cymbiform: concave and boat shaped; cf. *cochleariform* which is more deeply concave and round.

Deciduous: falling off, lost at maturity.
Decumbent: ascending from a prostrate base.
Decurrent: applied to the margins of leaves which extend down the stem, as ridges or narrow wings, below the insertion of the leaf.
Decurved: curved downward.
Deflexed: bent downward.
Dehiscent: splitting open, as capsules by opercula.
Dendroid: with the branched habit of a tree, from a main stem.
Dentate: with sharp teeth directed outward; *denticulate,* finely dentate.
Denuded: eroded away.
Depauperate: small, stunted, poorly developed.
Depressed: flattened.
Descending: directed gradually downward.
Diaphanous: colourless and transparent.
Dichotomous: with equal forks or branches.
Dimorphous: of two forms.
Dioecious (or *dioicous*): with male and female reproductive organs on separate plants.
Distal: away from the base or place of attachment, the converse of *proximal.*
Distichous: of leaves in two ranks, one on either side of the stem, as in *Fissidens.*
Divaricate: spreading widely from one another.
Divergent: spreading from one another.
Dorsal: the back, lower or *abaxial* surface of a leaf; the outer surface of a peristome tooth; the upper surface of a prostrate plant; *dorsal lamina,* in *Fissidens* the abaxial wing at the back of the costa, opposite to the vaginant laminae.
Dorsiventral: flattened with distinct upper and lower surfaces.

Echinate: bearing spiny projections; *echinulate,* minutely spiny.
Elliptical: the shape of an ellipse, oblong but convex at the sides and ends; *ellipsoid,* a solid with an elliptical profile.
Emarginate: broad at the apex with a shallow notch, deeper than *retuse.*
Emergent: partly exposed, as a capsule only partly protruding from among the perichaetial leaves.
Endemic: restricted to one country or floristic region.
Endostome: the inner peristome of diplolepideous mosses, consisting of *processes* and sometimes *basal membrane* and *cilia;* it is homologous to the single peristome of haplolepideous mosses.
Endothecium: the inner embryonic tissue of a capsule, inside the *amphithecium,* and the source of the *spore sac, columella* and other tissues.
Ensiform (or *ensate*): the shape of a sword.
Entire: with a smooth outline, not toothed or erose.

Epidermis: the layer of cells at the surface of a tissue, e.g. the *exothecium.*
Epiphragm: in Polytrichaceae, the circular membrane, formed of the expanded top of the columella, joining the peristome teeth.
Equitant: straddling like a rider, as in the conduplicate and sheathing leaves of *Fissidens.*
Erect: of leaves, nearly or quite parallel to the stem, but not appressed; of branches or stems, in a more or less vertical position with respect to stem or substrate; of capsules, upright.
Erecto-patent: spreading at an angle of 45° or less.
Erose: irregularly notched or dentate.
Excurrent: extending beyond the apex, as the costa of a leaf.
Exothecium: the superficial layer of cells of the capsule; adj., *exothecial.*
Exospore: the outer layer of the wall of a spore, often ornamented.
Exostome: the outer peristome of diplolepideous mosses, consisting of *teeth.*
Exserted: exposed, as a capsule protruding, on a *seta,* beyond the perichaetial leaves.

Falcate: curved like a sickle; *falcato secund,* strongly curved and turned in the same direction.
Fascicle: a group, bunch or tuft of branches; adj., *fasciculate.*
Fastigiate: with branches nearly parallel and of similar length; erect and columnar.
Fenestrate: with broad openings like windows, more extreme than perforate.
Fibrillose: with fine fibrous thickenings *(fibrils),* as in the *leucocysts* of *Sphagnum.*
Filamentous: like a thread.
Filiform: slender and elongate, as a thread.
Fimbriate: fringed.
Flabellate: shaped like a fan.
Flaccid: soft and limp.
Flagellum (pl. *flagella*): a slender branch, like the lash of a whip; also the organs of swimming of a spermatozoid; adj., *flagelliform.*
Flexuose: slightly and irregularly bent, wavy or twisted.
Foot: the basal absorbing organ of the sporophyte, embedded in the gametophyte.
Foveolate: pitted.
Fringed: with a shortly ciliate margin or edge.
Frondose: closely and regularly branched in one plane, as the frond of a fern.
Fruit: the capsule or sporophyte.
Fugacious: quickly or readily falling or vanishing.
Fusiform: narrow and tapered at each end, the shape of a spindle.

Gametangium (pl. *gametangia*): *antheridium* or *archegonium,* the structure forming gametes *(ovum, spermatozoid).*
Gametophyte: the green, leafy plant; the sexual generation.
Geminate: in pairs.

Gemma (pl. *gemmae*): a small globose, ellipsoid, clavate or filamentous organ of a few cells, borne on the aerial part of the plant, serving for vegetative reproduction.
Geniculate: bent abruptly, as at a knee.
Gibbous: swollen on one side.
Glaucous: with a bluish, greyish or whitish bloom.
Globose: spherical.
Gonium: the group of antheridia and associated paraphyses.
Granulose: minutely grainy, roughened with minute blunt projections.
Gregarious: growing close together in troops, but not in tufts or mats.
Guide cells: large, rather thinly walled cells in the centre of the costa, usually seen in transverse section.
Guttulate: with the cell lumina rounded due to heavy thickening of the walls, so resembling drops of liquid.
Gymnostomous: without a peristome, so the mouth of the urn is naked.
Gyrate: coiled, circinate.

Habit: the general appearance of a plant.
Habitat: the local environment in which a plant lives.
Hamate: hooked.
Heteroecious (or *heteroicous*): with several forms of inflorescence on the same plant or different plants of the same species.
Heteromallous: pointing in all directions, the converse of *homomallous.*
Hexagonal: equally six sided.
Hispid: bristly, with short stiff hairs.
Hoary: greyish or whitish, from numerous hair points.
Homomallous: pointing the same way.
Hyaline: colourless and transparent, commonly lacking chloroplasts.
Hyalocyst: in *Sphagnum,* a large, empty colourless cell which can store water; a synonym of leucocyst.
Hyaloderm: in *Sphagnum,* a cortex of large, empty colourless cells.

Imbricate: closely appressed and overlapping.
Immarginate: without a *border.*
Immersed: covered completely; immersed capsules are below the tips of the perichaetial leaves; immersed stomata have guard cells sunk below the surrounding exothecial cells.
Inclined: applied to capsules that are not vertical, but between erect and horizontal.
Incrassate: thickened, with thick walls.
Incurved: curved upward and inward, the opposite of *recurved,* applied to margins and to leaf tips.
Indehiscent: applied to capsules without an operculum that separates.
Inflated: swollen.
Inflexed: bent upward and inward, the opposite of *reflexed,* both applied to leaf margins and peristome teeth.

Inflorescence: a cluster of sex organs and the specialised leaves that surround them.

Innovation: a new shoot, especially a branch formed after the differentiation of an inflorescence, usually from its base.

Insertion: the line or place of attachment of a leaf, branch or peristome.

Intricate: tangled, interwoven.

Involute: strongly inrolled, opposite to *revolute*, applied to leaf margins.

Isodiametric: about as broad as long, applied to square, rounded or hexagonal cells.

Isophyllous: stem and branch leaves similar.

Julaceous: smoothly cylindrical, like a catkin, applied to shoots with crowded and imbricate leaves.

Keeled: carinate, sharply folded along the middle and usually with a rib.

Lacerate: deeply and irregularly cut or torn.

Laciniate: dissected into fine, deep, often irregular, divisions *(lacineae);* fringed with *cilia.*

Lacunose: with irregular *lumina* due to very porose cell walls; sometimes describing cells with very thick walls, the lumina resembling cavities.

Lamella (pl. *lamellae*): a longitudinal chlorophyllous plate on the costa of the leaves of some mosses; adj., *lamellate.*

Lamina (pl. *laminae):* the blade of the leaf, as distinguished from the *costa.*

Lanceolate: shaped like a lance blade, narrow and tapered from near the base, narrower than *ovate.*

Lanuginose: tomentose, woolly.

Lateral: to the side, as opposed to terminal.

Lax: soft or loose, commonly referring to a tissue of large cells with thin walls.

Leaf trace: the continuation of differentiated cells from the costa through the cortex to the axial strand, as in some species of *Polytrichum; false leaf traces* from the costa end blindly in the cortex.

Leptodermatous: wide thin walls, applied to leaf cells and to the thin and delicate wall of some capsules; the opposite is *pachydermatous.*

Leptoid: a well developed conducting cell, similar in form and function to a sieve tube, found in the stems and setae of Polytrichales and in the setae of many mosses.

Leptome: a tissue, similar to phloem, composed of leptoids and parenchymatous cells.

Leucocyst: a large, empty hyaline cell found in the leaves of *Sphagnum* and *Leucobryum;* a synonym of hyalocyst.

Lid: operculum.

Ligulate: shaped like a strap, with parallel sides and rapidly tapering apex.

Limb: the upper part of a leaf, the lower part being the *base.*

Limbate: with a border.

Linear: very narrow and elongate, with the sides nearly parallel; narrower than *ligulate.*

Lingulate: the shape of a tongue, broad with the sides more or less parallel.

Lumen (pl. *lumina):* the cell cavity.
Lunate or *Lunulate:* crescentic.
Lurid: wan or ghastly pale, usually referring to a dingy yellowish brown colour.

Mamilla (pl. *mamillae):* a protuberance from the cell surface into which the lumen of the cell projects; in surface view appearing like a *papilla;* adj., *mamillose, mamillate.*
Mat: a densely interwoven horizontal type of growth, e.g. *Hypnum.*
Median: middle; *median leaf cells* are those in the upper middle of the leaf or, in leaves with a costa, those between margin and costa about two thirds up the leaf.
Meiosis: the process of nuclear division by which a diploid nucleus yields four haploid nuclei.
Micron (pl. *micra*): micrometre, one thousandth of a millimetre, represented by μm.
Mid leaf: the position about half way up the leaf and mid way between margin and costa or an equivalent position if there is no costa.
Mitrate: conical and undivided or equally lobed at the base, descriptive of calyptrae, as opposed to *cucullate.*
Monoecious (or *monoicous*): with male and female reproductive organs on the same plant, as opposed to *dioecious*; includes *autoecious, synoecious, paroecious* and *polyoecious.*
Monopodial: with a main stem of unlimited growth, with inflorescences lateral.
Mucro: a short abrupt point; adj., *mucronate* ending abruptly in a short point, as in a leaf with a shortly excurrent costa; *apiculate* is somewhat longer; *cuspidate* is longer and stouter.
Multi-: a prefix meaning many.
Muricate: roughened with sharp points; the dimunitive *muriculate* indicates roughened with minute sharp points.
Muticous: without a point or awn.

Nanandry: sexual dimorphism, with dwarf male plants; see *Rhacopilum.*
Neck: the *apophysis*, the sterile basal part of a capsule.
Nerve: costa.
Nodose: knotted, furnished with swellings like knots; the diminutive *nodulose* indicates small swellings.

Ob-: a prefix indication inversion, as in *obovate.*
Oblate: wider than long.
Obloid: a solid with the profile of an oblong; applied to capsules, with rounded edges and corners.
Oblong: rectangular but, applied to leaves, usually rounded at the corners.
Obovate: with the profile of an egg, but the broad end distal.
Obscure: dark, indistinct.
Obsolete: almost lacking, as a scarcely evident *costa.*
Obtuse: broadly pointed, more than 90° angle; sometimes used loosely to mean blunt.
Ochraceous: brownish yellow.

Ochrea: cylinder of thin tissue surmounting the *vaginula.*
Olivaceous: olive-green.
Opaque: dark, not transparent nor translucent.
Operculum: the lid covering the mouth of a capsule, detached at maturity; adj., *operculate.*
Orbicular: nearly circular in outline.
Oval: shortly elliptical.
Ovate: with the profile of an egg, the base broader than the apex, about twice as long as wide.
Ovoid: a solid with an ovate profile.

Pachydermatous: with thick walls, *cf. leptodermatous.*
Panduriform: obovate with a sinus on each side, like the body of a violin.
Papilla: a minute solid protuberance from the cell surface (especially of leaves and spores) of various forms, commonly domed or spinous, simple or branched; adj., *papillate* or *papillose* roughened with one or more papillae. See also *mamilla, prora, scindula.*
Paraphyllia: small, green, filiform to lanceolate or ovate scales borne on the stems or branches of some pleurocarpous mosses; *pseudoparaphyllia* are paraphyllia restricted to where branches arise.
Paraphyses: uniseriate, septate hairs, coloured or hyaline, mingled with the antheridia and also often with the archegonia.
Parenchyma: a tissue of rather undifferentiated cells, usually isodiametric and with thin walls; adj., *parenchymatous* composed of short cells.
Paroecious (or *paroicous*): with the antheridia and archegonia in the same inflorescence but not mixed, the antheridia being immediately below the perichaetium in the axils of the leaves.
Patent: used of leaves spreading at an angle of about 45°; some authors use *patent* for spreading at 26-45° and *patulous* for 46-90°.
Pellucid: clear, transparent or translucent.
Pendent: hanging.
Percurrent: of the costa extending to the apex of the leaf and there ceasing.
Perichaetium: the female inflorescence, composed of perichaetial leaves surrounding the archegonia.
Perigonium: the male inflorescence, composed of perigonial leaves enclosing the antheridia.
Peristome: the single or double ring of teeth borne just inside the mouth of the capsule and revealed after dehiscence; see also *exostome, endostome, process* and *cilium.*
Persistent: not deciduous or vanishing.
Piliferous: with a hair point.
Pinnate: with spreading branches produced rather regularly on either side of the stem, so resembling a feather.
Plane: flat.
Pleurocarpous: with inflorescences produced laterally on short, usually specialized, branches from a monopodial main stem.
Plica (pl. *plicae):* a longitudinal fold or ridge; adj., *plicate.*

Plumose: closely and regularly pinnate and feathery in appearance.
Pore: a pit or opening in a cell wall; adj., *porose.*
Process: a segment of the endostome in diplolepideous mosses, alternating with the exostome teeth, except in *Funaria.*
Procumbent: prostrate.
Propagulum (pl. *propagula):* a reduced bud, branch *(surculus)* or leaf functioning in vegetative reproduction; see also *gemma* and *tuber.*
Prora: a mamillate projection formed by protrusion of the end of a prosenchymatous cell; adj., *prorate.*
Prosenchyma: a tissue composed of parallel, narrow, elongated cells, overlapping at their ends; adj., *prosenchymatous.*
Protonema (pl. *protonemata):* green, branched filamentous (or thallose in *Sphagnum)* tissue formed on germination of a spore or on regeneration from a gemma or propagulum and producing the leafy gametophyte.
Proximal: the end or part nearest the base or place of origin, as opposed to *distal.*
Pseudo-: a prefix meaning false or pretended.
Pseudoparaphyllia see *paraphyllia.*
Pseudopodium: an elongation of the gametophyte stem below the sporophyte in *Sphagnum.*
Pulvinate: like a cushion.
Punctate: dotted, applied usually to spore ornamentation.
Punctulate: minutely dotted.
Pungent: ending in a stiff, sharp point.
Pyriform: pear-shaped.
Quadrate: square or approximately so.
Radicle: rhizoid
Radiculose: covered with rhizoids.
Ramulus (pl. *ramuli):* the smaller, ultimate divisions, of a much branched plant.
Rectangular: about twice as long as wide.
Recurved: curved down and backwards or under.
Reflexed: bent back.
Reniform: shaped like a kidney.
Reticulate: forming a network.
Retort cells : cortical cells in some species of *Sphagnum,* shaped like a retort with a projecting neck, ending in a pore.
Retuse: a broad apex with a slight indentation.
Revoluble: rolling away, applied to an annulus which falls off as a ring.
Revolute: rolled strongly backwards and under, applied to leaf margins.
Rhizautoecious: monoecious with the male inflorescence on a short branch attached to the female branch by rhizoids and so appearing to be separate.
Rhizoid: simple or branched filaments of cells, separated by oblique cross walls, dead at maturity, anchoring the plant and sometimes clothing the stem.
Rhombic: diamond or rhomb shaped.
Rhomboidal: longer and narrower than rhombic, oblong hexagonal.
Rimose: with chinks or cracks.

Rostellate: with a short beak.
Rostrate: with a long beak.
Rosulate: like a rosette, with leaves enlarged and crowded at the tips of stems.
Rugose: with irregular, roughly transverse wrinkles or undulations.
Rugulose: slightly wrinkled transversely.
Rupestral: growing on rocks, *saxicolous.*

Saxicolous: growing on rocks.
Scabrous: rough.
Scalariform: like a ladder.
Scalpelliform: asymmetrical, shaped like the blade of a knife.
Scarious: membranous, dry and thin, papery in texture.
Scindula (pl. *scindulae):* projecting end of prosenchymatous cell, *prora;* adj., *scindulate.*
Scleroderm: the thickly walled cells of the woody cylinder of the stems of *Sphagnum.*
Secund: bent to one side.
Segment: process of *endostome.*
Septate: separated by cell walls; having partitions as in some leucocysts of *Sphagnum.*
Seriate: in rows.
Serrate: regularly toothed like a saw, with the teeth pointing apically; *doubly serrate,* with the teeth in two rows, overlapping and in pairs.
Serrulate: minutely serrate.
Sessile: of sporophytes, without a stalk or seta.
Seta: stalk of the capsule.
Setaceous: like a bristle.
Sheathing: surrounding or clasping the stem or seta.
Shoulder: the distal part of a leaf base where it is abruptly narrowed to the *limb.*
Sinistrorse: twisted spirally to the left.
Sinuate or *sinuose:* of cells, with wavy walls; of the leaf margin, wavy but not toothed by projecting cell walls.
Sordid: having a muddy or dirty colour.
Spathulate (sometimes *spatulate):* the shape of a spatula, narrow below and broad above.
Spermatozoid: male gamete, bearing two flagella in all bryophytes.
Spinose: with sharply pointed teeth.
Spinulose: with minute sharply pointed teeth.
Spore: minute, usually spherical, haploid body produced in the capsule and giving rise on germination to *protonema.*
Sporophyte: the diploid generation consisting of *foot, seta* and *capsule,* epiphytic on the haploid generation (the *gametophyte).*
Spreading: of leaves at 46-90° to the stem; *widely spreading* nearly 90°.
Squarrose: of leaves with the upper part strongly curved back at about 90° from the lower part of the leaf.
Stegocarpous: with a differentiated operculum, dehiscent, as opposed to *cleistocarpous.*

Stellate: shaped as a star.
Stereid: slender, elongate cell with very thick walls present in the costa of many mosses; sometimes applied also to marginal cells that are linear with thick walls.
Sterile: strictly without gametangia, loosely without capsules.
Stolon: a slender, elongated branch, with smaller often distinctly differentiated leaves, by which a colony may spread.
Stoloniform: stems arching and touching the substrate at points where they "root" down by forming rhizoids.
Stoma (pl. *stomata):* pore surrounded by two guard cells, in mosses restricted to the capsule and especially to the apophysis.
Stramineous: straw coloured.
Stria (pl. *striae):* a fine line or ridge; adj., *striate.*
Strict: straight and rigid.
Striolate: very finely ridged.
Struma: a swelling at the base of a capsule; adj., *strumose.*
Sub-: a prefix meaning nearly, almost or somewhat, as in *subacute, subentire* and *subquadrate;* also meaning under or below, as in *submedian.*
Subula: a long, slender, needle shaped point; adj., *subulate.*
Sulcate: with longitudinal folds or ridges, stronger than *striate.*
Superficial: of stomata in the same plane as the surface of the epidermis.
Surculus: a twig, applied to outgrowths from a horizontal rhizomatous primary stem and to the deciduous branches of species of *Philonotis.*
Sympodial: main stem of limited growth, further growth by branches *(innovations).*
Synoecious (or *synoicous):* with antheridia and archegonia mixed in the same inflorescence.

Teeth (sing. *tooth):* divisions of a peristome; serrations of a leaf margin.
Terete: smoothly cylindrical, round in cross section.
Terrestrial: strictly growing on soil, loosely not growing in water.
Tessellated: chequered in a pattern of squares, as the basal membrane of *Tortula.*
Tetrad: a group of four spores derived from one spore mother cell by *meiosis.*
Thalloid (or *thallose):* composed of a flat plate of tissue.
Theca: the *urn;* the part of the capsule in which spores are produced, as opposed to the apophysis and operculum.
Tomentose: densely woolly with a felt of abundant, long rhizoids.
Trabecula (pl. *trabeculae):* a cross bar on the inner surface of an exostome tooth; adj., *trabeculate.*
Tri-: a prefix meaning thrice; *triquetrous* three cornered; *trifarious, tristichous* in three rows.
Trigone: the thickened corner between adjacent cells.
Trilete spore: with a three-pronged scar on the wall, as in *Sphagnum,* the scars being where the spores of a tetrad were in contact.
Triradiate: three-pronged, as the scars of a *trilete spore.*
Truncate: cut off abruptly or squarely at the apex.

Tubular (or *tubulose):* of leaves with margins inrolled and overlapping to form a tube.
Tuft: a clump of more or less erect shoots.
Tumid: swollen or inflated.
Turbinate: shaped like a top, broadly pyriform with a rather flat top.
Turf: a tufted form of growth, with stems erect and parallel, in rather extensive patches.
Turgid: swollen or plump.

Umbonate: convex with an abrupt, rounded central point.
Uncinate: hooked.
Undulate: wavy, less extreme than *rugose.*
Unguiculate: ending in a point like a claw.
Uni-: prefix meaning one; *unilateral* one sided; *uniseriate* in one row; *unistratose* cells in one layer only.
Urceolate: the shape of an urn, applied to capsules narrowed below a wide mouth, then widened and sharply narrowed at the base.
Urn: theca, the part of the capsule bearing the spores.

Vaginate: sheathing; *vaginant lamina,* in *Fissidens,* the adaxial part of the leaf that sheaths the stem.
Vaginula: the sheath at the base of the seta, derived from the basal part of the venter of the archegonium.
Venter: the swollen part of archegonium, containing the egg.
Ventral: as opposed to *dorsal,* the adaxial side of a leaf, the inner surface of a peristome tooth, the under surface of a prostrate plant.
Vermicular: worm like; long, narrow and curving.
Verruca: a wart; applied to rather broad flattened papillae on spores; adj., *verrucose* roughened; *verruculose* roughened irregularly.
Vesiculose: inflated.
Vitta (pl. *vittae):* stripe; adj., *vittate.*

Weft: a loosely interwoven growth, often somewhat ascending.
Whorled: arranged in a circle.
Widely spreading: of leaves spreading from the stem at a wide angle, of nearly 90°.

Xerophyte: a plant of dry, often hot places, adapted to survive; adj., *xerophytic.*

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SUBJECT INDEX

TAXONOMIC INDEX

Principal references to descriptions of taxa are in bold; page numbers of text figures are added in brackets; synonyms, excluded and exotic taxa are in italics