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A TAXONOMIC REVISION
OF
BRYUM BILLARDIERI SCHWAEGR. AND RELATED SPECIES

Thesis submitted to the University of Glasgow
for the degree of Doctor of Philosophy
in the Faculty of Science

by

M. A. HAJI MOHAMED

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Summary

A taxonomic revision of B. billardieri Schwaegr. and the species commonly confused with it has been carried out. It has been found to be a complex of 16 species and 2 varieties. These are: B. billardieri Schwaegr. var. billardieri, B. billardieri Schwaegr. var. platyloma Mohamed, B. neelgheriense Mont. var. neelgheriense, B. neelgheriense Mont. var. wichurae Broth., B. andicola Hook., B. truncorum (Brid.) Brid., B. erythrocaulon Schwaegr., B. ekmanii Thér., B. ramosum (Hook.) Mitt., B. pycnophyllum (Dix.) Mohd., B. appressum Ren. et Card., B. sinense Mohd., B. subfasciculatum (Hamp.) Mitt., B. microrhodon C. Muell., B. perlimbatum Card., B. goudotii Hamp., B. torquatum Mohd. and B. lagarocarpum Mohd. B. sinense, B. torquatum and B. lagarocarpum are described as new species, while B. billardieri var. platyloma and B. neelgheriense var. wichurae are described as new varieties. B. pycnophyllum is proposed as a new combination. All have been fully described and figured and their geographical distribution recorded. Identification keys are also provided.

Some of the plants in the complex either fruit rarely or do not fruit at all. Therefore, attempts have been made to identify the plants in the sterile condition. Tubers and filamentous gemmae have been found to be important characters for differentiating the various species in the vegetative condition.

Efforts were made to cultivate B. billardieri var. billardieri, B. billardieri var. platyloma, B. andicola, B. neelgheriense var. neelgheriense, B. neelgheriense var. wichurae on agar in the laboratory. The plants maintained their typical vegetative characters in culture. However, only B. andicola produced tubers while filamentous gemmae were not produced at all in culture.

The geographical distribution of the species in the complex shows that it consists of three closely related ones which form the complex proper.

These are B. billardieri in the Southern Hemisphere, B. andicola in America and Africa and B. neelgheriense in Asia. The remaining species are less closely related to these.

Probable affinities between the species in the complex, continental drift as a cause of disjunct distribution and occurrence of plants of only one sex in certain geographical areas are also discussed.

INTRODUCTION

Bryum, which is the largest moss genus, is taxonomically notorious as difficult. One of the reasons for the difficulty encountered in species differentiation within this genus is that a large number of species are separated by minute and indistinct and yet apparently constant characters such as the shape of the leaf, size of the border of the leaf and shape of the capsule. The range of variation shown by each and every one of these minute characters over the range of this largest genus, is much more limited than in far smaller genera. The systematics of this genus is further made difficult by the fact that the range of variation of a single character within a particular species is wide, and usually overlaps into other species.

Not realising that the plants in the genus Bryum exhibit a wide range of variation within a single species, uncritical nineteenth century taxonomists such as Carl Mueller described numerous species within Bryum. Many of the species within this genus have been examined more critically in recent years either by region (Ochi 1957, '59, '67, '68, '70, '72) or by systematic affinities within the genus (Crundwell & Nyholm, 1964 with the erythrocarpa and Syed, 1973 with the Bryum capillare agg.). As a result of these studies, many species have been reduced to synonymy and a comparatively less complex picture of the genus has been produced. However, there are still many more species in this genus which need to be critically studied. It is believed that many of the species will succumb to careful investigation and thus be reduced to synonymy with the result that a simpler picture of the genus will emerge.

One of the groups of species of Bryum which has been the cause of much confusion for a very long time is the plants which resemble and are related to and commonly confused with either Bryum billardieri Schwaegr. or B. truncorum (Brid.) Brid. For ease of reference, I have called these

plants the 'Bryum billardieri complex' and they will be referred to as such or as merely 'the complex' from now on. The aim of this present study is to provide a clear picture of the plants in the B. billardieri complex and add to the knowledge of their characters and distribution.

Bryum billardieri Schwaegr. was described as a new species by Schwaegrichen in 1816, based on plants collected from 'Novo Belgio' (now believed to be Tasmania), and B. truncorum (Brid.) Brid. was described by Bridel in 1817 under Mnium based on plants collected in Réunion Island. Since 1817, numerous new species have been described in the genus Bryum, many of which have been relegated to synonymy with plants in the Bryum billardieri complex in recent years. A considerable synonymy, totalling nearly 100 species, has built up around the complex. The plants in this complex are to be found all over the world between the latitudes of 40°N and 60°S with the exception of Europe and U.S.S.R. Since these plants are distributed world-wide, the revision of the group has also to be done on a world-wide scale.

This group has not been studied on a world-wide scale previously although similarity of morphological features has led various workers to name the plants found in various parts of the world as B. billardieri or B. truncorum. In his monographs on the Bryoideae of selected geographical regions, Ochi (1957, '59, '70, '72) has studied the B. billardieri complex and reduced numerous species to synonymy with either B. billardieri or B. truncorum. Most of the synonyms are new and have not been indicated in the Index Muscorum. At this juncture, a particular debt of gratitude is owed to Dr. H. Ochi who has made this taxonomic revision much easier by indicating in his revisions of the Bryoideae the appropriate species that should be examined for the world-wide revision of this complex. It is hoped that this study of the B. billardieri complex on a world-wide scale will help to fill in the gap of knowledge concerning the range of distribution and systematic affinities of the species in the complex.

Since plants with systematic affinities are found in the same or adjacent regions, the knowledge of the range of distribution of the species will help to understand the systematic affinities between species in the complex.

In the past, the plants in the B. billardieri complex were often called either B. billardieri or B. truncorum. B. truncorum was believed to have a wide distribution. Hooker f & Wilson (1854) gave the name B. truncorum to the New Zealand plants and Dixon (1926) agreed with them, saying "Hook. f & Wils. were quite correct in giving Bridel's name to this". Sim (1926) included B. truncorum in the moss flora of South Africa. Later, Andrews (1940) recognized it to be related to B. canariense Brid. and as having the distribution through "South and Central America and Mexico and the West Indies; also generally through the Southern Hemisphere; reaching our area in Arizona.....also found in Texas.....". Bartram (1949) followed Andrews' interpretation of this species, of which he says, "a happy solution of a complex problem". Sainsbury's (1955) concept of B. truncorum seems to be similar to that of Andrews' and he says of its distribution, "wide in Northern and Southern Hemispheres". Andrews' concept of this species was accepted and adopted by Crum & Steere (1957), Bartram & Crum (1958), Florschütz (1964) and Crum et al. (1965).

Ochi (1957) reported the mosses of this complex under the name of B. ramosum (Hook.) Mitt. He was one of the first bryologists to notice similarity and affinity among the mosses of this group in the region extending from Japan to India on the East, Fiji on the West and Australia in the South. He proposed that the mosses in the group should be divided into several varieties on the basis of leaf morphology. Later, he (1959, '67, '68 etc.) reported these plants in the complex under the name of B. truncorum. In 1970, Ochi reduced B. truncorum to a synonym of B. billardieri Schwaegr. Then in 1971, he studied the type material of B. truncorum and concluded that it was specifically distinct from B. billardieri and that its distribution is restricted to Réunion Island and Madagascar. He further

stated that plants hitherto named B. truncorum from other areas should be transferred under B. billardieri. Gangulee (1974) in his treatment of the complex in India, has reduced B. truncorum to a synonym of B. billardieri along with numerous other species. Scott & Stone (1976), however, maintain the species concept of B. truncorum and B. billardieri as established by Ochi (1971).

Ochi (1967, '68, '70, '72) has based his differentiation of species in the genus Bryum predominantly on the basis of leaf morphology. Though leaf characters are extremely useful in species discrimination, these when used by themselves are not too reliable because they tend to be very variable according to the prevailing ecological conditions. Ochi has not paid any attention to tubers and filamentous axillary gemmae as organs of taxonomic value. The size and morphology of these vegetative reproductive units have been predominantly, if not exclusively, used by Crundwell & Nyholm (1964) in interpreting the taxonomy of the B. erythrocarpum complex, and by Syed (1973) with the B. capillare aggregate. Whitehouse (1966) in his studies on the tubers of European mosses has shown that the characters of tubers such as size, shape, colour and position can be used to determine a species with a high degree of accuracy. Up to the present, no report has been made on the occurrence of tubers in the plants of the complex, although the presence of filamentous gemmae in the plants from Hawaii (Bartram, 1933), Puerto Rico and Virgin Islands (Crum & Steere, 1957), and Surinam (Florschütz, 1964) has been reported. However, not much taxonomic significance seems to have been attached to the presence of the filamentous gemmae.

Tubers and filamentous gemmae have been found to occur in a large number of species in the complex. B. billardieri var. billardieri, B. billardieri var. platyloma, B. truncorum, B. sinense, B. erythrocaulon, B. andicola, B. perlimbatum, B. subfasciculatum, B. ramosum, B. appressum, B. neelgheriense var. neelgheriense and B. torquatum all produce tubers while B. pycnophyllum, B. lagarocarpum, B. microrhodon, B. ekmanii, B. neelgheriense var. wichurae, B. goudotii have not been observed to possess

them. Filamentous gemmae are seen only in B. andicola, B. neelgheriense var. neelgheriense, B. neelgheriense var. wichurae and B. sinense. Possibly the largest tubers in the genus Bryum are found in the plants of the B. billardieri complex. Tubers of B. billardieri var. platyloma, B. billardieri var. billardieri, B. andicola and B. neelgheriense var. neelgheriense reach a diameter of 1 mm or more. If the tuber is large, there is a consequent reduction in the number of tubers present on the plant. Further, the larger tubers are often attached to the base of the plant or found on the largest rhizoids. In plants with small tubers there are more of them and they are often attached to the smaller rhizoids. The characters of the tubers which I have found to be taxonomically important are the diameter of the tuber, the colour and the number of cells counted across the tuber.

The use of the rhizoid gemma or tuber as a taxonomic character is not easy. The tuber may not always be present, sometimes because the collector has been overzealous in washing the rhizoids free of all soil, and along with it the tubers; sometimes because the tubers, for various unknown reasons, may be produced for only a certain part of the life-cycle of the plant. Fewer tubers are borne on fruiting plants than on those which are not. Apparently production of tuber ceases when the plant starts fruiting. Factors which control the production of tubers and filamentous gemmae are not fully understood.

Since some of the tuber-producing plants grow in close proximity, their rhizoids may be intertwined and a connection between the tubers and parent plant cannot always be established. To demonstrate a connection between the tuber and the parent plant, it is necessary to grow the plants from their gemmae in the laboratory. Since all of the species involved in this study are found outside Britain, there was difficulty in obtaining fresh specimens to be used in laboratory culture. However, fresh specimens

of B. billardieri from Australia and New Zealand, B. andicola from Tanzania, Jamaica, Mexico and Hawaii, B. neelgheriense var. neelgheriense from South India and B. neelgheriense var. wichurae from Japan were obtained. Attempts were made to grow them in conditions of approximately constant temperature and illumination on a modified Knop's Agar medium (Crundwell & Nyholm, 1964) (KCl, 60 mg.; $MgSO_4 \cdot 7H_2O$, 90 mg.; $Ca(NO_3)_2 \cdot 4H_2O$, 100 mg.; KH_2PO_4 , 60 mg.; $NaNO_3$, 36 mg.; agar agar 2 g.; distilled water, 100 ml.). Cultures were attempted from shoot apices, spores and tubers. B. billardieri var. billardieri from Australia was grown from shoot apices but no tubers were ever produced. B. billardieri var. platyloma from New Zealand was grown from tubers, and typical B. billardieri plants were produced but these plants in turn refused to produce tubers in culture. B. andicola from Tanzania, Hawaii, Mexico and Jamaica were grown from spores and tubers and these did produce typical tubers in culture. Spores were used in the culture of B. neelgheriense var. neelgheriense plants but the felt of protonemata did not differentiate into shoots. B. neelgheriense var. wichurae from Japan was grown from shoot apices but no tubers were ever produced. It was also noticed that filamentous gemmae were not produced in culture although the parent plants possessed them. Not all the plants of a particular species which as a general rule possesses filamentous gemmae will produce them in the natural habitat. It was noticed that plants growing on logs and trees in the shade tend to possess filamentous gemmae more frequently than plants which grow on soil in the open. Obviously more research has to be done on the factors affecting the production of tubers and filamentous gemmae. However, examination of a large number of specimens from different parts of the world has shown that tubers of a particular size and morphology were specific to the particular plant producing them.

Rhizoid characters have been noted to be taxonomically significant (Crundwell & Nyholm, 1964 and Syed, 1973) in distinguishing species.

I have found rhizoid characters not to be of prime importance in the taxonomy within the B. billardieri complex, though the rhizoid colour and papillosity have been found to be additional characters on which species discrimination can be made.

The leaf, unlike the sporophyte, being an organ which is present for most of the mature stage of the life-cycle, is important as an organ of taxonomic value. The leaf characters are extremely variable depending upon the habitat of the plant. Certainty of any character of leaf can only be based upon the examination of a large number of specimens. I have been able to examine a large number of specimens of most of the species treated in this study and description of characters of organs are based on the examination of a large number of specimens. However, only few packets of specimens were available in the case of B. goudotii and B. lagarocarpum but the characters were so distinct that they could be established as good species. All the descriptions of the leaf characters are based upon the mature leaves at the middle portions of stems of mature gametophytes.

Sporophyte characters have been also useful but to a lesser degree than those of the gametophyte. This is because some of the species included in this study do not fruit and were found sterile, while others fruit rarely. Although over 100 packets of B. neelgheriense var. wichurae, B. sinense and B. ramosum from Japan have been examined, no sporophytes have been observed in any of them. However, B. ramosum produces sporophytes when growing in the Himalayan foothills and B. sinense also produces sporophytes when growing in China. Neither female plants nor sporophytes have been observed on B. torquatium from Brazil and Jamaica and B. andicola from Hawaai.

There is field evidence that hybridisation between closely related species in the genus Bryum is more frequent than is commonly assumed (Nyholm, 1958). Hybridisation may result in populations having abnormal characters of the sporophyte and also of the gametophyte. I believe that

hybridisation may hold the answer for the polymorphous nature of species such as B. billardieri. Any investigation into the occurrence and effects of hybridisation in the B. billardieri complex will pay off handsomely in understanding the taxonomy of this group.

I have not carried out any cytological work on any of the species. Ramsay (1967, '74, '77) reported chromosome numbers for B. billardieri from Australia and Tasmania. Four chromosome races were reported, $n = 10$, $(10 + m) 11$, 20 , and $(20 + m) 21$. The specimens on which chromosome counts had been made were obtained and examined. It was found that B. billardieri had chromosome counts of only $n = 10$ and $(10 + m) 11$ while the specimens having $n = 20$ and $(20 + m) 21$ were in fact B. capillare Hedwig which had been misidentified. One of the specimens having $n = 10$ was found to be B. subfasciculatum (Hamp.) Mitt. Despite careful comparative examination of B. billardieri specimens having $n = 10$ and $(10 + m) 11$, no appreciable morphological differences were found. Pande & Chopra (1958) and Kumar (1973) reported chromosome counts for B. ramosum (Hook.) Mitt. from the Himalayas, India to be $n = 10$. There are no reports of chromosome counts for other species of the complex.

The plants in the Bryum billardieri complex were placed in Section Rosulata by Brotherus (1924) with the exception of B. perlimbatum Card. and B. valdiviae Lor. (= B. billardieri), which he placed in Section Trichophora. Most of the plants in Section Rosulata are large and approach the size of the plants in the genus Rhodobryum. Various characters such as plant size, rosulate foliation, subterranean stolons, sporophyte number in a single perichaetium, etc., have been mentioned as peculiar characters of the genus Rhodobryum. Many plants in the B. billardieri complex also possess these characters. The smaller species of Rhodobryum can be much smaller than the larger forms of the plants in the B. billardieri complex such as B. billardieri Schwaegr., B. neelgheriense Mont. and B. truncorum (Brid.) Brid. Rosulate foliation is a common character of most of the plants in this complex. A

number of species in the complex produce several sporophytes in a single perichaetium. Such similarities in characters are probably the reasons which led Paris (1904) to transfer a large number of the plants in the B. billardieri complex to the genus Rhodobryum. Many of the species have since then been transferred back to the genus Bryum. In the course of the present study, a large number of the plants of genus Rhodobryum were found to have been wrongly identified and placed under the B. billardieri complex and vice versa. Judging from the large number of misidentified specimens, it is obvious that the differences between the genus Rhodobryum and plants of the Bryum billardieri complex are not clear-cut. It can be said that the B. billardieri complex is the 'link' between the genus Bryum and genus Rhodobryum. Ochi (1972) reduced the status of Rhodobryum to a subgenus of Bryum.

I have differentiated the genus Rhodobryum on the basis of plant size and a general appraisal of the characters of the whole plant. Some of the plants in Rhodobryum possess filamentous gemmae but tubers have not been observed on them at all.

I have tried to examine the type specimens of all the species in the complex, including all those now reduced to synonymy. Only a few type specimens could not be located, and even if they were located, I believe they would not affect the nomenclature of the species treated in this work.

For distributional data of the species, the species examined, limited to one or two records from each state, province or other geographical unit, following present-day boundaries, have been listed after each species. The locations of the specimens have been indicated by means of the Index Herbariorum abbreviations, for the private herbaria and for specimens collected by living bryologists, the owner's initials.

The following characters are generally true for all the species included

in this revision:

Plants moderately large to large, tomentose below; if tubers present, never axillary, tuber cells never protuberant; axillary gemmae if present, septate and filamentous; leaves often crowded in a rosette at least on fertile stems ("rosulate"), distant and smaller below, obovate-spathulate to obovate-lanceolate, erect to erect-spreading; toothed in upper margin, recurved below; border present; basal cells quadrate to rectangular, upper cells rhomboid-hexagonal.

Dioecious. Perigonial leaves ovate, smaller than vegetative leaves; perichaetial leaves lanceolate.

Capsule cylindrical to ovate, yellowish to brownish, suberect to pendulous; outer peristome teeth yellow with reddish tinge at the base, paler above; striations on the outer surface of teeth not forming any definite pattern; inner peristome pale yellow, finely papillose; teeth perforated; cilia well developed, appendiculate.

Spores round, papillose.

CHAPTER 2

Section I

KEY TO THE SPECIES

1. Filamentous gemmae present in the axils
of the leaves. 2
Filamentous gemmae absent. 5
2. Tubers present. 3
Tubers absent. 2b. B. neelgheriense var. wichurae.
3. Tubers large, mostly 200 - 1000 μ m
in diameter, over 10 cells across. 4
Tubers 80 - 180 μ m in diameter,
3 - 7 cells across; leaves tinged
with red at base, along nerve and
at edges; calcicolous. 10. B. sinense.
4. Leaves longly obovate-spathulate,
not strongly twisted around stem
when dry, leaf apex long acuminate,
never mucronate; nerve long
excurrent; nerve of perigonial
leaves long excurrent; capsule
lid long conical. 2a. B. neelgheriense var.
neelgheriense.
- Leaves short obovate-spathulate,
strongly twisted around the stem
when dry, leaf apex acute or short
acuminate, often mucronate; nerve
short excurrent; nerve of perigonial
leaves short excurrent; capsule lid

- short conical.
5. Tubers present. 6
Tubers absent. 14
6. Leaf border wide, up to 10 rows of elongated cells. 7
Leaf border narrow, up to 4 rows of cells only. 12
7. Tubers abundant, 80 - 160 μm in diameter, 5 - 9 cells across; leaves up to 3.5 mm long; nerve long excurrent in a flexuose arista, margin crenulate above; antheridia only at the tip of branches. 13. B. perlimbatum.
- Tubers larger than 180 μm in diameter, more than 8 cells across; leaves up to 7 mm long, margin dentate above. 8
8. Tubers 200 - 500 μm in diameter, 6 - 11 cells across; leaves arranged along stem, often folded upon themselves at apex, carinate; upper margin dentate for up to $\frac{1}{2}$ of leaf. 11. B. subfasciculatum.
- Leaves densely set at apex; upper margin dentate for $\frac{1}{3}$ of leaf or less. 9

9. Leaves appressed to stem; upper margin toothed for less than $\frac{1}{4}$ of the length of leaf; lower margin recurved for $\frac{3}{4}$ or more of length of leaf; border hardly distinct; nerve short excurrent. 10
- Upper margin of leaf dentate for at least $\frac{1}{4}$ of leaf; lower margin recurved for $\frac{2}{3}$ of length of leaf or less; border distinct; nerve moderately to longly excurrent. 11
10. Tubers 200 - 350 μm in diameter, tuber cells 5 - 8 across; leaves strongly twisted around stem. 15. B. torquatum.
- Tubers 170 - 390 μm in diameter, tuber cells 7 - 11 across; leaves not twisted around the stem, dark and brittle when dry. 9. B. appressum.
11. Tubers red to dark red, often dark when dry, 216 - 402 μm in diameter, 5 - 13 cells across; leaves shrinking when dry; nerve long excurrent; capsule asymmetrical. 7. B. ramosum.
- Tubers orange to red, 290 - 580 μm in diameter, 10 - 20 cells across; leaves not shrinking when dry; nerve shortly to moderately excurrent; capsule symmetrical. 5. B. erythrocaulon.

12. Tubers up to 940 μm in diameter, up to 23 cells across; lower margin recurved.

13

Tubers up to 320 μm in diameter, 8 - 14 cells across; leaf apex long acuminate; never mucronate; lower margin plane or slightly recurved.

4. B. truncorum.

13. Leaf apex acute to acuminate, sometimes mucronate; excurrent nerve short to moderately long; border narrow, not more than 4 rows of cells.

1a. B. billardieri var. billardieri.

Leaf apex acuminate, never mucronate; excurrent nerve moderately long; border wide, up to 8 rows of cells.

1b. B. billardieri var. platyloma.

14. Nerve of leaves vanishing below apex; decurrent.

14. B. goudotii.

Nerve of leaves excurrent.

15

15. Plants large, up to 3.5 cm high; leaves up to 5.3 mm long; upper margin dentate; nerve long excurrent.

16

Plants small, up to 2 cm high, leaves up to 3.2 mm long; nerve moderately excurrent; upper margin crenulate; lid of capsule subhemispherical.

17

16. Leaves strongly twisted around stem; nerve long excurrent; whitish tinge along edges of leaf and nerve; carinate; border 2 - 4 rows of cells wide; upper cells wide, up to 24 μm wide.

8. B. pycnophyllum.

Leaves not strongly twisted around stem; nerve moderately excurrent; border wide, up to 8 rows of elongated cells; lower margin slightly recurved or plane.

6. B. ekmanii.

17. Rhizoids reddish purple; leaves appressed to stem; nerve short excurrent in a recurved arista; base of leaf, nerve and margin tinged with red; capsule small, 2.3 - 4 mm long (with lid), horizontal to cernuous when dry; lid mamillate.

12. B. microrhodon.

Rhizoids reddish brown, leaf margin recurved up to $\frac{5}{6}$ length of leaf; capsule 5 - 7 mm long (with lid), suberect to horizontal when dry; lid convex-hemispherical.

16. B. lagarocarpum.

Section II

1. Bryum billardieri Schwaegr., Spec. Musc. Suppl. 1(2) : 115, 76, 1816.

Plants in loose or dense tufts, green or yellowish green, 1 - 6 cm high, repeatedly branched or simple, brown tomentum below.

Rhizoids brown to reddish brown, densely papillose. Tubers present but filamentous gemmae absent. Tubers orange to red, scattered to abundant, on short rhizoids, round, 340 - 950 μm in diameter, or oval, 294 - 933 x 348 - 965 μm ; tuber cells 30 - 49 x 38 - 63 μm in size, 10 - 25 across.

Leaves often densely set, usually tufted at the branch apex in a comal tuft, oblong to obovate-spathulate, sometimes ovate, when dry not much shrinking, not markedly twisted around themselves nor around the stem, 1 - 1.8 - (2.5) mm in breadth, 1.5 - 5 - (7) mm in length, widest at $\frac{2}{3}$ to $\frac{5}{6}$ from the base of the leaf, nerve large, wider at the base, colourless above, excurrent; margin distinctly toothed above, recurved strongly for $\frac{3}{4}$ of the leaf below; border present. Basal cells \pm broadly rectangular, 15 - 32 x 47 - 130 μm , porose; upper cells rhomboid - hexagonal, 12 - 23 x 40 - 81 μm , porose.

Dioecious. Perichaetial leaves light green, lanceolate; nerve excurrent. Perigonal leaves broadly ovate, concave, cuspidate; nerve excurrent. Antheridia in the axils of the perigonal leaves as well as at the tip of the branches.

Lower portion of seta brown to reddish brown, upper portion light brown; commonly plurisetose.

la. var. billardieri (Figs. 1 - 6)

B. leptothecium Tayl., Phytologist 1 : 1094. 1844.

B. robustum Hamp., Linnaea 28 : 205. 1856.

B. valdiviae Lor., Moosstud. 157. 1864.

Rhodobryum subtomentosum Hamp., Linnaea 36 : 516. 1870.

R. crispatum Hamp., ibid. 40 : 310. 1876.

R. breviramosum Hamp., ibid.: 310. 1876.

R. olivaceum Hamp., ibid.: 311. 1876.

Bryum brachyaris ^{C. Müll.} in Mitt., Trans. Proc. Victoria 19 : 73. 1882 nom. nud.

B. breviramosum (Hamp.) Mitt., ibid.: 73. 1882.

B. crispatum (Hamp.) Mitt., ibid.: 73. 1882.

B. olivaceum (Hamp.) Mitt., ibid.: 73. 1882.

B. subtomentosum (Hamp.) Mitt., ibid.: 73. 1882.

B. subcrispatum C. Muell., Hedwigia 37 : 101. 1898.

B. abruptinervium C. Muell., ibid.: 102. 1898.

B. ischyrorhodon C. Muell., ibid.: 103. 1898.

B. brunneidens C. Muell., ibid.: 105. 1898.

B. flavifolium C. Muell., ibid.: 105. 1898.

B. leucothecium C. Muell., ibid.: 106. 1898.

B. pohliaeopsis C. Muell., ibid.: 107. 1898.

B. dobsonianum C. Muell.: ibid.: 108. 1898.

B. angeliothecium C. Muell., ibid.: 108. 1898.

B. crenatidens C. Muell., Gen. Musc. Fr. 238. 1900. nom. nud.

B. globulare Hamp. in C. Muell., ibid.: 238. 1900. nom. nud.

B. vulcanicum Dus. in Par., Ind. Bryol. ed. 2,1 : 269. 1904. nom. nud.

B. forsythii Broth., Proc. Linn. Soc. N.S. Wales 41 : 592. 1916.

B. greenwoodi Dix., Proc. Linn. Soc. N.S. Wales 55 : 280. 1930.

Leaves densely tufted at apex to form comal tufts ('miniature cabbages'), occasionally distributed along the stem, olive to dull green, oblong to obovate, occasionally concave, often closely appressed; mucronate to cuspidate; nerve large, colourless, shortly to moderately excurrent in a toothed point often bent back abaxially; strongly recurved for $\frac{3}{4}$ of the leaf or more below; border distinct, 1 - 4 rows of elongated incrassate cells, rarely more.

Perichaetial leaves light green, lanceolate; nerve short to moderately excurrent; female paraphyses yellow. Perigonial leaves broadly ovate, concave, cuspidate; nerve shortly to moderately excurrent; male paraphyses bright orange.

Seta 1.5 - 5 cm long.

Capsule oval cylindrical to oblong cylindrical, with a distinct neck, neck shrinking when dry, 2.8 - 5 - (6.7) mm in length (with lid), horizontal to cernuous when dry, cernuous to pendulous when moist, slightly contracted below the mouth when dry, symmetrical, light brown to dark brown, mouth deep brown to reddish brown, glossy; exothecial cells at the mouth of 6 - 8 rows of short quadrate to hexagonal cells, transverse walls much more thickened than longitudinal walls, not arranged in longitudinal rows; cells below the mouth thin, transverse and longitudinal walls equally thickened, 13 - 28 μm in breadth, not arranged in longitudinal rows. Lid brown to deep brown, conical, cells narrow, mixed with few broad cells, 9 - 25 μm in breadth, in \pm concentric layers.

Spores (12) - 15 - 18 - (20) μm in diameter.

Australia. Victoria: Powell town, Pioneer Creek Road, dry Sclerophyll Eucalyptus forest, on dry, shaded clay bank of forestry track, March 1977, G.A.M. Scott (GAMS). Lorne, Erskine River, The Rapids, Nov. 1919, W.W. Watts No. 1076 (H). Apollo Bay, n.d., F. Muller (type of B. brachyaris Hamp.) (H, BM). N. Holland, Sources of the Yarra, n.d., F. Mueller (as B. brachyaris Hamp.) (H). Dandenong, Aug. 1936, J. Mauritzon, J.W. Andas (S). Moyston, Feb. 1883, J. Sullivan (type of B. pohliaeopsis C. Muell.) (S, NSW). Rock Beach, Sorrento, on dunes with scrub, July 1970, G.A.M. Scott 214 (GAMS). Cumberland Falls, on rock outcrop, Feb. 1970, G.A.M. Scott (GAMS). Loutit Bay, 1891, G. Luehmann (as Rhodobryum robustum Hamp.) (FI). Murrumbecna, prope Melbourne, Aug. 1886, F. Reader (type of B. abruptinervium C. Muell.) (H, NSW). East Gippsland, Genoa River, 1881, Witherhead (type of B. brunneidens C. Muell.) (H). Mt. William, Nov. 1887, Sullivan 25 (as B. breviramulosum (Hamp.) Mitt.) (H). Grampians, Mt. William, Oct. 1883, D. Sullivan (type of B. leucothecium C. Muell.) (H, NSW). Gippsland, Moe River, 1881, Luehmann (type of B. flavifolium C. Muell.) (H). Wimmera, 1890, G.I.J. Eikert 8a (as Rhodobryum leptothecium (Tayl.) Par.) (H). Australia Felix, Victoria 56, n.d., Ferd. Mueller (type of B. subtomentosum (Hamp.) Mitt.) (BM, H, NSW). Between Cape Otway and Cape Patten, 1874, C. Walter (type of B. crispatum (Hamp.) Mitt.) (BM). Mt. Ararat, July 1875, Sullivan (type of B. breviramulosum Hamp.) (BM). Nova Hollandia, 1881, Herb. Hampe (type of B. globulare Hamp.) (BM).

South Australia: Mt. Softy Ranges; Waterfall Gully, some distance from stream, Oct. 1947, Ivan L. Ophel 26E (FH). On wet shaded ground at the Hindmarsh Falls, Mount Lofty Range, Aug. 1956, H.J.M. Bowen (CCT).

Property of M.A. Clark, "Stringys" Echunga, Sept. 1964, D.E. Symon 75 (CCT).

Kangaroo Island, northern side of Flinders Chase, approx. 10 km East of Cape Borda, sandy clay soil under dense bush and tall Eucalypts in Creek Gully, Aug. 1972, R.D. Seppelt 0876 (GAMS). South East Forest Research Institute, Mt. Gambier, ca. 480 km SE of Adelaide, common in needle litter beneath Pinus radiata plantation, July 1966, I.B. Wilson 551 (COLO). Clarence River, n.d., Wilcox (type of B. ischyrorhodon C. Muell.) (H).

West Australia: Crawley, common on sandy soils, Aug. 1951, G.H. Willis (NSW). South western West Australia: Beedelup Falls, northwest of Pemberton; on rocks near the Falls, May 1968, W.A. Weber (COLO). On granite and clay, Serpentine Falls, Aug. 1944, A.W. Banwell (FH). Cannington Swamp, sandy bog overlying clay, Aug. 1973, H. Ramsay 14/73 (SYD). On granite outcrop in sand washed into crevices, Mt. Dale, Aug. 1973, H. Ramsay 19/73 (SYD).

New South Wales: Bodalla State Forest, (South Coast), growing on basalt rocks in creek bed, mixed with much Thuidium furfurosum Jaeg., Sept. 1953, E.F. Constable (S, NSW). Cann Valley Highway, 38 km S of Bombala at Victorian border, on ground in dry sclerophyll forest, July 1975, H. Streimann 058530 (H). Cambewarra, Dec. 1885, Th. Whitelegge (type of B. crenatidens C. Muell.) (S, H, NSW). Cambewarra, Dec. 1885, Th. Whitelegge (as B. abruptinervium C. Muell.) (S, H). Creeklet, Hunter's Scrub, Alstonville, Richmond River, Sept. 1901, W.W. Watts (NSW, H). Kerosine Bay, North Shore, wet rocks, Sept. 1884, Th. Whitelegge (type of B. abruptinervium C. Muell.) (H). Tumbarumba Distr., Nov. 1900, W. Forsyth (H). Lane Cove, near Sydney, wet banks, Sept. 1885, Th. Whitelegge (H). Kiama, Dec. 1899, W. Forsyth (type of B. forsythii Broth.) (H). On rocks, Creek road from Federal to Mullulimby, Aug. 1898,

W.W. Watts (as B. subolivaceum C. Muell.) (NSW). Mt. Dromedary, 1883,
Miss Bates (as B. viridulum C. Muell.) (NSW).

Queensland: Moist rocks, Campbell's Creek, North Queensland, Aug. 1940,
H. Flecker (as B. terrae-reginae Dix.) (BM). Toowoomba, Aug. 1886,
G. Hartmann, F. Mueller 38 (H). Atherton Table land; Mount Lewis, on
road from Julatten, 3000 ft, on tree base in upland rain forest, mixed
with Hypopterygium muelleri Hamp. April 1968, W.A. Weber (COLO). North
Queensland, on moist open road face about 2000 ft., near forest camp,
Tinaroo Creek Road, S.E. of Mareeta, Aug. 1968, Jack Berry 15029 (COLO).
Brisbane, 1887, no. 347 (as B. subleptothecium C. Muell.) (H). Austral
Felix 32, Port Darwin, n.d., F. Mueller (type of B. robustum Hamp.) (BM).

Tasmania: Dead Island, 1884, Judge Dobson (type of B. dobsonianum C. Muell.)
(H). Sine loco, ex Herb. Hampe, F. Mueller (type of B. brachyaris C. Muell.)
(H). Creek, Proctor's Road, Nelson Range, near Hobart, Nov. 1885,
A.J. Taylor (H). On rock, Cataract Gorge, Launceston, Nov. 1895,
W.A. Weymouth (H). Vicinity of Forth, north coast on Bass Strait;
coastal scrub (between Ulverstone and Devonport), Feb. 1968, W.A. Weber &
D. McVean (COLO). Southeast of Triabunna, Okehampton Bay, old sandstone
quarry, July 1966, Gillis Een 330 (S).

Norfolk Island: Feb. 1844, Alan Cunningham (type of B. leptothecium Tayl.)
(BM, FH). Austr. Or., Ins. Norfolk, 1884, Robinson (type of
B. angeiothecium C. Mueller) (FH, H).

Lord Howe Island: Frequent on ridge of Mt. Ligbirch, Sept. 1853,
Herb. Hook. (BM).

Papua. Milne Bay District, on rocks on river bank, north slopes of
Mt. Dayman, gorge of upper Gwariu River, alt. 2050 m., May 1953,
L.J. Brass 22658 (TNS).

Territory of New Guinea. North-east New Guinea, Eastern Highlands
District, Mt. Wilhelm, east slopes, alt. 3560 m., low on a tree in
subalpine forest, June 1959, L.J. Brass 30150 (FH). Western Highlands
District, Wabag area, Sugarloaf Mt. track from Tale River, south of
Wappenamada, Nothofagus beech forest at 9000 ft., corticolous on Pandanus,
June 1960, R.G. Robbins 2786 (FH).

New Zealand. North Island. Raglan County, Te Akatea, wet hollows, early
Sept. 1918, Herb. D. Petri (WELT). Hawkes Bay, Thomson's Mill near Ashley
Clinton, Upper Tukituki River, open river flat, on ground, Jan. 1950,
G.O.K. Sainsbury (WELT).

South Island. Nelson Dt., Lake Rotoiti (northern end),
open area at lakeside on track, on silty stony ground, Feb. 1947, G.O.K.
Sainsbury (F).

- Fiji. Viti Levu: flat damp rocks in open place, Mt. Evans, Lautoka, c.fr., April 1922, W. Greenwood 410 (type of B. greenwoodi Dix.) (BM).
Taveuni: slopes of Mt. Manuka, east of Wairiki, alt. 300 - 600 m., dense forest, on humus-covered rocks in dry stream bed, Aug. 1953, A.C. Smith 8338 (FH).
- Western Samoa. Upolu, Afiamalu, rocks in stream bed, 720 m., Sept. 1953, M.G. Irwin 35 (FH).
- Tahiti. District de Pare, Fautaua Valley, on fallen log, alt. 250 m., loose carpet, May 1934, H. St. John & F.R. Fosberg 14142 (FH, BISH).
- Raiatea. Temahani Range, S end, among other mosses on branches of shrubs, 500 m., Apr. 1927, John W. Moore (FH).
- Cook Islands. Rarotonga, Jan. 1935, A.J. Graham 38 (BM).
- Chile. Brunswick Peninsula, on soil under Berberis buxifolia, Seno Otway; along shore E of Canelos and just W of Ch. La Quema, Dec. 1967, John J. Engel 2055 (H). Valdivia, Chile Austr. n.d., (type of B. valdiviae Lor.) (BM). Prov. Osorno: australis in monte Osorno in terra, April 1897, P. Dusen 876 (type of B. vulcanicum Dus.) (BM).
Prov. Valdivia: Corral, Dec. 1905, R. Thaxter 91 (FH). Prov. Nuble; San Carlos San Fabian, Cu el suelo, base de los arboles, ambiente humido: Sept. 1972, C. Quierola 8642 (FH). Prov. Cautin: Cunco, S.E. of Temuco;

forest floor, second growth of Nothofagus forest, June 1970, Les Landrum 210 (COLO). Prov. Llanquihue: Rio Maullin, n.d., Dessaner (H). Prov. Coquimbo, Loma Frai Gorge, ad terram in silva; 670 m.s.m., May 1917, Carl O. Inga Skottsberg 181 (H). Juan Fernandez Islands: on ground at base of cliff, ca 4000 ft., Masfluera, below summit of Los Innocentes, Dec. 1965, R. Hatcher & J. Engel 670 (FH).

Argentina. Prov. Neuquen: Isla Victoria (Lake Nahuel Huapi), 820 m., Jan. 1951, H. Schummer 1714 (FH). Prov. of Jujuy: Yala Lakes 10 km N.W. of City of Jujuy in humid mountainous region on S.W.-facing rocky slope in alder (aliso) forest, glacial moraine, alt. 2100 m, on tree trunk, Nov. 1971, L. Arnow 3733 (COLO). Prov. Cordoba: Quebrada da Luna, 1010 m.s.m., March 1931, C.C. Hosseus 256 (as B. aequabile C. Muell.) (BM).

Equador. Galapagos Islands: Charles Island, Scalesia forest, 300 m., Jan.-March 1964, S. Itow (COLO). Floreana Island, Cerro Wittmer above Wittmer farm, NW exposed slope with dense mixed Psidium bush, on loose cinder in open Macrea bush, 350 m., April 1976, S.R. Gradstein (COLO). Isla Santa Cruz, trail from Bella Vista to Media Luna, in small Sphagnum bog by streamlet, upper Miconia zone, 550 m., June 1976, H. Sipman (COLO).

Falkland Islands. Antarctic Expedition, 1839 - 1843, J.D. Hooker 219 (FH).

Tristan da Cunha. Nightingale Island, at peak; on Scirpus tussock, 250 - 300 m, Feb. 1938, F. Christopherson 2188 (FH).

Inaccessible Island. Oct. 1873, Challenger Expedition, Moseley (BM).

Gough Island. S.Y. Scotia, April 1904, R.N.R. Brown (BM).

B. billardieri is a plant of varied habitats. It grows on soil, rocks, leaf litter, logs, on trees as epiphytes and even on animal bones. It is found growing from sea level to moderately high altitudes. It is distributed only in the Southern Hemisphere and can be said to have a Nothofagus type of distribution (Seki, 1974), except for the presence of this plant in Tristan da Cunha and Gough Island. If B. billardieri is found in South Africa and Madagascar, then the distribution would be the Podocarpus type (Seki, 1974).

This plant is very variable and as such, it has been a source of confusion for taxonomists for a long time. Examination of a large number of specimens from all the various parts of the world where it is known to be found show some interesting correlations between altitude and latitude upon plant size and morphology. It was noticed that plants growing at sea level or low altitudes are smaller whereas those growing at higher altitudes at the same latitude are larger. Similarly, plants growing in the wetter parts of Southern Australia, e.g. Victoria, tend to be larger than those growing in New South Wales or Western Australia. The plants growing in the western part of Australia and consequently the areas receiving lesser rainfall than eastern Australia, seldom, if ever, attain the large size of the Victorian plants. Obviously, the amount of

precipitation also affects the plant size.

As a result of the wide range of variation in plant size and morphology, various authors have tried to name the different forms as distinct species, as can be seen by the extensive synonymy built up by this species. Examination of tubers along with a number of other characters has shown that these plants growing in Australia, New Zealand, Chile, Argentina and the smaller islands along the area between the southern pan-tropical belt and circumsubantarctic belt are in fact one and the same species.

B. robustum Hamp. had been considered as a separate species on the basis of the mucronate costa ending in a stublike, short excurrent nerve and the nerve being of the same size throughout. There is so much intergradation between B. billardieri and this plant that it is not possible to draw a line between the two. Therefore, B. robustum is here reduced to a synonym of B. billardieri.

A small number of plants growing at high altitudes in Victoria show an extraordinarily large size along with a mucronate costa, and a short stub-like excurrent nerve. Not only is the vegetative part of the plant larger but there is a corresponding increase in the size of the sporophytes also (see Figs. 4 - 6). Essentially it seems to be a giant form of B. billardieri. Since all variations between this form and the smaller form of low altitudes are found, it is treated here merely as a form showing one extreme aspect of the variation which this species is capable of attaining.

lb. var. platyloma Mohd., var. nov. (Figs. 7-9, 40)

Leaves often spreading, seldom appressed, rarely concave, rarely mucronate, often long acuminate; nerve moderately to longly excurrent; border often very wide, prominent as whitish limb even in dry specimens, consisting of 2 - 8 rows of narrow elongated incrassate cells.

Perichaetial leaves light green, narrow lanceolate, long acuminate; nerve long excurrent; margin toothed above, recurved below; female paraphyses light orange. Perigonial leaves concave, ovate; nerve moderately to longly excurrent; margin toothed or crenulate above, recurved below; male paraphyses orange.

Seta 2 - 4 cm long, usually bent into a hook before meeting capsule.

Capsule long cylindrical or narrowly oblong, 2.5 - 6.5 mm in length (with lid), suberect to horizontal when dry, cernuous to pendulous when moist, often incurved, mouth large, contracted below the mouth when dry, symmetrical, light brown to brown; mouth reddish brown to dark brown; neck distinctly shrunken when dry; exothecial cells at the mouth forming 5 - 7 layers of irregularly hexagonal cells, not arranged in longitudinal rows, uppermost 2 - 3 rows at the mouth consisting of small transversely elongated cells; cells below the mouth forming 16 - 32 μ m in breadth, not in longitudinal rows. Lid brown to dark brown, conical apiculate, cells not arranged in concentric layers, 14 - 32 μ m in breadth.

Spores 12 - 16 μ m in diameter.

Type specimen: New Zealand. South Island: Old log in forest, Cascade Ck., Eglinton, 1500', May, 1971, J. Child 2713 (BM, JC, GL(holotype)).

New Zealand. Campbell Island: on soil beneath overhang, on north-north west slope of Mt. Honey near summit (1700 - 1800 ft), Dec. 1969, D.H. Vitt 2357 (NICH). On humus, near creek in thick Dracophyllum scrub just south of Garden Cove, Jan. 1970, D.H. Vitt 3050 (NICH, S).

Stewart Island: soil on stream margin, Table Hill hut, Feb. 1947, W. Martin 672 (WELT).

Chatham Island: in swampy bush, Aug. 1896, F.A.D. Cox (H). Manukau Point, in pasture grass hummocks in a seep, Aug. 1971, D.S. Horning (COLO).

South Island. Southland Prov.: Fiordland, just south of town of Manapouri in dry Nothofagus forest, along Waiiau River at outlet of Lake Manapouri, June 1973, D.H. Vitt 10343 (BA). Fiordland National Park, 22 miles S.E. of Milford Sound at summit of 1700 ft between Hollyford & Eglinton Rivers, along steep slope, on track, Jan. 1973, D.H. Vitt 10497 (COLO). (BA).

Otago Prov.: Near Lake Harris, Humboldt Mts., Lake Wakatipu, Jan. 1936, V.D. Zotov (WELT). Otago Peninsula, in shade, on old tree trunk, 1000 ft, April 1970, J. Child (JC).

Westland Prov.: Blue Duck creek, Haast Pass, ca. 1000 ft, river flat at forest edge, Dec. 1964, J.T. Linzey 2244 (JL). Paparoa Range, March 1946, H.W.H. Wellman (WELT).

Canterbury Prov.: Arthur's Pass, Beech forest, Feb. 1958, Ruth D. Svihla 5746 (CANM). Mound growing on forest floor litter amongst other mosses in beech forest on Woolshed Hill near Cass, Feb. 1973, L. Visch 124 (NICH).

Wainui, Banks Peninsula, forest, earth bank, Sept. 1976, B.H. Macmillan (BHM, GL).

Nelson: Lake Rotoiti, Nelson, May 1943, Miss B.M. Kidson 5 (WELT). Ruby Bay, Tasman, well drained sandy patch, almost on beach, June 1943, E. Deck (WELT).

Marlborough: n.d., J.H. Macmahon (WELT).

North Island. Wellington Prov.: Kapiti Island, April 1929, J.C. Anderson (WELT). June - July 1925, R. Mundy 64 (WELT). Pukatea bush, near Foxton, Sept. 1933, V.D. Zotov (WELT). Wanganui, on ± horizontal Willow trunk in gully, Brunswick Road, Wanganui, Jan. 1930, K.W. Allison (WELT).

Hawkes Bay Prov.: among Fagus leaves, Dannevirke, Herb. Colenso 67 (WELT). 4500 ft, Ruahine Range, Dec. 1943, Colenso (WELT). Adjoining sea beach, Blackhead, Feb. 1955, G.O.K. Sainsbury (F).

South Auckland Bay Prov.: Mayor Island, Bay of Plenty, Nov. 1936, Auckland University College Field Club (WELT). Coromandel Peninsula, Mt. Moehau, on rock in shade, Dec. 1930, L.B. Moore (BISH). On bark in light bush, sea edge, Buffalo Bay, Whitianga, Sept. 1945, G.O.K. Sainsbury (WELT).

Central Auckland Prov.: Tryphena, Gt. Barrier Island, near sea level, June 1933, A.E. Buggy (WELT). On humus, Thumb Track, Little Barrier Island, Hauraki Gulf, Oct. 1945, B. Molesworth 302 (F). Leigh, bank above tide, Feb. 1934, L.B. Moore (WELT). Waitakere Range, Auckland, alt. ca. 500 ft, on litter, forest floor, shaded under tall Leptospermum ericoides, May 1976, J. Linzey (JL, GL).

East Coast Prov.: On earth overlying rock, Lake Waikaremoana, Wairoa County, ca. 2200 ft., Jan. 1942, G.O.K. Sainsbury (FI).

B. billardieri var. platyloma is one of the commonest and most widespread mosses in New Zealand and the adjacent Islands. It grows on earth, rock, logs and stumps of trees. It is extremely variable but the typical plants are green, comose and rosulate, spreading when moist. Forms where the stems are flexuose and interruptedly comose are found when the plants grow in moderately wet conditions on leaf litter in the shade. Plants growing in marshy or swampy areas possess extremely long stems on which the leaves are arranged all along while plants growing on soil at low altitudes fully exposed to sunlight are rather small and the leaves imbricated in comose

heads. The effect of altitude and latitude on the size and morphology of this plant is very marked. The plants exhibiting the largest size, with long acuminate apex and wide border are seen from Campbell Island and Southland Province in South Island. There is a progressive reduction in size, width of border and acuminate nature of apex as one proceeds northwards. The North Island plants rarely, if ever, achieve the breadth in border of leaves seen in South Island plants. Similarly, for a particular latitude, the plants growing at higher altitudes show a larger size and wider border than those growing at lower altitudes. It was also noticed that the plants growing in the shade of the forest floor are often larger than those growing in the open.

This moss has been called B. truncorum since Hook. f. & Wils. gave this name to the New Zealand plants in 1854. The present moss differs from B. truncorum (Brid.) Brid. in the larger size of its tubers, the less dentate nature of the upper margin of the leaf and the strongly recurved margin below. This moss has also been much confused with B. perlimbatum Card. Differences between the present moss and B. perlimbatum are given under the description of B. perlimbatum. The other mosses with which this moss is often confused are B. laevigatum Hook. f. & Wils. and B. campylothecium Tayl. Both these latter mosses can be distinguished from B. billardieri var. platyloma by the possession of such characters as concave leaves, serrulate or entire upper margin and incrassate leaf cells. The nerve in B. laevigatum is either percurrent or shortly excurrent while in B. campylothecium it is a long smooth excurrent arista. The leaves are often arranged all along the stem in B. laevigatum while the leaves are often imbricated in a comose head in B. campylothecium.

2. Bryum neelgheriense Mont. in C. Muell., Syn. 1 : 255. 1848.

Plant densely tufted, robust, bright green above, brown with tomentum below, simple or branched with innovations, 1 - 5 cm high.

Rhizoids brown, moderately papillose. Filamentous gemmae axillary, densely papillose, abundant, arising near the tip of the branches.

Leaves densely set at apex, rarely arranged all along the stem, dark green, slightly twisted around themselves and slightly around the stem, not shrinking when dry, erect spreading when moist, ovate to longly spatulate, sometimes lanceolate, 1.2 - 2.7 mm in breadth, 3 - 7 mm in length, widest at $\frac{1}{4}$ to $\frac{3}{4}$ from the base of the leaf; nerve strong, broader at base, light red at base, colourless above, excurrent; border distinct, 2 - 4 rows of narrow elongated cells, rarely more, not coloured. Basal cells rectangular, 20 - 28 x 55 - 123 μm porose; upper cells longly rhomboid-hexagonal, not of regular shape and size, 14 - 20 x 40 - 82 μm .

Dioecious. Perichaetial leaves lanceolate, cuspidate; nerve long excurrent, reddish at base; margin crenulate above, recurved below; female paraphyses light orange.

2a. var. neelgheriense (Figs. 10 - 12)

B. decaisnei Doz. et Molk., Musci Fr. Ined. Archip. Indici 19. 9. 1845.

B. zollingeri Dub. in Moritzi, Syst. Verzeichn. Zoll. Pfl. 133. 1846.

B. medianum Mitt., J. Linn. Soc. Bot. Suppl. 1 : 74. 1859.

B. zickendrathii Card., Rev. Bryol. 28 : 114. 1901.

Bryum decaisnei var. longifolium Fleisch., Musci Fl. Buitenzorg 2 : 563. 1904.

B. decaisnei var. subramosum Fleisch., ibid. 1904.

B. ramosum var. nymanii Fleisch., ibid. : 567. 1904.

B. vellei Card. et P. Vard., Rev. Bryol. 50 : 22. 8. 1923.

B. ramosum var. decaisnei (Doz. et Molk.) Ochi, Bryologist 60 : 8. 1957.

B. ramosum var. longifolium (Fleisch.) Ochi, Bryologist 60 : 9. 1957.

Tubers present. Tubers on short rhizoids, red to reddish brown, round, 240 - 940 μm in diameter, or oval, 268 - 882 x 289 - 1056 μm ; tuber cells 34 - 50 x 37 - 62 μm , 12 - 27 cells across.

Leaves short to long acuminate, never mucronate; nerve often long excurrent.

Perigonial leaves broadly ovate, concave, cuspidate, nerve long excurrent; margin crenulate above, recurved below; male paraphyses orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 2.2 - 5 cm long, lower portion reddish brown to dark brown, upper portion dark yellow or brown.

Capsule cylindrical, 3.5 - 6.4 mm in length (with lid), with a distinct neck, neck distinctly shrunken when dry, horizontal to cernuous when dry, cernuous to pendulous when moist, contracted below the mouth when dry, symmetrical, light brown to brown; exothecial cells at the mouth arranged in \pm longitudinal rows, uppermost row of cells not transversely elongated, consisting of 5 - 6 rows \pm quadrate to pentagonal cells; cells below mouth narrow, arranged in \pm longitudinal rows of

vertically elongated cells, strongly thickened on the vertical walls, 10 - 23 μm in width. Lid reddish brown to dark brown, long conical, with sharp pointed tip, cells not in distinct layers, 15 - 30 μm in breadth.

Spores (13) - 15 - 17 - (19) μm in diameter.

India. Ind. Or. Nilgherris, n.d., Perrottet (type of B. neelgheriense Mont.) (FI, H, S). Tamil Nadu State; Nilghiri Hills, on dry soil in wood by roadside near Dodabetta, Jan. 1973, C.C. Townsend 73/567 (CCT). Tamil Nadu State; Nilghiri Hills, corticolous in Avalanche Valley between Avalanche and Emerald, Jan. 1973, C.C. Townsend 73/668 (CCT). Travancore; Kannan Deva Hills, May - June 1929, Rev. G. Foreau 1263 (as B. vellei Card. et P. Vard.) (BM). Madurai, Shembaganur, 2000 m, 1909, R.P. Ant. Velle' (type of B. vellei Card. et P. Vard.) (BM). Kodaikanal, on stones, alt. 2000 m., Sept. 1912, S. Foreau & Roine (as B. vellei Card. et P. Vard.) (GL). Dry clay banks near Verajpet, Coorg, March 1898, T.L. Walker (H, CANM). In Mont. Nilghiri, n.d., M'Ivor ! (type of B. medianum Mitt.) (BM). Tranquebar, Madras, June 1924, B. Sjostrand (as B. zollingeri Dub.) (S, H). Nilghiri Mts., 7 - 8000', 1893, Surg. Gen. Bidie (as B. wightii Mitt.) (BM).

Ceylon. Central Province: Nuwara Eliya District, on sloping rock in forest by track c. 1½ miles from Farr Inn on way to North Cove, Horton Plains, alt. c. 7000 ft., March 1973, C.C. Townsend 73/1289 (CCT). Central Province: Kandy District, on rocks by a stream in semi-evergreen forest, Hantane, above Peradeniya, Feb. 1973, C.C. Townsend 73/775 (CCT).

Burma. Kentung State: Toimive, epiphytic, 6500 ft., May 1940, F.G. Dickson No. 9741.1 (FH).

Thailand. Payap, granitic massive, Doi Mt., Inthanon, on burnt soil of grassy slope along path; 1650 m; 98° 30'E, 18° 35'N; Dec. 1965, A. Touw 10263 (BM, HO). Poo Kradeng, evergreen forest, July 1959, F. Floto 7415 (NICH). Udawn, sandstone massive Phu (Mt.) Luang, open forest; on tree trunks, alt. 1150 - 1250 m., 101° 25'E, 17° 25'N, A. Touw 10456 (BM, HO).

Malaysia. Malaya: Perak, Maxwell's Hill, 3500 - 4000 ft, 1939, G.H. Spare 2037 (BM). Pahang, Fraser's Hill, on tree root, c. 4000 ft, March 1929, R.E. Holttum (BM).

Sarawak: Dulit Ridge, on shrubs in undergrowth of shady moss-forest, light green, hanging, c. 1230 m., Sept. 1932, P.W. Richards 2000A (BM).

Indonesia. Sumatra: Sumatra Occid., Poentjak Boekit, on the ground among grass, 1200 m. alt., Dec. 1929, E. Jacobson, No. 97D (BM). In Monte Singalung; in regione inferiore Kampong Parkan Kirieg, Regio Pluvialis, alt. 7230 m., July 1894, J. Baumgartner (S). Merapi, N.W. Schattige, Schluchtau steinem 1520 m., July 1894, Schiffner 11659 (S). Java: Java, April 1850, (type of B. decaisnei Doz. et Molk., type of B. ramosum var. decaisnei (Doz. et Molk.) Ochi.) (S). Java ad rivulos montis Pangerongo, alt. 5000 - 6000', Zollinger collect No. 1944 (type of B. zollingeri Dub.) (BM). Kandang Badack, 2500 m, July 1898, Max Fleischer (type of B. decaisnei var. subramosum Fl.) (FI, H). Rarahan bei Tjibodas, 1450 m., April 1900, M. Fleischer (type of B. decaisnei var. longifolium Fl. and type of B. ramosum var. longifolium (Fleisch.) Ochi; (S, H, FI). West Java, Tjikoray, n.d., M. Fleischer (type of B. decaisnei var. nymanii Fl.) (H.S.). Ost-Java; Am Ardjoeno bei Lalidjiwa auf Waldboden 2100 - 2600 m., May 1901, M. Fleischer (S). M. Java; Gunong Lawu, Sendang Dradjat, 3265 m., Sec. 1928, F. Ruttner no. 246 (S). Prov. Batavia, In monte Megamendong;

ad saxa secus viam supra pagum Tugu., Regio Pluvialis, alt. 1090 - 1300 s.m.,
V. Schiffner no. 10653 (BM).

Celebes: Bua-Krang, 5000 - 7000 ft., 1895, H. Fruhstarfer, (type of
B. zickendrathii Card.) (FI, S).

Philippines: Luzon: Province of Benguet, Baguio, May 1911, C.B. Robinson
no. 14056 (BM). Dist. of Lepanto, Jan. 1909, E. Bacani no. 17043 (BM).
Bontoc subprovince, Mt. Masapilid, March 1920, M. Ramos, G. Edano (BM, H).
Mt. Province, Mt. Data, on dead Cyathea (bark), Oct. 1974, B.C. Tan no.
74 - 215 (NICH).

Taiwan. Lushan, Jenai Hsiang, Nantow Hsien, alt. 1100 m., on rock in
evergreen hardwood forest along stream, Oct. 1966, C.K. Wang 10399 (HO).
Hsiah sueh Shan; Hoping Hsiang, Taichung Hsien, 2600 m., on rock in
hemlock forest, Oct. 1960, C.K. Wang 0723 (HO). Nanfeng Shan; Maolin
Hsiang, Kao - hsiung Hsien, alt. 1250 m., on humus along roadside in
hardwood forest, March 1961, C.K. Wang 1046 (HO). Mt. Ari, Prov. Tainan,
July 1927, H. Sasaoka, 3882 (as B. euryneuron Dix.) (BM). Near guest
house, ca. 2200 m., Mt. Ali, Chia-yi Co., March 1965, Z. Iwatsuki,
A.J. & Evelyn Sharp, 118 (FH). Kelung, 1903, Faurie 91 (FH).

B. neelgheriense often grows on soil and rocks, and occasionally on logs
and tree trunks as an epiphyte. It is mostly found at moderately high
altitudes of around 1000 m or above. It is distributed in Ceylon, South
India, Burma, Thailand, Malaysia (Malaya, Sarawak), Indonesia (Sumatra,
Java, Celebes), Philippines (Luzon Island) and Taiwan.

Two specimens have been cited by Mitten as types of B. medianum.
The specimen 'In Mont Khasian, reg. Temp. J.D. Hook. et Thompson No. 369'
from the British Museum is sterile and it is in fact B. ramosum (Hook.) Mitt.

The other specimen 'In Mont Nilghiri, M'Ivor !' has sporophytes and is B. neelgheriense. Therefore, the M'Ivor specimen is taken to be the type specimen of B. medianum and is here reduced to a synonym of B. neelgheriense. Most of the specimens labelled as B. wightii Mitt. from the British Museum were found to be B. neelgheriense which had been misidentified. Gangulee (1974) based his description of B. wightii on a Bidie specimen. I have examined the Bidie specimen from the British Museum and found it to be B. neelgheriense. The type specimen of B. wightii was not available for examination.

B. neelgheriense and B. andicola are very similar to each other but differ in a number of characters. The differences are given below:

<u>B. neelgheriense</u>	<u>B. andicola</u>
Leaves often large, ratio of leaf width to length 1 : 2.8	Leaves often smaller, ratio of leaf breadth to length 1 : 2.3
Leaves occasionally arranged all along stem.	Leaves densely set at apex, rarely arranged all along stem.
Leaves only slightly twisted around stem, rarely appressed to stem when dry.	Leaves often spirally twisted around stem in a comal tuft, strongly appressed to stem when dry.
Leaves ovate to long spatulate.	Leaves oblong to spatulate, seldom ovate.
Leaf apex often long acuminate, cuspidate, never mucronate.	Leaf apex acute, often mucronate.
Nerve long excurrent.	Nerve short excurrent, sometimes percurrent.

Upper cells often of irregular size and shape, width to length ratio high.

Nerve of perigonial leaves long excurrent.

Seta 2.2 - 5 cm long.

Exothecial cells at mouth of capsule in \pm longitudinal rows.

Lid long conical, with sharp pointed tip.

Spores (13) - 15 - 17 - (19) μm in diameter.

Upper cells of regular shape and size, width to length ratio low.

Nerve of perigonial leaves short excurrent.

Seta 1.5 - 3.5 cm long.

Exothecial cells at mouth of capsule not in longitudinal rows.

Lid short conical, with acuminate tip.

Spores 11 - 14 - (16) μm in diameter.

2b. var. wichurae (Broth.) Mohamed comb. nov. (Fig. 13)

B. wichurae Broth. in Hedwigia, 38 : 219 (1899)

Tubers absent.

Leaves occasionally mucronate; nerve short to moderately excurrent.

Male inflorescence and sporophytes not found.

Japan. Kyushu: Nagasaki Pref., Nagasaki, 1893, Wichura 1393 (type of B. wichurae Broth.) (BM). Nagasaki Pref., Isl. Tsushima; on the summit of Mt. Ariake, 500 m. alt., on soil in sunny station, April 1956, T. Osada 4043 (NICH, HO). Saga Pref., Saga city, March 1940, M. Kurita 206 (NICH). Kagoshima Pref., Mt. Kaimon, on rocks in fairly sunny place with Aerobryopsis subdivergens (Broth.) Broth., ca. 560 m. alt., Jan. 1956, Z. Iwatsuki No. 28778 (NICH). Kumamoto Pref., Hitoyoshi, on moist rocks, alt. ca. 300 m., April 1954, K. Mayebara 457 (CANM, S, BM). Miyazaki Pref., on semishaded rocks along stream, ca. 30 m. alt., Takisan Shrine, Kushima, Dec. 1964, Z. Iwatsuki & E. Sharp no. 1006 (COLO, CANM, NICH). Oita Pref., Tabaru - mura, Mt. Sobo, ca. 700 m., July 1951, Y. Kuwahara 1043 (NICH). Fukuoka Pref., Chikushi-gun, Iwato-mure, Myoken Waterfall, alt. 100 m., Jan. 1951, M. Omura M49 (NICH).

Shikoku: Ehime Pref., Ochi-gun, Sakurai-mura, Feb. 1950, K. Oti 4549 (NICH). Kochi Pref., Kudarukawa, Takaoka-gun, on rotten logs in shade, ca. 400 m., March 1922, I. Nagano 7210 (HO).

Honshu: Yamaguchi Pref., Mine-gun, Mito-cho, Aka, Taishodo limestone cave, on rock near entrance, Dec. 1962, S. Atake 21 (NICH). Shimane Pref., Jan. 1966, Y. Nishida no. 71440 (NICH). Tottori Pref., Kurayoshi, ca. 70 m., on soil among herbs, Jan. 1953, H. Ochi (HO). Wakayama Pref., Higashimuro-gun, Mt. Nachi, in a valley near Ichinotaki Falls, 300 m.,

Oct. 1962, Z. Iwatsuki no. 601 (NICH). Nara Pref., Totsugawa-mura, on wet rocks, Aug. 1951, T. Nakajima 151 (NICH). Mie Pref., Ueno Sen, ca. 400 m., on rock, Nov. 1961, K. Yamada 679 (NICH). Aichi Pref., Minami-shitara-gun, Horai-cho, Kawai, Tsunemichi, ca. 200 m. alt., on crevice of rock cliff, Aug. 1976, Z. Iwatsuki, T. Suzuki, & T. Yamamoto no. 11856 (NICH). Saitama Pref., Chichibu-gun, Minano-machi, Nobayashi, on serpentine, ca. 400 m. alt., Oct. 1955, I. Nagano 8428 (NICH). Tokyo Pref., Kaminoiwa, Nippara, Nishitama, n.d., A. Tezuka (TNS).

Okinawa Island: Loo Choo, Katsu-dake, July 1938, T. Kanashiro (CANM).

China: Prov. Kweitschou Orient: inter urbes Kutschou et Liping prope vicum Luduan ad rupes., substr. marner; alt. s.m. ca. 650 m., July 1917, Dr. Heinr. Frh. V. Handel-Mazzetti Diar. Nr. 2161, Nr. 10968 (as B. ramosum (Hook.) Mitt.) (H). Prov. Yunnan: in regione calide temperata prope urbem Yunnanfu, in silva Ketteleriae ad templum Djindien-se in terra, substr. marneo; s.m. ca. 2050 m., Feb. 1914, Dr. Heinr. Frh. V. Handel-Mazzatti Diar. no. 21 (as B. ramosum (Hook.) Mitt.) (H). Prov. Fukien: Shaowu & vicinity, 3500 ft, on cracks in tile roof, July 1926, Fan Hsioh Niao no. 9212a (FH). Prov. Chekiang: Sang Chuan, n.d., Missionaire Thorstik no. 20 (S). Prov. Kong Tcheou: Pin Fa, R.P. Fortunat, Feb. 1903 (S). Amoy Island, marshy ground, near reservoir; alt. 50 ft, July 1931, G.A.C. Herklots & W.H. Burrel, no. B10 (BM).

Hong Kong. 1000 - 1500 ft, Dec. 1930, Youngsaye (as B. globicoma f. minor) (BM).

B. neelgheriense var. wichurae grows mostly on rocks and soil and occasionally on logs. It is found at low to moderately high altitudes

in the shade or semi-shade.

B. neelgheriense var. wichurae differs from var. neelgheriense mainly in the absence of tubers. Over 60 packets of var. wichurae from China and Japan have been examined but none of these possessed tubers, male plants or sporophytes although these are commonly possessed by var. neelgheriense. Besides the absence of these features, var. wichurae differs from var. neelgheriense in the short to moderate excurrent of the nerve whereas it is long excurrent in the var. neelgheriense. The leaves in var. wichurae are sometimes mucronate while the leaves of var. neelgheriense are never mucronate.

B. sinense Mohd. and B. ramosum (Hook.) Mitt., both of which are found in China and Japan, produce sporophytes when growing in China but no sporophytes have been seen from Japan. It is highly probable that var. wichurae found in China and Hong Kong may possess male plants and sporophytes while the absence of male plants in Japan may have resulted in the inability to produce sporophytes.

3. Bryum andicola Hook. in Kunth, Syn. Pl. Aequin. 1 : 58. 1822 (Figs. 14-16).

B. ehrenbergianum C. Muell., Syn. 1 : 255. 1848.

B. lindigianum Hamp., Ann. Sc. Nat. Bot. ser. 5,4 : 340. 1872.

B. comatum Besch., Mem. Soc. Sc. Nat. Cherbourg 16 : 199. 1872.

B. liebmanni Schimp. in Besch., *ibid.*: 200. 1872.

B. sartorii Schimp. in Besch., *ibid.*: 200. 1872.

B. subroseum Besch., *ibid.*: 200. 1872.

Rhodobryum stenothecium Hamp. in Vid. Med. Naturh. For. Kjoebenh. ser. 3,6 : 147. 1875.

Bryum stenothecium (Hamp.) Hamp., Vid. Medd. Naturh. For. Kjoebenh. ser. 4,1 : 103. 1897.

B. limbato-marginatum C. Muell., Flora 82 : 440. 1896.

B. streptorhodon C. Muell., Bull. Herb. Boiss. 5 : 179. 1897.

B. cygnopelma C. Muell., *ibid.*: 550. 1897.

B. superpensum C. Muell., Bull. Herb. Boiss. 6 : 32. 1898.

Rhodobryum andicola (Hook.) Par., Ind. Bryol. Suppl.: 1114. 1898.

Bryum schlumbergeri Hamp. in C. Muell., Gen. Misc. 236. 1900. nom. nod.

B. pumiliroseum Dix., Trans. R. Soc. S. Afr. 8 : 203. 9. 1920.

B. microdontum Dix., J. Bot. 76 : 258. 1938. hom. illeg. (non B. microdontum (Hedwig.) P. Beauv., 1899).

B. spiralifolium Dix., J. Bot. 76 : 258. 13. 1938.

Plants in rather dense tufts, robust, dark or bright green above, simple or branched with innovations, 1 - 5 cm high, with brown tomentum below.

Rhizoids reddish brown, moderately papillose. Tubers and filamentous gemmae present. Filamentous gemmae axillary, brown, densely papillose, abundant, arising from the comal tufts near the tip of the branches. Tubers on short rhizoids, red to reddish brown, round, 260 - 986 μm

in diameter, or oval, 245 - 977 x 314 - 1140 μm ; tuber cells 32 - 55 x 42 - 72 μm , 11 - 25 cells across.

Leaves small, distant, ovate and appressed to stem when moist and dry in the lower part, abruptly larger in size and densely crowded towards apex of stem to form a comal tuft above, shrinking when dry, slightly twisted round themselves and usually strongly spirally twisted round the stem when dry, erect spreading when moist, oblong to spatulate, rarely ovate, 1 - 2.5 mm in breadth, 3 - 6.5 mm in length, widest at $\frac{2}{3}$ to $\frac{3}{4}$ from the base of the leaf, mucronate to cuspidate; nerve strong, reddish brown at the base, sometimes reddish brown throughout, shortly excurrent; margin serrate or serrulate in upper part, recurved for up to $\frac{3}{4}$ of leaf below; border distinct, consisting of 2 - 4 rows of narrow elongated cells, rarely up to 6 rows, yellowish in older leaves. Basal cells broadly rectangular in longer leaves, quadrate in smaller leaves, (15) - 19 - 28 - (32) x (32) - 65 - 110 - (155) μm , porose; upper cells broadly rhomboid - hexagonal, of regular shape and size, 15 - 24 x 40 - 83 μm , porose.

Dioecious. Perichaetial leaves narrow, reddish at the base, lanceolate, cuspidate; nerve moderately excurrent; margin recurved, female paraphyses orange. Perigonial leaves broadly ovate, concave, cuspidate; nerve short excurrent; margin rarely recurved; male paraphyses light orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 1.5 - 3.5 cm long, lower portion reddish brown to deep brown, upper portion yellow.

Capsule ovoid - pyriform to oblong, 3.4 - 5.6 - (7.2) mm in length (with lid), with a distinct neck, horizontal or cernuous when dry, cernuous to pendulous when moist, slightly contracted below the mouth when dry, sometimes not contracted, symmetrical, light brown to brown, mouth brown to deep brown, glossy; neck distinctly shrunken when dry;

exothecial cells at the mouth \pm quadrate, uppermost row of cells not transversely elongated, 7 - 8 rows of short cells with walls equally thickened on all sides; cells below the mouth not in longitudinal rows, narrow, 9 - 28 μm in breadth. Lid brown to dark brown, conical acuminate, cells 10 - 29 μm , in broken concentric layers.

Spores 11 - 14 - (16) μm in diameter, papillose.

Hawaii. HVNP: trail to summit of Mauna Loa from Mauna Loa Strip Road. On litter covered ground, as patch ca. 3" x 4" under Styphelia, with Dicranum speirophyllum and Anoetangium haleakalae. Elev. 7300', June 1966, W.J. Hoe no. 679.0 (WJH, TNS). Maui: Insula Sandwick, in insula Maui Occid., mountain ravines, trunks of trees, 3500 ft, 1876, D.D. Baldwin 240b (FI). Oahu: N. Wainae Mountains; Summit Puu Kaala, epiphytic on rather large clump of leafy hepatic about 4 ft., from ground on fork in branch of Myrsine, elev. 4000 ft., Dec. 1965, W.J. Hoe No. 504 (WJH). Hillebrand (type of B. limbato-marginatum C. Muell.) (H).

U.S.A. Arizona: Cochise Co., Cave Canyon, Huachuca Mts., March 1927, Edwin B. Bartram 1697 (FH). Santa Cruz Co., Patagonia Mts., near Flux Canyon, dry bank, alt. 5000 ft., Feb. 1924, Edwin B. Bartram 171 (FH, CANM). Pima Co., wet soil at edge of streamlet near ski lodge, alt. 9000 ft., Catalina Mts., Coronado Nat'l Forest, 12 miles north. Tanque Verde, April 1965, F.J. Hermann 19750 (GL). New Mexico: Grant Co., west slope of Black Range between Emory Pass and San Lorenzo, Oct. 1963, W.A. Weber, A. Vaarama & A. Khanna B - 11652 (COLO). Texas: Brewster Co., Chisos Mtns., E. slope of Pulliam Bluff, small canyon between Pulliam Bluff and Pulliam Peak, oak woodlands, alt. 6000 ft., June 1973, R.E. Magill 1145 (FH). Western Texas, Jeff Davis Co., Ft. Davis, 5200 ft., May 1926, C.R. Orcutt 7084 (FH).

Mexico. "In frigidis Tolucae et Islahuacae, alt. 1330 hexapod., Regio Mexicano" (Humboldt per Kunth. SV 86) No. 2473, n.d. (type of B. andicola Hook.) (GL). Mexique, 1865, Bescherelle (type of B. schlumbergeri Hampe) (BM). Valle' de Mexico, 1865, n.d., Bourgeau 1357 (type of B. comatum Besch.) (BM). Mirador, n.d., 6/41, Liebmann (type of B. sartorii Schimp.) (BM). Mirador, n.d., Liebmann (type of B. liebmanni Schimp.) (BM, H). Prope Santa Fe, e valle Mexicansi (Bourg. no. 1330, Aug. 1865) (type of B. subroseum Besch.) (BM). Ehrenberg, (Herb. Hampe 1881) - (type of B. ehrenbergianum C. Muell.) (BM). Durango: on exposed root, 40 km. west of El Salto, 8850 ft., Dec. 1944, A.J. Sharp 1865 (FH). Nuevo Leon: very sparse on limestone - clay embankment of road through oak-pine woods, Chipinque Sierra Madre Oriental, alt. 4900 ft., ca. 9 miles NW, Monterrey, Jan. 1975, F.J. Hermann 26060 (GL). San Luis Potosi: Alvarez, Dec. 1924, C.R. Orcutt 6517 (FH). Jalisco: south-western Jalisco, dry oak forest, shaded soil, steep bank, 4200 ft., north slope of La Cumbre, 10 miles south-west of Autlan on La Resolana Road, Aug. 1943, H.A. Crum 1226 (F). Michoacan: vicinity of Morelia, Loma del Zapote, 1950 m. Sept. 1911, Bro. G. Arsens No. 7503 (F, FH). Mexico: about Km. 50 on road from Mexico City to Puebla, 98° 53' W, 19° 22' N., Jan. 1953, A.L. Andrews B-243 (F). Hidalgo: Municipality of Jacala, in shallow soil on rock, alt. 4500 ft., July 1939, V.H. Chase No. 7416 (F, MU). Vera Cruz: damp forest above 2000 m. western edge of State, Orizaba, 97° 18' W, 18° 43' N., Mar. 1953, A.L. Andrews B-554 (F). Morelos: Cuernavaca, Sept. 1925, C.R. Orcutt No. 6903 (FH). Guerrero: oak-pine forest about 10 Km. west of Camotla, Municipio de Chichihualco, about 40 Km. west of Chilpancingo; elev. 2500 m., Dec. 1963, Jennie V.A. Dieterle No. 3207a (CANM). Puebla: 1 mile north of Villa Juarez, forested hillside, on soil, bare bank, elev. 3500 ft., Feb. 1961, Ronald L. Mcgregor 16398 (S). Chiapas: dry dolomite boulder, 7000 ft., under Crataegus, south of Las Casas, April 1945, A.J. Sharp 3382 (FH). Magdalen Iful, 1868. (Hahn) (BM).

Guatemala. Dept. Totonicapan: on road between Huehuetenango and Sija, alt. 3000 - 3450 m., shaded bank, Feb. 1939, Paul C. Standley 65886a (F).

Dept. Sacatepequez: alt. 1800 - 2100 m, on log, Dec. 1938, Paul C. Standley 59499 (F). Dept. Quezaltenango: Cerro la Pedrera, south of Quezaltenango, alt. about 2400 m., on rock, Feb. 1939, Paul C. Standley 65558 (F). Dept. Chimaltenango: above Las Calderas, alt. 1800 - 2100 m, on tree, Dec. 1938, Paul C. Standley 60068 (F). Dept. Jutiapa: vicinity of Jutiapa, alt. about 850 m., on shaded bank, Oct. - Nov. 1940, P.C. Standley 76320 (F).

Dept. Zacapa: slopes of Monte Virgen, around summit of mountain, alt. 2200 - 2400 m., on slope, Jan. 1942, J.A. Steyermark 42640 (F, FH, UC).

Dept. Jalapa: Volcan Jumay, north of Jalapa, alt. 1300 - 2200 m., on bark of fallen log in cloud forest near top, Dec. 1939, J.A. Steyermark 32482 (F, FH). Dept. Santa Rosa: near Cuilapilla, alt. about 900 m., damp shaded rock, Nov. 1940, P.C. Standley 78101 (F). Dept. Chiquimula: Volcan Ipala, near Amatillo, alt. 900 - 1510 m., epiphyte on bark of tree bordering lake in cloud forest around summit, Oct. 1939, J.A. Steyermark 30592 (F). Dept. Suchitepequez: Volcan Santa Clara, between Finca El Naranjo and upper slopes, alt. 1250 - 2650 m., on decayed bark of log, May 1942, J.A. Steyermark 46712 (F, FH). Dept. El Progreso: between Pinca Fiamonte and top of Montana Piamonte, along Joya Pacayal, alt. 2500 - 3000 m., on earth bank on summit, Feb. 1942, J.A. Steyermark 43698 (F, FH). Dept. Solola: Pana Jaachel, near Lake Atitlan, lat. 91° 11' N., long. 14° 46' W., elev. 5184', Oct. 1945, Ruth D. Svihla 2897 (FH).

Dept. Guatemala: Guatemala City, in gulch near cemetery, elev. 4910', about lat. 90° 34' N., long. 14° 40' W., Sept. 1945, Ruth D. Svihla 2799 (FH). Alta Vera Paz, Pansamala in ligno putr., 3800 p., Dec. 1887, H.V. Turckheim (syntype of B. streptorhodon C. Mueller) (FI). Alta Vera Paz, in rupe humidissima prope 4400', Feb. 1886, V. Turckheim (syntype of B. streptorhodon C. Muell.) (H, FI).

Honduras. Dept. Atlántida: Lancetilla Valley, near Tela, alt. 20 to 600 metres, on log, Dec. 1927 - Mar. 1928, P.C. Standley 55648 (F). Dept. El Paraiso: Güinope, alt. 1430 m., Dec. 1943, J.V. Rodriguez 1815 (F). Dept. Intibuca: vicinity of La Esperanza and Intibuca, alt. 1500 - 1600 m., on rocks, Jan. - Feb. 1950, P.C. Standley 25380 (F). Sta. Rosa, n.d., pharmacopola, Hjalmarson (as B. ehrenbergii C. Muell.) (H).

British Honduras. El Cayo Dist., ravine, mountain pine ridge, March 1931, H.H. Bartlett 11898a (FH).

Costa Rica. Prov. San Jose: summit of American Highway at Cerro de La Muerte, alt. 3333 m., 83° 45' W, 9° 30' N., on rocks, April 1966, M.R. Crosby 3892 (CANM). Prov. Heredia: finca Isla Bonita near Vara Blanca, cloud forest, Atlantic slope, elev. about 5500 ft., Dec. 1947, Ruth D. Svihla 3060 (FH). Prov. Cartago: S. side of Volcan Irazu, below summit, alt. 3030 m., on base of tree trunk, April 1969, I.M. Lamp & U.V. Metger (FH). San Ramon, July 1932, A.M. Brene (F). Cerro de Las Vueltas, Dec. 1925 - Jan. 1926, P.C. Standley & J. Valerio 43538 (as B. rosulicoma Ren. et Card.) (H).

Panama. Prov. Chiriqui: Boquete, alt. 3600 - 5000 ft., Sept. 1940, Ruth D. Svihla 2712 (CANM).

Colombia. Bogota, Guadalupe, 2900 metres, n.d., A. Lindig (type of B. lindigianum Hampe) (BM).

Venezuela. Quebrada di San Lazaro, on shady situations, Prov. Caracas, 1854, Herb. Hooker (BM). On soil, near Jajo, Edo Trujillo, 1800 m., Aug. 1858, E. Medina & L. Aristeguietez 1273 (FH).

British Guinana. Decaying log, western extremity of Kanuku Mountains, in drainage of Takutu River, dense forest, alt. 600 m., March 1938, A.C. Smith 3282 (as Rhodobryum beyrichianum (Hornsch.) Par. (FH, BM). Vicinity of Kaieteur Falls, July 1955, Marie L. Farr 1571 (IJ, CANM).

Surinam. Lijn Saramaca near Paka - Paka, on the way to Ebbatop. On wet stones. Nov. 1951, J. & P.A. Florschütz 1417 (NICH.).

Brazil. Ad confines Rio de Janeiro - Minaes Geraes. In Paludosis partis superioris montis Itatiaya. 2000 - 2500 m.s.m. ad araucariae brasil. truncos, Sept. 1910, V. Schiffner 1859 (BM). Rio de Janeiro, Glaziou 6362, Herb. Hampe (type of B. stenothecium (Hamp.) Hampe) (BM, H). Santos, in silva litorali, humida ad terram, Jan. 1875, Hj. Mosen 285 (H, S). Serra de Itatiaya, un walde auf Erdboden, 1900 m., Feb. 1894, G. Ule 1770 (type of B. superpensum C. Muell.) (H).

Ecuador. Near Hacienda Monjas, Concepcion, Pichincha, c. 10200 ft., on bank by the road, March 1951, P.R. Bell 38a (BM).

Peru. Mito, shaded places, about 9000 ft., April 1923, George S. Bryan 255 (F). Forontoy Valley, Cedrobamba, 2200 m., Aug. 1927, F.L. Herrera 1597 (F, FH).

Jamaica. St. Andrew: Bellevue, terrestrial, April 1952, R.G. Robbins B1982 (UCWI). Cinchona, 5200', 1896, W. Harris (type of B. cygnopelma C. Muell.) (S, BM). St. Thomas: along trail from Portland Gap to Blue Mountain Peak, 18° 03' N, 76° 35 - 36' W, on rock, elev. about 6000 ft, M.R. Crosby 3476 (CANM). Farm Hill, Oct. 1927, C.R. Orcutt 3632 (CANM).

Haiti. Damp soil of steep grassy slope, east of Ennery, Dept. de l'Artibonite, alt. 325 to 900 metres, Jan. 1926, E.C. Leonard 9017 (FH).
On log in pine forest, north of Savane-Zombie. 6000 - 7000 ft., June 1955, Marie L. Farr 1644 (UCWI, CANM, IJ).

Puerto Rico. On moist ledge near summit of conspicuous twin mountains between Cayey and Salinas, Dec. 1939, W.C. Steere 5317 (FH, UC). On rocky bank along upper "Barrio Guama" trail, CCC Camp, Buena Vista, Maricae Insular Forest, Dec. 1939, W.C. Steere 5834 (UC).

Kenya. On ground, Egoji, Kenya Colony, Aug. 1934, B. Favaro (type of B. microdontum Dix.) (BM). Tghembe, Kenya Colony, Nov. 1921, L. Balbao 615 (as Rhodobryum minutirosatum (C. Muell.) Broth.) (BM). Chania Falls, Thika, Kenya Colony, Aug. 1929, Priestly and Scott 43 (type of B. spiralifolium Dix.) (BM).

Zaire. (West Tropical Africa). Oubangi, Sept. 1934, Eckendorf (as B. microdontum Dix.) (BM).

Tanzania. Roadside bank, south side of Ngorongoro Crater, Aug. 1969, A.C. Crundwell 595 (GL).

Malawi. On rock, 4400 ft., alt. in forest on north-east side of Soche, near Blantyre, Southern Province, July 1969, A.C. Crundwell 343 (GL, CANM).

Republic of South Africa. Cape Province: Campsbay, 1875 - 77, Dr. A. Rehmann 229 (as B. chrysoloma C. Muell.) (BM). Hogsback, Tyumie, 1917, D. Henderson 337 (type of B. pumiliroseum Dix.) (H, GL, BM, BOL).

Bryum andicola grows mostly on logs, stumps and on trees as epiphytes and occasionally it grows on soil and rocks in shaded moist areas. It is mostly found at high altitudes, between 500 m and 3000 m in tropical and subtropical America and South Africa. It is often found occurring in cloud forests at the top of mountains in Central America. The plants reach their largest size when growing in the mountains of Central America and the West Indies. The plants occurring in Arizona, New Mexico and Texas, which is also the northern limit of their distribution, are rather small and rarely fruit. No male plants or fruiting specimens have been observed from Hawaii. It is highly probable that only female plants are found in Hawaii. The Hawaiian plants have certain slight differences from the plants on the American mainland. The leaves of Hawaiian plants are ovate, slightly concave and the border is often wide, consisting of 4 - 8 rows of linear, incrassate cells.

Due to the wide distribution of B. andicola, a wide range of variation in the morphology of the leaf would be expected. However, the leaves of B. andicola show ^{more} a limited range of variation than other species which have a wide distribution. The leaves are typically strongly twisted around the stem to form a comose head at the apex. Due to the extra growth on the outer side of the leaf in the direction of twisting, the leaves may be elongated on one side and shorter on the inner side, giving it somewhat an arcuate appearance. The leaves of Hawaiian plants show slightly an ovate - spatulate shape, while specimens from Central America and Africa show an oblong to obovate-spatulate shape. All the plants usually have numerous brown, septate, cylindrical, papillose filamentous gemmae in the axils of the leaves of the rosulate tuft at the apex. Male plants are rare and only very few specimens have been examined.

B. andicola is a pan-tropical species and is distributed in Hawaii, the Americas (from the southern border of U.S.A. extending through Central America up to Bolivia), West Indies (except Cuba) and South Africa

(Tanzania to Republic of South Africa).

B. andicola has been confused with B. billardieri Schwaegr. in the past. The important characters in which it differs from B. billardieri are as follows:

Bryum andicola

Leaves often strongly twisted around stem to form comal tufts at apex when dry.

Numerous filamentous gemmae in the axils of the leaves.

Leaves oblong to spatulate, sometimes ovate.

Leaf apex often short acuminate, nerve short excurrent, often mucronate, sometimes cuspidate.

Border narrow but distinct, 2 - 4 rows of elongated cells.

Seta not hooked at the junction between capsule and seta.

A South Hemispherical species.

Bryum billardieri

Leaves rarely twisted around the stem when dry, sometimes loosely twisted.

Filamentous axillary gemmae never present.

Leaves mostly obovate-spatulate, rarely ovate.

Leaf apex often long acuminate, nerve often long excurrent, seldom mucronate, often cuspidate.

Border rarely indistinct, 1 - 4 rows of elongated cells.

Seta often hooked at the point of junction between capsule and seta.

A pan-tropical species.

4. Bryum truncorum (Brid.) Brid., Mant. Musc. 119. 1819 (Mnium, 1817)
 , (Figs. 17 - 19)

B. albolimbatum Card. in Grand., Hist. Madag. 39 : 298. 1915 (non
 Jaeg., 1875) hom. illeg.

B. scariosum Thér., Receuil. Publ. Soc. Havraise Etud. Div. 1925 :

Plants densely tufted, robust, bright green above, radiculose below,
 1 - 5.5 cm high, stems simple or branched with innovations.

Rhizoids brown, finely papillose. Tubers present but filamentous
 gemmae absent. Tubers few to abundant, on short rhizoids, orange to red,
 round, 190 - 320 μm in diameter, or oval, 176 - 286 x 260 - 420 μm ; tuber
 cells 22 - 46 x 25 - 63 μm in size, 8 - 14 across.

Leaves densely crowded at apex to form rosette, erect to appressed
 to stem when dry, erect spreading to spreading when moist, not much
 twisted around themselves nor around the stem when dry, obovate to oblong
 lanceolate, 1 - 2.5 mm in breadth, 3 - 7 mm in length, widest at $\frac{2}{3}$ to $\frac{3}{4}$
 from base of leaf, apex long acuminate, never mucronate; nerve strong,
 narrower towards apex, long excurrent in a toothed point, colourless;
 margin distinctly toothed above, slightly recurved to not recurved at all
 below; border wide and distinct, consisting of 3 - 9 rows of narrowly
 elongated cells, seen as a whitish limb even in dry specimens; basal
 cells rectangular, 20 - 38 x 56 - 132 μm , porose; upper cells longly
 and narrowly rhomboidal to hexagonal, 16 - 22 x 53 - 91 μm , porose.

Dioecious. Perichaetial leaves light green, lanceolate; nerve
 long excurrent; margin crenulate above, recurved below; female paraphyses
 orange. Male plants not seen.

Seta 2.5 - 4.4 cm long, lower portion reddish brown, upper portion
 yellowish brown.

Capsule long cylindrical, horizontal to cernuous when dry, pendulous when moist; neck not distinct, shrinking when dry; 4.5 - 5.3 mm long (without lid), symmetrical, brown; mouth large, deep brown; contracted below the mouth when dry; exothecial cells at the mouth 5 - 7 rows of short rectangular to rounded hexagonal cells, thickened on all sides, the uppermost 1 - 2 layers of cells may be transversely flattened; exothecial cells below the mouth \pm rectangular, strongly thickened on transverse walls, 13 - 30 μ m in breadth, \pm in longitudinal rows. Lid not seen.

Spores 11 - 14 μ m in diameter.

Madagascar. Mt. Tsaratnana, 1200 - 2400 m, April 1924, Perrier de la Bathie (type of B. scariosum Ther.) (H, S). Zone du Plateau Central: Imerina, environs de Tananarive, 1911, Miss Elsie Sibree (type of B. albolimbatum Card.) (BM).

Reunion. Vincent, s.n., Herb. Bridel 569 (type of B. truncorum (Brid.) Brid.) (B). Isle de Bourbon (Richard), n.d., Herb. Arnott (as Mnium erythrocaulon Schwaegr.). Basse Vallee above St. Philippe, forest with high rainfall, Nov. 1973, M.J.E. Goode 4672 (CCT). Riviere des Ramparts, Roches Plates Path, very steep hillside with high rainfall of c. 200 ins., fairly thick vegetation but dappled shade, heath association on upper part and larger trees on lower alt., c. 5000 ft., Nov. 1968, Sir Colville Barclay 1292 (CCT).

B. truncorum grows mainly on logs and trees, and occasionally on soil at moderately high altitudes in the shade or semi-shade.

The species concept of this moss is the same as that established by Ochi (1971). I have included B. scariosum among the synonyms by virtue of the wide border and dentate margin above although the lower margin is

recurved.

B. truncorum might be confused with B. erythrocaulon which is found in the adjacent areas of Mauritius, Madagascar and South Africa. The important differences by which B. truncorum may be distinguished from B. erythrocaulon are given below:

<u>B. truncorum</u>	<u>B. erythrocaulon</u>
Plants large, 1 - 5 cm high.	Plants smaller, 1 - 3 cm high.
Tubers 190 - 320 μ m in diameter, 8 - 14 cells across.	Tubers 290 - 580 μ m in diameter, 10 - 20 cells across.
Leaves obovate to oblong lanceolate.	Leaves oblong to oblong spathulate.
Leaves up to 7 mm in length, widest at $\frac{2}{3}$ to $\frac{3}{4}$ from base of leaf.	Leaves up to 5 mm in length, widest at $\frac{1}{3}$ to $\frac{2}{3}$ of leaf.
Leaf margin strongly dentate above, slightly or not recurved at all below.	Leaf margin not strongly dentate above, strongly recurved below.
Leaf border distinct and wide, up to 9 rows of elongated cells.	Leaf border slightly distinct and narrow, up to 3 rows of elongated cells.
Capsule long cylindrical, up to 5.3 mm long without lid.	Capsule short, ovoid cylindrical, up to 4.8 mm long without lid.
Mouth of capsule often large.	Mouth of capsule often small.

B. truncorum

Exothecial cells below the mouth
irregular in shape, cells narrow,
13 - 30 μm in breadth.

B. erythrocaulon

Exothecial cells below mouth \pm
regular in shape, quadrate to
rectangular, cells broad,
15 - 37 μm in breadth.

B. truncorum may be compared with B. ekmanii Thèr. from Cuba. Both have similar characteristics such as wide border, margin almost plane and long cylindrical capsule. The fruiting plants of B. ekmanii examined had somewhat immature and deformed capsules and therefore this character is not reliable for purposes of comparison. I hesitate to treat both as the same species because of the larger robust size and the presence of tubers in B. truncorum. Further, both plants are distributed far apart, and thus have a disjunct distribution which makes it likely that the characters are derived more from parallel evolution, rather than being derived from the same parent plant.

5. Bryum erythrocaulon (Schwaegr.) Brid., Mant. Musc. 119. 1819 (Mnium, 1816) (Figs. 20 - 22).

B. nanorrhodon C. Muell. ex Besch., Ann. Sc. Nat. Bot. Ser. 6, 10 : 237. 1880.

B. subappressum Ren. et Card., Bull. Soc. R. Bot. Belg. 33 (2) : 123. 1895.

B. fluminale C. Muell. ex Broth., Bot. Jahrb. 24 : 248. 1897.

B. ischyrospeiron C. Muell. in Par., Ind. Bryol. Suppl. 1 : 65. 1900 nom. nud.

B. lato-marginatum C. Muell. in Par., Ind. Bryol. Suppl. 65. 1900 nom. nud.

B. angustissimifolium C. Muell., Rev. Bryol. 28 : 88. 1901.

B. subgracilescens Ren. et Par., Rev. Bryol. 39 : 85. 1902.

B. madagasso-ramosum Broth. in Voeltzk., Reise Ostafrika 3 : 57. 1908.

B. suberythrocaulon Ren. et Card., Prodr. Fl. Bryol. Madag. Suppl. 57. 1909.

B. subappressum var. forsythii Ren. et Card. in Grand., Hist. Madag. 39 : 297. 1915.

B. homalobolax var. minor Ther., Receuil. Publ. Soc. Havraise Etud. Div. 1922 : 126. 1922.

B. pseudotruncorum Ther., ibid. : 125. ic. 1922.

Plants loosely or densely tufted, green, 1 - 3 cm high, radiculose below.

Rhizoids orange brown, finely papillose. Tubers present but filamentous gemmae absent. Tubers on short rhizoids, few to abundant, round, 290 - 580 μ m in diameter, or oval, 252 - 582 x 315 - 630 μ m, orange to red; tuber cells 25 - 42 x 27 - 59 μ m in size, 10 - 20 across.

Leaves densely set at apex, occasionally arranged all along the stem, green, not twisted around themselves nor around the stem, not shrinking when dry, erect spreading when moist, oblong to oblong spatulate, 1 - 1.8 mm in breadth, 3 - 5 mm in length, widest at $\frac{1}{3}$ to $\frac{2}{3}$ from the base of leaf, apex short acuminate, rarely mucronate; nerve strong, orange at the base, short excurrent to moderately excurrent, toothed at tip; margin moderately dentate in upper $\frac{1}{4}$ to $\frac{1}{3}$ of leaf, recurved

strongly for up to $\frac{3}{4}$ of leaf below; border indistinct to distinct, 1 - 3 rows of slightly elongated cells, rarely more. Basal cells rectangular, 21 - 35 x 45 - 120 μm , porose; upper cells mostly rhomboidal, cell walls incrassate, 16 - 20 x 50 - 72 μm , porose.

Dioecious. Perichaetial leaves lanceolate, cuspidate; nerve moderately excurrent; margin crenulate above, recurved below; female paraphyses light orange. Perigonial leaves ovate, slightly concave, cuspidate; nerve shortly to moderately excurrent; margin recurved below; male paraphyses orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 2.5 - 3.8 cm long, lower portion reddish brown, upper portion yellowish brown.

Capsule short ovoid cylindrical, 4 - 4.8 mm in length (without lid); neck not distinct, shrunken when dry, cernuous to pendulous when dry or moist, slightly or not contracted at all below the mouth when dry, mouth small, symmetrical, light brown to brown; exothecial cells at the mouth arranged in longitudinal rows, the uppermost 2 - 3 rows consisting of short rounded quadrate cells, occasionally transversely elongated and then 5 - 7 layers of abruptly larger, regularly shaped \pm quadrate to rectangular cells, thickened on all sides; exothecial cells below the mouth strongly thickened on the longitudinal walls, wide, 15 - 37 μm in breadth, \pm in longitudinal rows. Lid not seen.

Spores 10 - 14 μm in diameter.

Republic of South Africa. Cape Prov., Albany Division, "Faraway", Just outside Grahamstown in open veldt, 5 km WSW of town center, 33° 20' S, 26° 29' E, 2400 ft. alt., Sept. 1975, D.K. Bailey and C. Jacot-Guillermod 75 - 102c (COLO). Transvaal, Drakensberg, on soil, stream running into Sabie River, 8 km from Sabie on Hazyview Road in natural forest area in Rietfontein forest, approx. 1075 m in shade, Sept. 1976, J.M. Rankin

267a (BM).

Madagascar. Fort Dauphin, July 1926, R. Decary (as B. scariosum Ther.) (FH). Fianantrosa, 1890, Dr. Besson (type of B. suberythrocaulon Ren. et Card.) (H). Ost-Madagascar, Sakana, Urwald, 1904, A. Voeltzkow (type of B. madagasso-ramosum Broth.) (H). Circa un Moramanga, 1901, indigen collect (as B. subgracilescens Ren. et Card.) (FH, H). Massif d' Andringstra, alt. 1600 - 2500 m, 1921, Perrier de la Bathie (type of B. pseudo-truncorum Ther.) (BM, H). Prov. Fort Dauphin, June 1926, R. Decary (as B. pseudo-truncorum Ther.) (FH). Vinanybe', district de Fort Dauphin, sur le sable, en foret littorale, Oct. 1932, R. Decary (BM). Analamazaoka, 1901, Lovoil (type of B. subgracilescens Ren. & Par.) (FI). Sine loco, n.d., Sikora (type of B. lato-marginatum C. Muell.) (H). Amperifery, alt. 1300 - 1400 m, 1890, Campenon (type of B. subappressum Ren. & Card.) (S). Tenerive, distr. Tamatave, 1896, Perrot (type of B. angustissimifolium C. Muell.) (H, FI, S). Central Madagascar, Ambonimitombo Forest (Tanala), 1350 - 1440 m, Dec. 1894, D. Forsyth, Major No. 480 (type of B. subappressum var. forsythii Ren. et Card.) (FI). Statio Forestiere de Fort Dauphin, sur le Sable, au bord d'un chemin, forestier: alt. ca. 20 m, M. Onraedt (MB). Route de Moramanga, Cakato Sous-bois; foret om brophile de Moyenne altitude, Aug. 1963, J. Bosser (MB). Betsileo, 1905, Villaume (H).

Mauritius. Maurice, n.d., Robillard (type of B. ischyrospeiron C. Muell.) 1876, Robillard (type of B. nanorrhodon C. Muell.) (BM, NSW). Isle de France, n.d., Commerson (type of B. erythrocaulon Schwaegr.) (BM, G). Crown land Perrier, Indigenous forest, approx. 1500 ft, corticolous, Nov. 1969, Sir Colville Barclay 1687 (CCT). Perrier Forest Reserve, on trees and shrubs in low forest, Nov. 1973, M.J.E. Goode 4022a (CCT).

B. erythrocaulon grows mostly on soil and leaf litter in shaded forest areas at low to moderately high altitudes. It is distributed in South Africa, Madagascar and Mauritius.

B. truncorum (Brid.) Brid. which is found in Reunion and Madagascar may be confused with the present moss. Differences between B. truncorum and the present species are discussed under the description of B. truncorum. This moss may also be compared to B. billardieri Schwaegr. which one would expect to find in these areas if it had a Podocarpus type of distribution (Seki, 1974). Further, B. billardieri is found in nearby Gough Island and Tristan da Cunha which raises the probability of it being also found in South Africa, Madagascar and the Mascarene Islands. The only clear cut differences between the present moss and B. billardieri are in the smaller size of the tubers in B. erythrocaulon and in the morphology of the capsule.

A sufficient number of specimens was not available from Madagascar and Mauritius to be able to study this moss critically. Most of the specimens available were either scanty and/or sterile. A more thorough study of this moss is necessary to confirm it as a distinct species.

6. Bryum ekmanii Thér., Mem. Soc. Cubana Hist. Nat. 13 : 279. 35f. 3.
1939 ("i") (Figs. 23 - 24).

Plants loosely or densely tufted, simple, occasionally branched, green, robust, 0.5 - 2.5 cm high, with loose brown tomentum below.

Rhizoids brown, moderately papillose. Tubers and filamentous gemmae absent.

Leaves densely tufted at apex to form comal tuft, green, when dry not shrinking, slightly twisted around themselves and also around the stem, ovate to obovate-spathulate, 1.2 - 1.6 mm in breadth, 3.5 - 5.3 mm in length, widest at $\frac{1}{2}$ to $\frac{2}{3}$ from the base, with an acute to acuminate apex, cuspidate, rarely mucronate; nerve nearly of same size throughout, moderately excurrent, reddish at the base, colourless above; margin dentate above, slightly recurved or plane below; border often distinct and wide, up to 8 rows of narrowly elongated cells, colourless; basal cells rectangular, variable in size, 17 - 31 x 73 - 140 μ m, densely porose, upper cells elongate rhomboidal or hexagonal, 15 - 19 x 48 - 90 μ m, often densely porose.

Dioecious. Perichaetial leaves lanceolate, cuspidate, nerve moderately excurrent; upper margin denticulate, recurved below; female paraphyses yellow. Male plants not seen.

Seta 2.2 - 3 cm long, lower portion reddish brown, upper portion light brown to yellow.

Capsule long cylindrical, 4.5 - 5.2 mm in length (with lid); neck not distinct, not distinctly shrunken when dry; suberect to horizontal when dry, cernuous to pendulous when moist, not contracted or slightly contracted below the mouth when dry, symmetrical, brown to reddish brown, glossy; mouth often large, reddish brown; exothecial cells at the mouth consisting of 7 - 9 rows of short cells, not in longitudinal rows, strongly thickened on all sides; cells below the mouth relatively thin

walled, 12 - 30 μm in breadth, in longitudinal rows. Lid reddish brown to dark brown, conical-acuminate.

Spores 16 - 17 μm in diameter.

Cuba. Prov. Oriente: Sierra Maestra, northern spur of Pico Turquino, 1950 m.s.m., on the ground, April 1915, E.L. Ekman 5483 (type of B. ekmanii Thér.) (NY). Turquino region, July 1922, Fre Leon (F). Prov. Oriente: Region de Moa; in pinetis humidis lateriticis serentinosi vallis Rio Toa, 550 m.s.m. in reserv. Cupeyal, Nov. 1970, A. Borhidi, O. Muniz, S. Vasquez (MB). Prov. Pinar de Rio pan de Guajaibon, in dense thickets on the eastern top of mountain, the highest in Pinar del Rio, c. 750 - 800 m, Jan. 1921, E.L. Ekman (S).

B. ekmanii grows mostly on soil but rarely on wood at low to moderately high altitudes. It is closely related to B. andicola Hook. and can be easily confused with it. A number of important differences between B. ekmanii and B. andicola are given below.

<u>B. ekmanii</u>	<u>B. andicola</u>
Filamentous gemmae and tubers absent.	Filamentous gemmae and tubers present.
Leaves not markedly twisted around the stem.	Leaves often spirally twisted around the stem.
Leaf apex often long acuminate, cuspidate.	Leaf apex acute, often mucronate.
Nerve moderately to long excurrent.	Nerve often short excurrent.
Leaf margin sometimes not recurved at all below.	Leaf margin recurved below, rarely plane.

B. ekmanii

Leaf border often wide, up to 8 rows of narrow elongated cells.

Upper cells elongate hexagonal or rhomboidal, not of regular size.

Neck of capsule not distinct, not distinctly shrunken when dry.

Exothecial cells at mouth strongly thickened on the walls.

B. andicola

Leaf border often narrow, 2 - 4 rows of narrow elongated cells, rarely more (except in plants from Hawaii).

Upper cells short rhomboid - hexagonal, of regular shape and size.

Neck of capsule distinct, distinctly shrunken when dry.

Exothecial cells at mouth moderately thickened on the walls.

7. Bryum ramosum (Hook.) Mitt., J. Linn. Soc. Bot. Suppl. 1 : 75, 1859.

(Figs. 25, 26).

Mnium ramosum Hook. in Icon. Pl. Rar., 1 : 20. 1836.

Bryum ptychothecium Besch., Ann. Sc. Nat. Bot. ser. 7, 15 : 66. 1892.

B. globicoma C. Muell. Nuov. Giorn. Bot. Ital. n. ser. 4 : 246. 1897.

Plants loosely tufted, branched, olive green to dark green, 1 - 5 cm high, with brown tomentum below.

Rhizoids reddish brown to brown, moderately papillose. Tubers present but filamentous gemmae absent. Tubers on long rhizoids, scattered to abundant, red to dark red, often dark when dry, round, 216 - 402 μm in diameter; tuber cells 20 - 32 x 25 - 43 μm in size, 5 - 13 across.

Leaves densely or loosely set, olive green to dark green, glossy, twisted around themselves and also around the stem, shrinking when dry, ovate to ovate - spatulate, 0.8 - 1.4 mm in breadth, 2 - 5.9 mm in length, widest $\frac{1}{2}$ to $\frac{2}{3}$ from the base, cuspidate; nerve strong, long excurrent, sometimes flexuose, yellow to pale brown; margin strongly dentate above, recurved below for $\frac{3}{4}$ of leaf from base; border narrow but distinct, consisting of 2 - 3 rows of narrow elongated cells, usually yellowish in older leaves. Basal cells broadly rectangular, 22 - 35 x 60 - 110 μm , porose; upper cells \pm regularly hexagonal, 20 - 28 x 47 - 93 μm , not much porose.

Dioecious. Perichaetial leaves green, lanceolate, cuspidate; nerve long excurrent; margin toothed above, recurved below; female paraphyses golden yellow. Male plants not seen.

Seta 2 - 3.5 cm high, lower portion dark orange, upper portion light orange.

Capsule ovate - cylindrical, slightly arcuate, asymmetrical, 3 - 4.2 mm in length (with lid), with a short distinct neck, horizontal

to cernuous when dry, cernuous to pendulous when moist, mouth small and slightly oblique, not contracted below the mouth when dry, pale brown to dark brown, mouth deep reddish brown, neck shrunken when dry; exothecial cells at the mouth forming 5 - 7 layers of short cells, the two uppermost layers usually with transversely elongated cells, in longitudinal rows. Cells below the mouth \pm in longitudinal rows, cell walls thickened on all sides, 14 - 35 μm in breadth. Lid brown to deep brown, conical apiculate, cells narrow, 10 - 33 μm in breadth, not in concentric layers.

Spores 16 - 20 μm in diameter.

India. Simla (S.E. Punjab), summit of Mount Jako, on trees, 8000 ft., Aug. 1904, W. Gollan, No. 6379 (FH, FI). Mussoorie, 4 - 7000 ft. above sea level, on soil, Aug. & Sept. 1950, R.S. Chopra & B.K. Abrol, No. 448 (FH, CANM). Himalaya, Jakri Garhwal, Deota Valley, 7 - 8000 ft., May 1899, J.F. Duthie (H).

Nepal. Nepal, n.d., Wallich, Herb. Hooker, H 3650 (type of B. ramosum (Hook.) Mitt.) (BM). East Nepal: Between Shewaden and Papung, alt. 2000 - 2600 m., on rock, June 1972, Z. Iwatsuki No. 1980 (as B. salakense Card.) (NICH). Eastern Nepal: Dhankuta Province, Milke Bhanjjang, alt. 10,000 ft., Dec. 1961, A.H. Norkett No. 8627d (BM). Khatmandu Area: Mt. Phulchoki summit area, alt. 2300 - 2670 m., on rock cliff, July 1972, Z. Iwatsuki No. 2488 (NICH, TNS).

Sikkim. Yoksam, 1700 m., May 1960, H. Hara, H. Kanai, G. Murata, T. Togashi, T. Tuyama No. 75a (NICH). Sikkim-Himalaya, Prope Kurseong, Sonada, 7200 ft., (2195 m), May 1899, Rev. P. Decoly et Schaul (FI).

Bhutan. East bank of Thimphu Chu, 10 km N. of Thimphu Dzong, ca. 2600 m, on soil on shaded bank in mixed forest, with Mnium sp., June 1975, A.J.C. Grierson & D.G. Long No. 633 (GL). Tzatogang (3000) - Dotanang (2500), 2800 m, in Tsuga forest, May 1967, H. Hara, H. Kanai, G. Murata, H. Ohashi, O. Tanaka & T. Yamazaki No. 1706 (NICH).

Burma. So. Shan States; Taunggyi, Crag trails, March 1953, R.V. Svihla No. 3752 (FH).

China. Yunnan: Delavag, July 1890, Herb. Bescherelle (type of B. ptychothecium Besch.) (BM). Prov. Yunnan: In montium inter Dali (Talifu) et Hodjiang regione temperata supra vicum Hsiang Schuiho, 26° 15', substr. ligno quercum; alt. s.m. ca. 2900 - 3200 m, May 1915, Dr. Heinr. Frh. v. Handel - Mazzetti No. 6487 (H). Prov. Yunnan bor - occid.; in pluviisilvis mixtis temperatis Vallis Doyon - lumba ad fluvium Lu - djiang (Salween) ca. 28° 2', ad marquem viae, substr. schistacea; Sept. 1915, Dr. Heinr. v. Handel - Mazzetti No. 8317 (H).

Japan. Kyushu: Prov. Osumi, Mt. Kirishima, ca. 1300 m, on humus, July 1952, H. Ochi 2138 (CANM). Honshu: Prov. Musashi, Nishi-tama-gun, on rocks in shade, Mrs. U. Mizushima No. 5859 (as B. ramosum var. longifolium (Fl.) Ochi) (CANM). Honshu: Saitama Pref., Chichibu, ca. 1400 m, on humus, Aug. 1954, I. Nagano (HO).

B. ramosum grows mostly on humus, soil and rocks, and occasionally on logs in the shade. It is found at moderate to high altitudes.

B. ramosum has been long confused with B. neelgheriense. Some of the important differences between the two species are given below:

B. ramosum

Tubers moderately large, 216 - 402 μm in diameter, red to dark red, often dark when dry, 5 - 13 cells across.

Axillary gemmae absent.

Leaves strongly twisted around the stem.

Leaves much shrinking when dry.

Leaves often ovate to ovate-spathulate.

Width of leaf border constant, 2 - 3 rows of cells, rarely more.

Upper cells of leaf of regular shape and size, regularly hexagonal.

Width of upper cells wide, 20 - 28 μm .

Seta 2 - 3.5 cm high.

Capsule ovate-cylindrical, 3 - 4.2 mm in length (with lid), asymmetrical.

Capsule slightly or not contracted below mouth when dry.

Exothecial cells below mouth of

B. neelgheriense

Tubers large, 240 - 940 μm in diameter, red to reddish brown, 12 - 27 cells across.

Axillary gemmae present.

Leaves only slightly twisted around the stem.

Leaves not shrinking when dry.

Leaves often longly spathulate, sometimes ovate.

Width of leaf border variable, 2 - 4 rows of cells, sometimes more.

Upper cells of leaf not of regular shape and size, longly rhomboid-hexagonal.

Width of upper cells narrow, 14 - 20 μm .

Seta 2.2 - 3.5 cm high.

Capsule cylindrical, 3.5 - 6.5 mm in length (with lid), symmetrical.

Capsule contracted below mouth when dry.

Exothecial cells below mouth

B. ramosum

capsule thickened on all sides,
14 - 35 μm in breadth.

Lid short conical-apiculate, cells
narrow, 10 - 33 μm in breadth.

B. neelgheriense

thickened on the vertical walls,
10 - 23 μm in breadth.

Lid long conical, with sharp
pointed tip, lid cells 15 - 30 μm
in breadth.

8. Bryum pycnophyllum (Dix.) Mohamed, comb. nov. (Figs. 27, 28)

B. syntrichoides C. Muell. in Geh., Rev. Bryol. 5 : 70. 1878 nom. nud.

B. truncorum var. pycnophyllum Dix., S. Afr. J. Sc. 18 : 321. 1922.

B. chrysoloma C. Muell. in Dix. et Gepp, Bull. Misc. Inf. Kew 1923 : 206. 1923 nom. nud.

Plants densely or loosely tufted, sometimes branched, light green to dark green, robust, 1 - 3.5 cm high, with tomentum below.

Rhizoids dark reddish brown, finely papillose. Tubers and filamentous gemmae absent.

Leaves densely set towards the apex, sometimes arranged all along the stem, yellowish green to dark green, glossy, with a whitish tint along the edges and along the nerve, when dry shrinking, twisted around themselves and also around the stem, rarely spreading, ovate to obovate-spathulate, carinate, 1.2 - 1.7 mm in breadth, 3.2 - 5.3 mm in length, widest at $\frac{1}{2}$ to $\frac{3}{4}$ from the base, cuspidate; nerve strong, long excurrent, sometimes flexuose, usually colourless or yellow; margin dentate above, strongly recurved below for $\frac{3}{4}$ of the length of the leaf from the base; border distinct, consisting of 2 - 4 rows of narrow elongated incrassate and non-chlorophyllose cells, usually colourless. Basal cells broadly rectangular, 22 - 32 x 50 - 102 μm , moderately porose; upper cells regularly hexagonal, 15 - 24 x 43 - 68 μm , porose.

Dioecious. Perichaetial leaves oblong to obovate, cuspidate, margin recurved; nerve long excurrent; female paraphyses light yellow. Perigonial leaves concave, broadly ovate; nerve long excurrent; male paraphyses light orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 1.5 - 2.4 cm long, lower portion reddish brown, upper portion yellow. Capsule clavate, slightly arcuate, 3.2 - 4.6 mm in length (with

lid), neck not very distinct, suberect to horizontal when dry, horizontal to pendulous when wet, not contracted below the mouth when dry, asymmetrical, pale brown to brown, mouth reddish brown; neck not distinctly shrunken when dry; exothecial cells at the mouth forming 5 - 7 layers of short irregular cells, uppermost layer \pm transversely elongated, not in longitudinal rows, cells below the mouth not in longitudinal rows, 12 - 34 μm in breadth. Lid reddish brown, conical with a blunt apex, cells 15 - 35 μm in breadth, not in concentric layers. Spores 15 - 16 μm in diameter, papillose.

Republic of South Africa. Cape Province: Stockenstroom Div., on the Katberg, Winterberg Mts., about 98 Km. nearly due N of Grahamstown; rainforest with Widdringtonia cupressoides, 32° 28' S, 26° 36' E, 1500 m.s.m., Sept. 1975, D.K. Bailey & A.J. Guillarmod 75 - 105 (COLO). Bathurst Div., "Brooklands" farm, ca. 23 Km. SSW of Grahamstown on only now known locality of Encephalartos caffer; open veldt 33° 30' S, 26° 36' E, 1500 ft., Sept. 1975, D.K. Bailey & A.J. Guillarmod 75 - 103d (COLO). Albany Div., "Faraway", just outside Grahamstown in open veldt, 5 km WSW of town center, 33° 20' S, 26° 29' E, 2400 ft., Sept. 1975, D.K. Bailey & A.J. Guillarmod 75 - 104b (COLO). Hogsback, Tyumie, 1917, D. Henderson 342 (BM). Cape of Good Hope, Cape Town, Campsbay, Rehmann, A.A., 229 (co-type of B. chrysoloma C. Muell.) (S, BM). In silvis supra Blanco, 1875 - 1877, Rehmann 228 (type of B. syntrichoides C. Muell.) (S, H, FI).

Natal: Bergville District, Natal National Park, locally frequent on sandstone slab in semishade, alt. 4800', July 1947, E. Schelpe 2145 (BOL). Zululand, Nkhandla, Ekombe, 1300 m, Jan. 1910, L.M. Tialestead (H). Estcourt Dist., Emmersdale, along Blauwkrantz River on the farm, Nov. 1949, O.A. Hoeg (BM). Pondoland, 1888, Brachymann (H). Plants De Howick et Pinetown, 1000 m, 1893, H. Junod, missionary, 13a (BM). Ngotsche District; Ngome, above forest near Police Post, on rocks mixed

with Papillaria africana, alt. c. 4250 t., April 1977, O.M. Hilliard & B.L. Burt 9978 (CCT). Orange Free State: On walks in the Drakensberg and Eastern Free State Botanic Garden, Harrismith, 5500 ft., 28° 16' S, 29° 07' E, April 1971, D.K. Bailey 7135b (COLO). Kadziberg, 228b, 1875 - 1877, Rehmann (FI). Transvaal: In montibus Kwatlamba ad Pilgrim's Rest, n.d., Mac Lea, 557 (as B. syntrichoides C. Muell.) (FI). South slopes of mountain, Soutpansberge, June 1929, M. Bosman 1354 (FH). Drakensberg, Rietfontein, H.J.H. Schumyn farm, on trees in shade, old deciduous/evergreen wood amongst large rocks at edge of conifer plantation, c. 1675 m., c.fr., Sept. 1976, J.M. Rankin 364 (BM). Waterval, 1914 - 15, H.A. Wager (BM).

Rhodesia. Umtali, 5000 ft., on rock in shade, June 1919, F. Eyles 1725 (syntype of B. truncorum var. pycnophyllum Dix. (BM). Zimbabwe, 3000 ft., July 1920, T.R. Sim (syntype of B. truncorum var. pycnophyllum Dix.) (BM).

Tanzania. Usambara Mts., Handeni, July 1893, C. Holst 9036b (S, FI).

Bryum pycnophyllum grows mostly on soil, rocks and sandstone in the open, semishade and shade at medium altitudes. It rarely grows on trees. It is distributed in Tanzania, Rhodesia and the Republic of South Africa.

Ochi (1972) had included the present species under B. voeltzkowii Broth. I have examined the type specimen of B. voeltzkowii from Helsinki Museum and found that it differs from the present species. The differences between B. voeltzkowii and B. pycnophyllum are tabulated below:

B. voeltzkowii

Plants large, up to 6 cm high.

Leaves 5.4 - 6.3 mm long

B. pycnophyllum

Plants up to 3 cm high.

Leaves 3.2 - 5.3 mm long.

B. voeltzkowii

Size of upper cells 20 - 25 x
65 - 113 μm .

Basal cells 25 - 40 x 85 - 152 μm .

Leaves not twisted round the stem.

Found in Madagascar only.

B. pycnophyllum

Size of upper cells 17 - 23 x
40 - 65 μm .

Basal cells 22 - 32 x 50 - 102 μm .

Leaves spirally twisted round
the stem.

Found in Tanzania, Rhodesia and
Republic of South Africa.

These differences, especially in cell size, show that B. pycnophyllum is quite different from B. voeltzkowii. The type specimen of B. voeltzkowii is sterile and no other specimens of this are known.

Dixon (1922) considered B. pycnophyllum as a variety of B. truncorum (Brid.) Brid. sensu Dixon which I believe to be B. andicola Hook. as treated in this study. However, B. pycnophyllum is quite distinct from B. andicola. The important characters in which B. pycnophyllum and B. andicola differ are as follows:

B. pycnophyllum

Plants often yellowish green.

Tubers absent.

Axillary gemmae absent.

Leaves ovate to obovate-spathulate.

Leaves cuspidate, never mucronate.

Nerve long excurrent, sometimes flexuose.

B. andicola

Plants often dark green.

Tubers present.

Axillary gemmae present.

Leaves seldom ovate, oblong to obovate - spathulate.

Leaves mucronate to cuspidate.

Nerve short excurrent, never flexuose.

B. pycnophyllum

Leaf margin distinctly dentate above.

Nerve of perigonal leaves long
excurrent.

Capsule clavate, arcuate, 3.2 - 4.6 mm
in length, asymmetrical.

Capsule erect to horizontal.

Exothecial cells below the mouth
12 - 34 μm in breadth.

Spores 15 - 16 μm in diameter.

Found in Tanzania, Rhodesia and
Republic of South Africa.

B. andicola

Leaf margin dentate to nearly
crenulate.

Nerve of perigonal leaves short
excurrent.

Capsule ovoid - pyriform to
oblong, 3.4 - 5 - (7.2) mm in
length, not arcuate, symmetrical.

Capsule horizontal to cernuous.

Exothecial cells below the mouth
9 - 28 μm in breadth.

Spores 11 - 14 - (16) μm in
diameter.

Distributed in Hawaii, North
America, Central America, West
Indies and South Africa.

9. Bryum appressum Ren. et Card., Rev. de Bot. 9 : 395. 1891 (Figs. 29, 30).

Plants loosely or densely tufted, repeatedly branched, sometimes with slender innovations at the apex, dark green to dark, 1 - 2 cm high, sparsely tomentose below.

Rhizoids reddish purple, moderately papillose. Tubers present but filamentous gemmae absent; tubers on short rhizoids, scattered, cherry red to dark red, round, 170 - 390 μm in diameter, or oval, 164 - 340 x 218 - 390 μm ; tuber cells 22 - 37 x 25 - 50 μm , 7 - 11 cells across.

Leaves densely set at apex, hard in texture, brittle when dry, younger leaves green, older leaves dark green to dark, when dry shrinking, not twisted round themselves nor around the stem, closely appressed to stem, oblong to obovate - spatulate, 0.9 - 1.4 mm in breadth, 2 - 3.7 mm in length, widest at $\frac{3}{4}$ to $\frac{5}{6}$ from base, mucronate to shortly cuspidate; nerve shortly excurrent, toothed, thick, of \pm equal thickness up to apex, brownish in older leaves; margin at upper part distinctly toothed, strongly recurved for up to $\frac{5}{6}$ of leaf from base in the lower part; border short, restricted to vicinity of apex, distinct, 1 - 2 rows of incrassate, elongated cells, yellow in older leaves. Basal cells \pm rectangular, 18 - 30 x 58 - 102 μm , porose; upper cells hexagonal, 15 - 20 x 44 - 75 μm , porose.

Dioecious. Perichaetial leaves light green, lanceolate with cuspidate apex; nerve excurrent; margin crenulate above, recurved below; female paraphyses yellow. Male plants not seen.

Seta 2.2 - 2.6 cm long, lower portion dark brown, upper portion brown.

Capsule cylindrical, 3 - 3.5 mm in length (without lid), with a distinct neck, horizontal to cernuous when dry, cernuous to pendulous when moist, not contracted below the mouth when dry, symmetrical, dark brown to reddish brown, mouth brown to reddish brown; neck not distinctly shrunken when dry; exothecial cells at the mouth forming 5 - 7 layers of short

cells, uppermost two layers being transversely elongated, not in longitudinal rows; cells below the mouth 15 - 30 μm in breadth, \pm in longitudinal rows, strongly thickened on the longitudinal walls. Lid not seen.

Spores 12 - 16 μm in diameter.

Madagascar. Ambositro, Betsileo, n.d., Rev. Saula (type of B. appressum Ren. et Card.) (BM, FI). W. Madagascar, Prov. d'Antsirabe, ad amnem Andrantsay, Oct. 1902, Galinon (as B. homalobolax C. Muell.) (S).

Republic of South Africa. Transvaalia: in montis Kwatlamba, ad Mac Mac, n.d., Mac Lea 558 (as Bryum sp. No. 1) (BM).

Ochi (1972) reduced B. appressum Ren. et Card. to a synonym of B. robustum Hamp. After examining the type specimens of both B. appressum and B. robustum, it was found that B. appressum is quite different from B. robustum. Besides the type specimen of B. appressum, two other specimens were examined to confirm that it is indeed a distinct species.

B. appressum is distinct in that the stems and the leaves darken to a dark green or dark colour on drying. The stems and leaves also become somewhat brittle on drying. The lower part of the leaf margin is recurved for most part of the leaf and the margin near the excurrent nerve is dentate for only a short distance. The cherry red tubers are also quite distinct for this species.

10. Bryum sinense Mohamed, n. sp. (Figs. 31-33)

Plantae laxae vel densae caespitosae, e rubro virides, 1 - 3 cm altae, infra tomentosae. Rhizoidea fusca rubra vel rufa. Tubera rubra vel fusca rubra, globosa, 80 - 180 μm , cellulis 20 - 36 x 33 - 50 μm , non protuberantibus, 3 - 7 in diametro tuberi. Gemmae filamentosae in axillis. Folia, in apice caulis majora et densa caespitosa, fusca viridia, basi costa et margine rubra tincta, in sicco vix contracta, vix contorta, leviter ad caulem appressa, lanceolato - obovata ad longe obovato - spathulata, 1 - 2.4 mm lata, 2.4 - 5.7 mm longa, latitudine maxima $\frac{2}{3}$ - $\frac{3}{4}$ supra basem, mucronata vel cuspidata; costa breviter excurrens, basi latior; margo valde recurvata, supra crenulata vel denticulata; cellulae in parte superiori folii porosae, anguste hexagonae vel rhomboides, 15 - 20 x 45 - 72 μm , in marginibus sublimbatis 1 - 2 seriebus cellularum angustarum elongatarum; cellulae in basi folii rectangulares, 20 - 30 x 37 - 126 μm . Dioicum. Folia perichaetialia viridia, lanceolata, longe acuta; margo supra crenulata, infra recurvata; costa valde excurrens; paraphyses pallide flavae. Plantae masculae non vidi. Seta 2.5 - 4 cm longa, infra brunnea, supra flava ad pallide brunnea. Capsula subcylindrica ad elongata - pyriformis, operculata 3.5 - 5 mm longa, in sicco sub ore contracta, collo claro, congruenti, in sicco contracto, pallide brunnea ad rufa; cellulae exothecii \pm in seriebus longitudinalibus, apud orem in 4 - 6 stratis breves, 14 - 30 μm latae. Operculum rufum, subhemisphericum, apice brevi apiculato, cellulis 11 - 32 μm latis, haud in stratis concentricis. Sporae 14 - 15 μm , modice papillosae.

China. China Interior, Provincia Schen-si septentr., Prope In-Kia-Po, March 1896, Rev. Jos Giraldi (as B. globicoma C. Muell.) (FI). Kong Tcheou, Than Li, 1100 m., c.fr., March 1912, J. Esquirol (S). Chine Or.,

Kon Tchong Chan, 1200 - 1500, Oct. 1910, Rev. D. Courtois 321 (type of B. sinense Mohamed) (H).

Japan. Kyushu. Kumamoto Pref.: Kumamoto, Kuma, Koonose, alt. ca. 100 m., preferably on calcareous rocks, March 1951, K. Mayebara 260 (CANM, NICH, WJH, S). Issochi, on calcareous rocks, March 1951, K. Mayebara 1145 (NICH). Yasshirogura, Mt. Ryuko, April 1950, I. Kaku 659 (NICH). Fukuoka Pref., Kokura, ca. 400 m, on limestone, May 1955, T. Osada 855 (HO).

Shikoku. Ehime Pref.: Niigun, foot of Mt. Ishizuchi, ca. 600 m, on moist rock wall, Aug. 1954, H. Ochi 4778 (HO).

Honshu. Yamaguchi Pref.: Mine-gun, Shuho,cho, around Kanekyo-no-ana Cave, 100 m alt., on stone wall, Aug. 1976, Z. Iwatsuki & T. Shiomi 12130 (NICH). Hiroshima Pref.: Taishaku Gorge, ca. 400 m, on limestone, April 1956, H. Ando 7121 (HO). Okayama Pref.: Niim-shi, Rashomon, on limestone, 1954, A. Noguchi 43561 (NICH). Okayama Pref., Niizato, Atetsu-gun, April 1950, C. Igi 293 (HO). Saitama Pref., Chichibu, Mt. Buko, ca. 610 m., Nov. 1952, I. Nagano 3239 (HO).

Bryum sinense grows on limestone or calcareous rocks in Japan. The substrate on which all the available specimens from Japan were growing was tested with hydrochloric acid. Fizzing or effervescence occurred with the majority of the substrates, showing the limestone origin of the soil and the calcicolous nature of the plant. The soils on which B. neelgheriense var. wichurae Mont. and B. ramosum (Hook.) Mitt., the two other closely related species, were found growing did not show the 'fizzing' reaction with hydrochloric acid. However, only 3 packets of B. sinense were available from China and there was too little substrate attached to the rhizoids and so whether it was of limestone origin could not be tested. Further, nothing concerning the nature of the substrate on which the plants were growing has been mentioned by the collectors.

11. Bryum subfasciculatum (Hamp.) Mitt., Trans. Proc. Soc. Victoria
19 : 73. 1882 (Rhodobryum, 1876). (Figs. 34, 35).

B. laxifolium Besch. Ann. Sc. Nat. Bot. ser. 5, 18 (3); 216. 1873 (Non
Lindb. 1867; non Warnst. 1887) hom. illeg. (type specimen not seen).

Rhodobryum subfasciculatum Hamp., Linnaea 40 : 312. 1876.

Bryum dilatato-marginatum C. Muell., Hedwigia 37 : 102. 1898.

B. amoenum Wright in Watts et Whitel., Proc. Linn. Soc. N.S. Wales Suppl.
30 : 126. 1906 (non Broth., 1898; non Bruch et Schimp. ex C. Muell.,
1900; non Podp., 1903) nom. nud.

B. neocaledonicum Ther., Rev. Bryol. 48 : 23. 1921.

B. sigmatellum Ther., ibid. : 24. 1921.

B. chrysophyllum Ochi, Hikobia 6 (3-4): 220. 1973.

Plants loosely or densely tufted, yellowish green or green, lustrous in
the upper part, brown tomentum below, 1 - 5 cm high. Stems simple or
occasionally branched by 1 - 2 subfloral innovations, erect but sometimes
flexuose.

Rhizoids brown to reddish brown, coarsely papillose. Tubers present
but axillary gemmae absent. Tubers on short rhizoids, round, 200 - 488 μm
in diameter or oval, 189 - 451 x 326 - 540 μm , light red to orange red,
scattered and few; tuber cells 24 - 29 x 30 - 39 μm in size, 6 - 11 across.

Leaves usually a little distantly placed along the stem, arranged in
a distinct rosette surrounding the antheridia and paraphyses in male heads,
not much twisted around themselves nor around the stem, rarely loosely
twisted around the stem, sometimes spreading, carinate, often folded upon
themselves at apex, ovate to lanceolate, sometimes obovate, 0.8 - 1.5 mm
in breadth, 2.3 - 6.6 mm in length, widest at $\frac{1}{2}$ to $\frac{2}{3}$ of the length of
the leaf from the base, mucronate to cuspidate; nerve shortly to
moderately excurrent, reddish in the basal part, yellowish green above;

margin distinctly dentate in the upper half to quarter of leaf, the lower half slightly reflexed or plane; border moderately distinct, consisting of 2 - 3 rows of slightly differentiated elongated cells, yellowish in older leaves. Basal cells \pm rectangular, variable in size, 16 - 23 x 55 - 103 μm porose; upper cells elongated rhomboidal, occasionally hexagonal, 13 - 16 x 52 - 80 μm , porose.

Dioecious. Perichaetial leaves yellowish green, narrow lanceolate, cuspidate; nerve excurrent; margin reflexed below, denticulate above; female paraphyses light orange. Perigonial leaves light green, ovate, concave; nerve excurrent; male paraphyses orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 1.5 - 3.5 cm long, lower portion dark brown, upper portion reddish brown.

Capsule clavate-pyriform, 4 - 6 mm in length (with lid), horizontal to cernuous when dry, pendulous when moist, contracted below the mouth when dry, symmetrical, light brown to reddish brown, mouth deep brown; neck distinctly shrunken when dry; exothecial cells at the mouth thick-walled, irregular in size and shape, mostly hexagonal, 5 - 8 layers of short cells, \pm in longitudinal rows; cells below the mouth 10 - 33 μm in breadth, not in longitudinal rows. Lid short conic with indistinct apiculus, brown, cells arranged in \pm concentric layers, 11 - 35 μm in breadth.

Spores 10 - 15 μm in diameter.

Australia. Queensland: Tropical East Australia, n.d., Eaves (type of Bryum subfasciculatum (Hamp.) Mitt.) (BM, H). Duma Creek, Ravenshoe, on bark, summer 1922, T.V. Sherrin (FH). North Queensland, Atherton Tableland; Mount Lewis, on exposed tree root in rain forest, April 1968, W.A. Weber (COLO). Brisbane, Aug. 1890, H. Tryon (as B. subolivaceum C. Muell.) (S). Indooroopilly, Swan's Paddock, on ground, July 1901,

F. Whitteron (H). Millaa Millaa, Cairns, May 1939, Mrs. Sparwell (BM).
 Pine Creek, Cairns, n.d., H. Flecker 2093 (as B. chrysophyllum Ochi) (BM).
 New South Wales: Cambewarra. Dec. 1885, T. Whitelegge (type of B. dilatato-
marginatum C. Muell.) (S, H, NSW). Myocum, Brunswick River, Sept. 1897,
 W.W. Watts 1717 (FI). On ground, damp places, scrub, off Tintenbar Road,
 1 mile from Ballina, Sept. 1899, W.W. Watts 3651 (H). Mt. Duval, near
 Armidale, Nov. 1903, W.W. Watts 7526 (H). Head of Wilson's Creek, Richmond
 River, Aug. 1898, W.W. Watts (NSW). No detailed location, F.M. Bailey (as
B. viridulum C. Muell.) (NSW). On prostrate trunks, Tintenbar, Richmond
 River, Ballina District, W. Bauerlen 1613 (type of B. amoenum Wright.) (NSW).

New Caledonia. Tonghoue, au Pont-du-Diable, 150 m, June 1909, Franc (type
 of B. sigmatellum Thér.) (S, BM). Mt. Mon, July 1909, Franc 51, (as
B. laxifolium Besch.) (BM). Plateau de Dogny, alt. 900 m, Jan. 1911,
 Franc (type of B. neo-caledonicum Thér.) (BM). Caricone, ad rufes humidis,
 Feb. 1906, Le Rat (as B. leptothecium f. luxurians) (S). Mt. Koghis, Aug.
 1901, Le Rat No. 22 (H).

New Hebrides. Aneityum, 1915, Rev. W. Lillie (H, GL).

B. subfasciculatum grows on wet humid places at low altitudes. It grows
 on soil, rocks, logs and tree trunks. In Australia, it is distributed
 in the coastal areas of Subtropical states of Queensland and New South Wales.
 It is also found in New Hebrides and New Caledonia.

This moss is probably related to B. densifolium Brid. of Central and
 South America. Both have similar characteristics such as lanceolate
 leaves, strong denticulation down to the middle of the leaves and arrangement
 of leaves all along the stem. However, B. densifolium has more lanceolate
 leaves, stronger denticulation and the lower margin is often not recurved.

Ochi (1973) gave the name Bryum chrysophyllum to Bryum laxifolium Besch.,

which was an illegitimate later homonym. He did not examine the type specimen of B. laxifolium as the type material was not available. He therefore did not cite a type specimen but cited a specimen from Mt. Koghis, New Caledonia, collected by Franc as agreeing well with the original description of B. laxifolium Besch. Two of the specimens cited by Ochi have been examined by me and these indeed were B. subfasciculatum. The other two specimens cited by him are from Mt. Koghis and Jur Jugo Dogny in New Caledonia. I have also examined specimens from these two localities which were B. subfasciculatum. In addition, the original description of B. laxifolium Besch. confirmed that B. laxifolium Besch. and B. chrysophyllum Ochi are indeed synonyms of B. subfasciculatum.

B. subfasciculatum has been confused with B. billardieri Schwaegr. in the past. A number of important characters by which it can be distinguished from B. billardieri are given below:

B. subfasciculatum

Plants often have leaves arranged all along stem.

Tubers 200 - 488 μm in diameter, 6 - 11 cells across.

Leaves ovate to lanceolate, upper portion usually folded on itself at apex, carinate.

Margin strongly dentate in upper half of leaf, lower half may be plane or slightly recurved.

Border not very distinct, 2 - 3 rows of slightly differentiated cells, rarely distinct.

B. billardieri

Plants often comose, leaves often densely tufted at apex.

Tubers 340 - 950 μm in diameter, 10 - 25 cells across.

Leaves obovate - spatulate, upper portion rarely folded upon itself, rarely carinate.

Margin dentate or denticulate for $\frac{1}{3}$ or $\frac{1}{4}$ of leaf from apex, lower portion recurved.

Border often distinct, up to 6 rows of narrow elongated cells.

12. Bryum microrhodon C. Muell. Hedwigia, 37 : 108 (1898) (Figs. 36, 37).

Plants densely or loosely tufted, green above, reddish below, 0.5 to 2 cm high; lower portion of stem maybe devoid of leaves or tomentum, sometimes with loose reddish purple tomentum.

Rhizoids reddish brown to reddish purple, coarsely papillose. Tubers and axillary gemmae absent.

Leaves small, densely set, appressed to stem, sometimes in small compact heads, green tinged with red at base, edges and nerve, cochleariform, concave, carinate, 1 - 1.4 mm in width, 2.5 - 3.2 mm in length, widest $\frac{1}{2}$ to $\frac{3}{4}$ from the base, mucronate to cuspidate; nerve moderately thick, red, excurrent in a shortly recurved arista, not toothed; margin crenulate above, recurved above, recurved for $\frac{2}{3}$ of leaf from the base; border may or may not be present, if present, consisting of 1 - 2 rows of slightly differentiated cells. Basal cells rectangular, 15 - 25 x 58 - 102 μm , not much porose; upper cells short hexagonal or rhomboidal, 16 - 20 x 25 - 45 μm , not porose.

Dioecious. Perichaetial leaves green tinged with red, lanceolate, cuspidate; nerve long excurrent in an arista; margin plane to crenulate above, recurved below; female paraphyses orange. Male plants not seen.

Seta 1.4 - 2.9 cm high, erect, lower portion dark brown below, light brown above.

Capsule oblong to clavate, symmetrical, glossy, 2.3 - 4 cm in length (with lid), with a narrow neck, horizontal to cernuous when dry, cernuous to pendulous when wet; mouth large, theca small, slightly contracted below the mouth when dry, light brown to dark brown, mouth deep brown; exothecial cells at the mouth forming 6 - 9 layers of \pm quadrate to pentagonal cells, not in longitudinal rows; cells below the mouth \pm in longitudinal rows, 13 - 30 μm in breadth. Lid deep brown, convex - subhemispherical, mamillate, cells 11 - 29 μm in breadth, not in concentric layers.

Spores 11 - 13 μ m in diameter.

Tasmania. Mt. Wellington, St. Crispin's Track, Nov. 1890, W.A. Weymouth (type of B. microrhodon C. Muell.) (H, S). Van Diemen's Land, No. 101, 1874, Lyall (as B. erubescens Wils.) (BM). Launceston, on rock, Trevallyn Creek, Nov. 1911, W.A. Weymouth (H). The Sugar Loaf, Green Ponds, May 1892, W.A. Weymouth (as B. rufescens H. f et Wils.) (H). Bate's Creek, Peppermint, Nov. 1889, Weymouth (H). New Town Creek, near Hobart, (N.W. Bank opposite cottage) Sept. 1887, Weymouth (H). On wood, Hospital Bay, Huon, Nov. 1892, Weymouth (H).

B. microrhodon grows mainly on soil and rock but rarely on logs. It is found only in Tasmania.

This plant seems to be intermediate between B. billardieri Schwaegr. and B. campylothecium Tayl. Specimens showing all variations between these two species have been observed. On one hand it possesses concave leaves, a reddish tinge on the leaves and a crenulate margin; characters also possessed by B. campylothecium. On the other hand, the leaf shape, the presence of a border and the arrangement of the leaves are characters which are possessed by B. billardieri. A moderately large number of specimens from all parts of Tasmania have been examined to show that this plant is not an oddity resulting from local ecological conditions. It is possible that this plant could be a result of hybridisation between B. billardieri and B. campylothecium. Wilson (1874) had noticed these plants to be distinct and had described them as B. erubescens and also as B. mamillatum. Description and notes by Wilson on this species are found on the sheets of specimen 'Lyall No. 101' from the British Museum, though these were not validly published. Mueller (1898) described it as B. microrhodon and this is taken as the correct name for the species.

The important differences between B. microrhodon and B. billardieri

are as follows:

B. microrhodon

Plants small, up to 3 cm high.

Rhizoids reddish brown to reddish purple.

Tubers absent.

Leaves small, up to 3.2 mm in length, often concave.

Edges of leaf and nerve reddish throughout.

Nerve moderately excurrent in a recurved arista, not toothed.

Margin crenulate above.

Border not distinct, 1 - 2 rows of differentiated cells.

Capsule oblong to clavate, up to 4 mm in length.

Lid convex - subhemispherical, mamillate.

Spores 11 - 13 μm in diameter.

B. billardieri

Plants large, up to 6 cm high.

Rhizoids brown to reddish brown.

Tubers present.

Leaves large, up to 6 mm in length, rarely concave.

Edges of leaf not reddish, nerve \pm reddish or brown at base.

Nerve often short excurrent, toothed.

Margin dentate above.

Border often distinct, consisting of 1 - 4 rows of narrow elongated cells.

Capsule oval - cylindrical to oblong - cylindrical, up to 7 mm long.

Lid conical - acuminate, not mamillate.

Spores 12 - 15 - 18 - (20) μm in diameter.

13. Bryum perlimbatum Card., Bull. Herb. Boiss. ser. 2, 5 : 1007. 1905

(Figs. 38, 39, 40)

B. herpetineuron Ther., Bull. Mus. Hist. Nat. Paris 34 : 117. 1c. 1928.

B. pseudothyridium Bartr., Farlowia 2 : 314. 1946.

Plants in loose or dense tufts, light green, soft, 1 - 2.5 cm high, unbranched or branched with up to 3 subfloral innovations, leaves densely set above, distant below, sometimes with brown tomentum below.

Rhizoids reddish brown, finely papillose. Tubers present but filamentous gemmae absent. Tubers usually on long rhizoids, dark orange to reddish brown, abundant, round, 80 - 160 μm , or oval, 84 - 148 x 100 - 210 μm in diameter; tuber cells 21 - 26 x 31 - 37 μm in size, 5 - 9 across.

Leaves loosely or densely set, soft in texture, oval or ovate, usually concave, not much twisted round themselves but slightly twisted round the stem, when dry not much shrinking, 0.9 - 1.5 mm in width, 1.8 - 3.5 mm in length, widest at $\frac{1}{2}$ to $\frac{2}{3}$ of the length of leaf from the base; nerve strong, long excurrent, flexuose, colourless but sometimes yellow; margin crenulate above, recurved in the lower part for $\frac{2}{3}$ of leaf from base; border wide and distinct, consisting of 3 - 10 rows of narrow elongated, incrassate, non-chlorophyllose cells, visible as a whitish limb when dry. Basal cells quadrate to rectangular, 20 - 27 x 35 - 96 μm , porose; median cells \pm rhomboid - hexagonal, 15 - 22 x 39 - 65 μm , often extremely porose.

Dioecious, perichaetial leaves light green, narrow lanceolate with cuspidate apex; margin entire or crenulate; nerve excurrent; female paraphyses light orange. Perigonial leaves narrowly ovate, slightly concave, nerve excurrent, male paraphyses golden yellow; antheridia only at the tip of the branches (fig. 40).

Seta 1.7 - 2 cm high, erect, lower portion dark orange, upper portion light orange.

Capsule subcylindrical, 3.4 - 5 mm in length (with lid), with a short distinct neck, horizontal to cernuous when dry, cernuous to pendulous when moist, hardly contracted below the mouth when dry, symmetrical, light brown to brown, neck distinctly shrinking when dry; exothecial cells at the mouth arranged in \pm longitudinal rows, uppermost two rows consisting of transversely elongated cells and then 4 - 5 rows of short quadrate - hexagonal cells, cell walls equally thickened; cells below the mouth in \pm vertical rows of elongated cells, 12 - 35 μ m in breadth. Lid orange brown to dark brown, conical-apiculate with short blunt tip, cells not in distinct concentric layers, 11 - 35 μ m in width.

Spores 12 - 17 μ m in diameter.

Chile. Prov. de Magallanes: Fuegia Occ., Puerto Yartou, *Coco uliginoso*, March 1929, H. Roivainen (syntype of *B. pseudothyridium* Bartr.) (FH, BA). Fuegia Media, Rio Bueno, Oct. 1928, H. Roivainen (syntype of *B. pseudothyridium* Bartr.) (FH).

Argentina. Tierra del Fuego: Ushuaia, July 1896, P. Dusen 383 (as *B. hamatum* Dus.) (H).

Falkland Islands. Duperrey Harbour, in rupib., maritimus, Aug. 1902, Carl Skottsberg No. 236 (type of *B. perlimbatum* Card.) (FI, S).

New Zealand. (South Island). Otago Prov.: Kinloch, Western Otago, dry bank in beech forest, Jan. 1890, W. Bell (H). Central Otago District: near Paerau Rock and Pillar Range, Jan. 1956, G.M. O'Malley (F). Waikouti Co., Mt. Watkin, ca. 1800 ft., on fern on rock, May 1965, J. Linzey 801 (JL, GAMS). Dunedin, near Signal Hill Trig., East side of free stone wall, Oct. 1965, J. Linzey 3314 (JL). Taire Co., Whare Flat, Powder Creek, alt. ca. 100 ft., on basalt boulder in light shade of thin

scrub, Jan. 1965, J. Linzey 728 (JL). Near Middlemarch, Deep Stream, rocks above stream, Oct. 1964, J. Linzey 650 (JL). Coastal Otago, Warrington, base of Blue Gum tree, dry, June 1963, J. Linzey 1597 (GL). Canterbury Prov.: Tawera Co., Porter's Pass, alt. ca. 2000 ft, dry gravel, streamside, open, Nov. 1965, G.A.M. Scott & J. Linzey 1061 (JL). Castle Hill Distr., forest, 2400 p, April 1895, L. Cockayne (H). Marlborough Prov.: Kaikoura, n.d., Naylor-Becket (H). Westland Prov.: Mount Cook Dist., n.d., Jas. Murray (British Antarct. Exped.) (H).

B. perlimbatum grows mostly on silt, rock, gravel, earth and occasionally on logs by the side of streams. It is mostly found in the open or in areas with light shade. It occurs at lower altitudes and is seldom found above 2500 ft. This moss is restricted to the Southern Hemisphere at latitudes above 30°S. In general it is found at the southernmost tips of South America, South Africa and New Zealand and thus has a circumsubantarctic distribution. In New Zealand, it is found only in South Island, occurring mostly in Otago Province.

I have not examined the type specimen of B. herpetineuron Thér. from Paris which has been collected from Port Natal, Republic of South Africa. The figures and description of the type specimen by Ochi (1972) are unmistakably that of B. perlimbatum, especially in the ovate and concave leaves, crenulate margin, extremely wide border and the long excurrent nerve. Therefore, I agree with Ochi in reducing B. herpetineuron Thér. to a synonym of B. perlimbatum Card.

B. perlimbatum in New Zealand had been confused with B. billardieri var. platyloma (B. truncorum sensu Sainsbury, Dixon etc.) in the past. Neither Dixon (1929) nor Sainsbury (1955) made any mention of B. perlimbatum in their floras of New Zealand and their description of B. billardieri var. platyloma (B. truncorum sensu Sainsbury, Dixon etc.) is a mixture of B. billardieri var. platyloma and B. perlimbatum. The important characters of B. perlimbatum, as compared with B. billardieri var. platyloma are as

follows:

B. perlimbatum

Plants small, 1 - 2.5 cm high, soft.

Tubers abundant, 80 - 160 μ m in diameter, 5 - 9 cells across.

Leaves up to 3.5 mm long, oval or ovate.

Leaf margin nearly entire or crenulate above.

Leaf border often wide, up to 10 rows of narrow elongated cells.

Upper cells of leaf short rhomboidal, often extremely porose.

Antheridia only at the tips of branches.

Seta 1.7 - 2 cm long.

Seta not hooked when meeting capsule.

Capsule subcylindrical, 3 - 5 mm in length, not incurved, hardly or not contracted below mouth when dry.

B. billardieri var. platyloma

Plants large, up to 6 cm high, robust.

Tubers few and scattered, 340 - 950 μ m in diameter, 10 - 23 cells across.

Leaves up to 6 mm long, often obovate - spatulate.

Leaf margin distinctly dentate above.

Leaf border occasionally wide, up to 8 rows of narrow elongated cells.

Upper cells of leaf longly rhomboidal, moderately porose.

Antheridia in the axils of perigonial leaves as well as at the tip of the branches.

Seta 2 - 5 cm long.

Seta hooked at the junction when seta meets capsule.

Capsule cylindrical or narrowly oblong - pyriform, 3 - 7 mm in length, often incurved, mouth large, contracted below mouth when dry.

14. Bryum goudotii Hamp., Ann., Sc. Nat. Bot. ser. 5,4 : 340. 1865

(Figs. 40 - 42).

Plants loosely or densely tufted, branched, yellowish green, robust, 2 - 6 cm high, with rusty red tomentum below.

Rhizoids reddish brown, roughly papillose. Tubers and filamentous gemmae absent.

Leaves densely set at the apex, distant below, lower leaves interrupted by tomentum, light green, appressed to stem when dry, erecto-patent to spreading when moist, when dry not shrinking, not twisted round themselves nor around stem, corrugate when dry, smooth and polished when moist, sometimes concave, decurrent, ovate to oblong - ovate, 1.8 - 2.3 mm in breadth, 3.4 - 4.4 mm in length, widest at $\frac{1}{2}$ to $\frac{2}{3}$ from the base, with an acute or apiculate apex, shortly cuspidate; nerve wide at the base, narrower towards apex, usually vanishing just below the summit, reddish brown at the base, light red towards apical end; margin dentate above, recurved below for $\frac{2}{3}$ of the leaf from the base; border not very distinct, consisting of 2 - 5 rows of slightly differentiated cells, yellowish in older leaves; basal cells rectangular, variable in size, 21 - 28 x 56 - 114 μm , porose; upper cells rhomboid hexagonal, 18 - 23 x 45 - 75 μm , moderately porose.

Dioecious. Perichaetial leaves oblong to ovate - lanceolate, cuspidate; margin recurved; nerve percurrent or slightly excurrent; female paraphyses golden yellow. Perigonial leaves concave, ovate, with acuminate apex; nerve excurrent; male paraphyses orange. Antheridia in the axils of the perigonial leaves as well as at the tip of the branches.

Seta 2.2 - 3 cm long, lower portion dark reddish brown, upper portion light red.

Capsule oblong-pyriform, 5 - 5.8 mm in length (with lid), neck distinct, cernuous to pendulous when dry and moist, not contracted below the mouth

when dry, symmetrical, light brown to reddish brown, mouth deep reddish brown, glossy, neck distinctly shrunken when dry; exothecial cells at the mouth 7 - 10 layers of short, irregularly shaped cells, uppermost two layers \pm transversely elongated, not in longitudinal rows, cells below the mouth 18 - 40 μ m in breadth, not in longitudinal rows. Lid acute red or reddish brown, conical with an umbo, cells 14 - 37 μ m in breadth, not in concentric layers.

Spores 18 - 20 μ m in diameter, papillose.

Colombia. Bogota, Tolima ad nives, n.d., Goudot. (type of B. goudotii Hamp.) (BM).

Venezuela. Cordillera de Los Andes, Estado Merida, Distrito Rangel: Sierra de Santo Domingo, Paramo de Mucubaji. Around the Laguna Negra on moist humic soil. Elev. 3350 - 3600 m., July - Aug. 1972, Dana Griffin III, Manuel Lopez F.Y. Luis Ruiz - Teran (WJH).

Ochi (1957) considered B. goudotii to be a synonym of B. decaisnei Doz. et Molk., which has itself been reduced to a synonym of B. neelgheriense Mont. in this study. After examining the type specimens of B. goudotii and B. decaisnei, I have found that B. goudotii is quite distinct from other species. Therefore it should be retained as a valid species. This plant might be confused with B. andicola Hook. which is also found near these areas. Important differences between B. goudotii and B. andicola are as follows:

B. goudotii

Tubers and axillary gemmae absent.

Leaves not twisted around the stem.

B. andicola

Tubers and axillary gemmae present.

Leaves spirally twisted around the stem.

B. goudotii

Leaves ovate to oblong - ovate.

Leaves decurrent.

Border indistinct.

Capsules oblong - pyriform.

Exothecial cells below the mouth
wide, 18 - 40 μm .

Spores 18 - 20 μm in diameter.

B. andicola

Leaves mostly obovate - spatulate.

Leaves not decurrent.

Border distinct.

Capsules ovoid - pyriform.

Exothecial cells below the mouth
9 - 28 μm .

Spores 11 - 14 - (16) μm in
diameter.

15. Bryum torquatum Mohamed, sp. nov. (Figs. 43, 44).

Plantae laxae vel densae caespitosae, saturae virides, 0.5 - 1.5 cm altae, infra tomentosae. Rhizoidea rufa, subtile papillosa. Gemmae filamentosae desunt. Tubera in rhizoideis longis, aurantiaca ad rubra, globosa, 200 - 350 μ m, cellulis 36 - 55 x 42 - 62 μ m, non-protuberantibus, 5 - 8 in diametro tuberi. Folia laxa vel densa, haud molles, fusca viridia, oblongo - obovata ad obovata, plana, in sicco contracta, ad caulem appressa, raro circum se contorta, valde circum caulem contorta, 1.2 - 1.5 mm lata, 3 - 4.2 mm longa, mucronata ad cuspidata; costa valida, rufa ad vinosa, breviter excurrens; limbus solum in regione apicali, e 1 - 3 seriebus cellularum elongaturum formatis, in foliis senioribus flaviusculus; margo supra dentata, $\frac{3}{4}$ - $\frac{5}{6}$ recurvata. Cellulae in basi folii rectangulares, porosae, 18 - 28 x 40 - 104 μ m; cellulae superiores rhomboido - hexagonae, 15 - 20 x 30 - 60 μ m, raro porosae, parietibus tenuibus. Dioicum. Folia perichaetialia angusta, lanceolata, cuspidata; margo valde recurvata; costa excurrens; paraphyses femineae auranticae. Plantae masculae et fructus ignoti.

Jamaica. Blue Mountain, Sept. 1927, C.R. Orcutt 2984 (CANM). Parish of St. Andrew, Bellevue House, Port Royal Range near Kingston, Forest remnant, terrestrial, moist situation, Dec. 1950, R.G. Robbins 7 (type of B. torquatum Mohd.) (CANM, UCWI). Moy Hall, Nov. 1928, C.R. Orcutt 7045 (CANM). Arntully, Nov. 1927, C.R. Orcutt 3854 (CANM).

Brazil. Rio de Janeiro, No. 7176, n.d., A. Glaziou (as B. stenothecium (Hamp.) (S)).

B. torquatum grows mostly on litter and soil at low altitudes. At present, this moss is known only from Jamaica and Brazil.

This species is easily distinguished by the strong twisting of the leaves around the stem and the small size of the tubers. The leaf margins are strongly recurved for the lowest $\frac{5}{6}$ of their length and the border is restricted to a short area near the apex. Most of the specimens of this species had been mislabelled as B. truncorum. However, this plant is quite different from any other moss in the B. billardieri complex and is therefore described as a new species. No closely related species are known from Jamaica or from Brazil.

16. Bryum lagarocarpum Mohamed, sp. nov. (Figs. 45, 46).

Plantae laxae caespitosae, molles, pallide virides, parce ramosae, 0.5 - 1.4 cm altae, infra laxae tomentosae. Rhizoidea rufa vel brunnea, crasse papillosa. Tubera et gemmae filamentosae desunt. Folia laxa caespitosa, pallide viridia, in sicco parum contracta, raro circum caulem laxa contorta, ovata vel obovata, 0.8 - 1.2 mm lata, 2.3 - 3.0 mm longa, latitudine maxima $\frac{1}{2}$ - $\frac{2}{3}$ supra basem, mucronata vel cuspidata; costa excurrens, plerumque sine pigmento, subinde flava vel aurantiaca; margo $\frac{3}{4}$ - $\frac{5}{6}$ recurvata, supra crenulata; cellulae in parte superiori folii raro porosae, hexagonae, 15 - 18 x 41 - 63 μ m, in marginibus apicalibus limbatis 3 - 4 seriebus cellularum angustarum elongatarum, flavarum in foliis senioribus; cellulae in basi folii rectangulares, raro porosae, 17 - 26 x 40 - 90 μ m. Dioicum. Folia perichaetialia lanceolata, cuspidata, margine recurvata, costa excurrenti; paraphyses pallide flavae. Folia perigonialia ovata, raro concava, costa excurrenti, paraphyses aurantiacae. Antheridia qua in axillis foliorum qua in apicibus caulim. Seta 2.5 - 3.5 cm longa, infra rufa supra pallide brunnea. Capsula cylindrica, inclinata ad suberecta, operculata 5 - 7 mm longa, in sicco leviter sub ore contracta, congruens, rufa ad brunnea, ore rufo, nitido; collum in sicco contractum. Cellulae exothecii apud orem in 4 - 6 stratis breves, sub ore \pm in seriebus longitudinalis, 12 - 30 μ m latae. Operculum rufum, subhemisphaericum, apice brevi apiculato, cellulis 11 - 28 μ m latis \pm in stratis concentricis. Sporae 14 - 16 μ m, papillosae.

Guatemala. Dept. Totonicapan, on road between Huehuetenango and Sija, alt. 3000 - 3450 m., shaded bank, Feb. 1939, Paul C. Standley (type of B. lagarocarpum Mohamed.) (F). Dept. Huehuetenango, limestone Juniperus forest, along road in region of Chémal, Sierra de Los Cuchumatanes, at Km. 36, alt. about 3300 m, Dec. 1940, Paul C. Standley 81717 (F).

Mexico. Vallee' de Mexico, Desierto, Nov. 1913, M. St. Pierre (S).
State of Hidalgo, Mineral Del Chico, May 1925, C.R. Orcutt 6770 (FH).

B. lagarocarpum grows at altitudes of around 3000 m in shaded areas.

I have been able to examine only 4 packets of this species to generalise about its habitat. It is distributed in Mexico and Guatemala. All the 4 packets examined contain a large number of fruiting specimens. Although plants of this species are the smallest of all the species included in this study, the capsules are very distinct in their large size, shape and position of attachment to the seta. This moss has been confused with B. andicola Hook. in the past. The important characters of B. lagarocarpum, as compared with those of B. andicola, are as follows:

<u>B. lagarocarpum</u>	<u>B. andicola</u>
Plants small, in loose tufts, up to 1.4 cm high.	Plants large, in dense tufts, up to 5 cm high.
Tubers and axillary gemmae absent.	Tubers and axillary gemmae present.
Leaves not twisted round themselves nor round stem.	Leaves slightly twisted round themselves and spirally twisted round the stem.
Margin crenulate above.	Margin serrate to serrulate above.
Border not distinct, restricted to apex.	Border distinct, up to $\frac{1}{4}$ of leaf from the apex.
Leaves ovate to obovate, up to 3 mm long.	Leaves oblong to spatulate, up to 6.7 mm long.
Perigonial leaves narrowly ovate, rarely concave.	Perigonial leaves broadly ovate, concave.
Capsules suberect to inclined.	Capsules horizontal to cernuous.

Capsule long cylindrical,
contracted below the mouth when
dry, neck not very distinct.

Exothecial cells at the mouth 4 - 6
layers of short cells with
abruptly elongated cells below,
arranged in longitudinal rows.

Lid deep reddish brown,
subhemispherical with short
apiculate apex.

Capsule ovoid-pyriform to oblong,
not contracted below mouth when dry,
neck distinct.

Exothecial cells at the mouth 7 - 8
layers of short cells, with
progressively elongated cells below,
not in longitudinal rows.

Lid brown to dark brown, conical
acuminate with no apiculus.

Excluded Species

B. pyrothecium C. Muell. et Hamp., Linnaea 26 : 495, 1855, was regarded as a synonym of B. billardieri Schwaegr. The type material from British Museum has been examined by me and was found to be B. torquescens Bruch of which it is a synonym (Syed, 1973).

The type material of B. ramosum var. latifolium Ochi, Bryologist 60 : 8. 1957, collected in Burma from Farlow Herbarium was found to be a Rhodobryum species.

B. rigidum (Hornsch.) C. Muell., Syn. 1 : 263. 1848 (Mnium, 1840) (non (Hedw.) Dicks ex With., 1801) and B. patens Hook. et Wils. London J. Bot. 3 : 155. 1844 (non Dicks ex Hedw., 1801) were both considered to be synonyms for B. andicola Hook. Examination of the type materials from British Museum showed that these are quite distinct from B. andicola. These may be more related to B. brasiliense Hamp.

Doubtful Species

Not all the type specimens of the species which were reported to be related to, or considered as synonyms of B. billardieri complex could be procured for examination. Those species, the type specimens of which have not been examined are mentioned below. The probable status of these doubtful species are mostly drawn from the original descriptions.

The following species may be synonyms for B. andicola Hook.:

B. rosulatum C. Muell., Bot. Zeit. 14 : 416. 1856.

B. schimperi Jaeg. Ber. S. Gall. Naturw. Ges. 1877-78 : 448. 1880
(Ad. 2 : 712) nom. illeg. incl. spec. prior.

B. rosulicomma Ren. et Card., Bull. Soc. R. Bot. Belg. 31 (1) : 166. 1893.

B. nitido-nigrum C. Muell. ex. Prodr. Fl. Bryol. Madag. 168. 1898.

B. subelimbatum Thér., Smiths. Misc. Coll. 81 : 13. 5. 1928.

B. ehrenbergianum var. elimbatum (Thér.) Thér., Rev. Bryol. Lich. 5 :
102. 1933.

B. microdontum var. compactum P. Vard., Rev. Bryol. Lich. 9 : 204. 1937.

B. pumili-roseum var. ruwenzorense Thér. & Nav., Bull. Soc. Roy. Bot. Belg.
60 : 41, 20. 1927.

B. petrophilum P. Vard., Rev. Bryol. Lich. 17 : 18, 2. 1948.

The following three species may be synonyms of B. subfasciculatum (Hamp.)
Mitt:

B. subleptothecium C. Muell. in Geh., Rev. Bryol. 3 : 3. 1876 nom. nud.

B. subolivaceum C. Muell., Hedwigia 37 : 102. 1898.

B. viridulum C. Muell., ibid. : 104. 1898 (non Dicks., 1801; non With.,
1801) hom. illeg.

The following three species are likely to be synonyms of B. billardieri
var. billardieri:

B. lechleri C. Muell., Bot. Zeit. 14 : 416. 1856.

B. rufescens Hook. f. et Wils., Fl. Tasman. 2 : 192. 174f. 1. 1859 (non With., 1801) hom. illeg.

B. crassulum Bartr., Brittonia 9 : 39. 1957.

The following three species are most probably synonyms for B. billardieri var. platyloma:

B. gracilithecium R. Br. ter. in Trans. N.Z. Inst., 31 : 453. 1899.

B. searlii R. Br. ter. ibid. : 459, 1899.

B. gracilicarpum R. Br. ter. ibid. : 462. 1899.

The following species is likely to be a synonym of B. microrhodon:

B. rufescens var. mamillatum Hook. f. et Wils. in Hook. f., Fl. Tasman. 2 : 192. 1859.

A number of specimens from the British Museum labelled by Wilson as B. mamillatum were in fact B. microrhodon C. Muell. The epithet 'mamillatum' is self-explanatory in describing the distinctive mamillate shape of the lid of the capsule.

B. salakense Card., Annuaire, Cons. Jard. Bot. Genève, 15 - 16 : 166. 1912, was described from Sumatra. From what I have seen of Sumatran specimens of the complex and also from the description and figures given by Ochi (1969), I believe this to be a synonym of B. neelgheriense var. neelgheriense.

B. ramosum ssp. zollingeri (Dub.) Fleisch., Musci. Fl. Buitenzorg 2. 563. 1904, may also be a synonym of B. neelgheriense var. neelgheriense.

B. fortunatii Thér., Bull. Ac. Int. Géogr. Bot. 19 : 19. 1909, may be a synonym of B. neelgheriense var. wichurae (Mont.) Broth.

CHAPTER 5

Probable affinities between the species in the *B. billardieri* complex.

It is possible to speculate on the probable relationships between the species within the *B. billardieri* complex from the morphological similarities and geographical distribution. Though a more thorough study backed by cytological information, in-breeding experiments between species in the complex etc., is necessary to confirm the relationships, such speculation may help to understand the probable position of a species in relation to others within the complex.

One of the organs of a plant which is least likely to be affected by ecological factors which may bring about changes in morphological characters is the tuber. Since the tubers occupy a niche in the soil which has a fairly constant temperature régime, not exposed to changes in intensity of light etc., the climatic factors may not be able to affect it to the extent that an exposed organ such as a leaf may be affected. Although *B. billardieri* var. *billardieri*, *B. billardieri* var. *platyloma*, *B. neelgheriense* var. *neelgheriense* and *B. andicola* show constant differences in such characters as leaf and sporophyte, their tuber characteristics remain the same. Therefore, affinities between species established on the basis of tuber characteristics are more likely to be true than affinities based upon characters in which tuber characteristics are not included. Relationships between species discussed below are based mainly upon tuber characters, whenever they are present, in addition to other morphological characters.

The most obvious and distinct relationships in the complex are those between *B. billardieri* var. *billardieri*, *B. billardieri* var. *platyloma*, *B. neelgheriense* var. *neelgheriense*, *B. neelgheriense* var. *wichurae* and *B. andicola*. These plants are what may be termed the *B. billardieri* complex proper. The following species are rather less closely related

to them:-

B. subfasciculatum, B. microrhodon, B. ekmanii, B. truncorum and B. erythrocaulon.

The presence of such closely related taxa as B. andicola in Central America and Africa, B. neelgheriense in Asia and B. billardieri in the Southern Hemisphere can tentatively be explained in terms of the recent 'continental drift' theory. According to recent studies, fossil, geographical and geophysical evidence strongly supports the fact that India was once connected with the southeastern part of Africa and they constituted a large southern continent with South America, Australia and Antarctica. This antipodal continent known as "Gondwana" began to separate in the mid or late Cretaceous; India moved northwards to contact with the Asiatic continent and South America drifted to the west. A common ancestral type of the B. billardieri complex proper may have been distributed on the Gondwana in what is now South America, South Africa, Madagascar, India and probably a part of Antarctica, and the range was broken up by the drifting apart of the continents. B. billardieri var. billardieri is probably the species most resembling the ancestral form. Such distributions as that of B. billardieri in Tasmania, New Zealand, and South America have been noticed in other taxa of Musci (Herzog, 1926). These species are probably remnants of an early southern Gondwana flora which developed in the Pan-Antarctic continent which existed in the late Palaeozoic to the early Cretaceous.

The B. billardieri complex is at present widely distributed in America, Africa, South Asia and Australia. This resembles the distribution pattern of certain Mesozoic conifers (Fulford, 1964). It can be assumed that the ancestral forms of B. billardieri complex originated in the old southern land-mass (Gondwanaland) and migrated northwards into tropical areas after Mesozoic break-up of the Gondwana continent. The southern origin of the complex probably accounts for the scarcity of the species

of the complex in the northern hemisphere and the diversity in the southern hemisphere. The presence of filamentous gemmae may be considered as an advanced character, these probably having been derived from rhizoids. The presence of filamentous gemmae in species such as B. neelgheriense, B. andicola and B. sinense which occur mostly in the northern hemisphere, supports the theory that northern species are more specialised and derived from southern ancestral forms. It has also been found in the genus Orthotrichum that the specialised taxa are mostly found in North America, Europe and northern Asia while the less specialised taxa are found in the southern hemisphere i.e. South America (Vitt, 1971). Species diversification from the ancestral forms probably took place on the drifting continents while climatic changes affected the areas of distribution of the species. With regard to climate affecting distribution, the northern limit of the distribution of B. billardieri var. billardieri is the southern limit of distribution of B. andicola in America and Africa and the southern limit of B. neelgheriense var. neelgheriense in Asia.

The presence of B. billardieri var. billardieri in Tristan da Cunha and Gough Island suggests long distance dispersal by spores from South America. Similarly, the presence of B. andicola in Hawaii suggests long distance dispersal of spores from mainland America. Both Tristan da Cunha and Hawaii are of recent origin (\pm 1,000,000 years old). However, actual evidence does not seem to support long distance dispersal by spores (Fulford, 1951). There are reports of the pollens of Nothofagus being carried by prevailing winds from South America to Tristan da Cunha and Gough Island (Hafsten, 1951 apud Darlington, 1965).

B. billardieri var. billardieri, besides having close affinities to B. andicola and B. neelgheriense, may also be related to B. laevigatum Hook. f. et Wils. and B. campylothecium Tayl. These two latter species have a roughly similar distributional pattern to that of B. billardieri, being found in Australia, Tasmania, New Zealand and South America. B. billardieri

var. platyloma is probably a recently evolved variety; the differences between it and var. billardieri having arisen due to geographical isolation, diversification and selection. The different ecology of the area must have played a large part in producing the morphological differences.

At this point, it is pertinent to discuss the presence of only female plants of B. andicola in Hawaii, B. sinense, B. ramosum and B. neelgheriense var. wichurae in Japan. Excepting B. neelgheriense var. wichurae all^{the} other three species possess tubers. The way by which only female populations of these species could have arisen opens up some interesting speculations.

One possibility which could have given rise to only female populations of the species is by the introduction of only female plants to the particular area by spores or other disseminules. The plant reproducing and spreading solely by means of tubers managed to survive till the present day. The other possibility is that both male and female spores or disseminules were introduced, but that the male plant could have become extinct. The female plant carried on by means of tubers. However, in the case of B. neelgheriense var. wichurae in Japan, neither means of sexual reproduction nor tubers are found, yet it is a very widespread species in Japan. The presence of only female plants in these particular species means that they may not have the capability to undergo adaptive radiation due to the absence of sexual reproduction. This is clearly seen in B. andicola in Hawaii and B. sinense and B. ramosum in Japan which show a more uniform morphology and habitat preference than their counterparts on the mainland which possess the means of undergoing sexual reproduction. B. sinense in Japan is strongly calcicolous, though its habitat in China could not be ascertained due to too few available specimens and inadequate labelling. B. andicola in Hawaii exhibits a very broad border, a character true to Hawaiian specimens but not to the plants on the mainland. Further, B. andicola in Hawaii grows mainly on woody substrates while the substrate range is wider on the mainland. When in all or part of the geographical range of a dioecious moss species only one sex is known, it

appears that this is more often the female than the male, as with the plants discussed above. These plants having only female populations can also diversify by mutation and selection, though at a much slower rate than those plants capable of sexual reproduction.

B. ramosum and B. pycnophyllum show morphological similarities. I believe these ^{species} ^{closely} are more related to B. neelgheriense var. neelgheriense and B. andicola respectively. It is probably a case of parallel evolution rather than being derived from the same parent plant. Similarly, B. ekmanii may be compared with B. truncorum. Here again is a case of parallel evolution from closely related plants. B. ekmanii has more affinities with B. andicola while B. truncorum is closely related to B. billardieri var. billardieri and B. erythrocaulon. B. erythrocaulon probably originated in Madagascar and spread in recent times to South Africa and Mauritius. This is probably one of the reasons why B. erythrocaulon is found only on the south eastern part of South Africa.

B. subfasciculatum has a localised distribution, being found in Queensland, northern New South Wales, New Caledonia and New Hebrides. On one hand it may be compared with B. billardieri var. billardieri while on the other hand it may be compared with B. densifolium Brid. found in south and central America. B. subfasciculatum probably segregated from B. densifolium which had migrated as an ancestral form from Australia.

B. microrhodon is another localised species and has common features with both B. campylothecium Tayl. and B. billardieri var. billardieri to such an extent that it may be thought of as intermediate between these species. It may have been derived from an ancestral form common to them.

B. perlimbatum is a circum-sub-antarctic species which seems to have affinities with the *Trichophora* as well as the *Rosulata* in which the B. billardieri complex is placed. The presence of antheridia only at the tip of the branches is considered to be an advanced character, having been derived from species with antheridia in the axils (Crundwell & Syed, 1973).

It is probably derived from an ancestor common to both the B. capillare and B. billardieri complexes. B. lagarocarpum also has affinities to both the Trichophora and the Rosulata.

B. goudotii may be compared with some of the Rhodobryum species and may be more closely related to them than to the Rosulata.

B. torquatum and B. appressum are likely to have affinities with B. canariense Brid. judging from the morphology of the plants and the size of the tubers. Morphologically B. canariense has greater similarities to these two species than to any others in the complex. The distribution of B. canariense extends from eastern America to South Africa. B. torquatum is found at the western limit of distribution of B. canariense while B. appressum is found in its southern and eastern limit.

Although B. sinense resembles B. neelgheriense in its vegetative morphology, it differs greatly in its tuber characteristics. Therefore, they are not likely to be closely related. B. sinense is quite distinct from other species in the complex.

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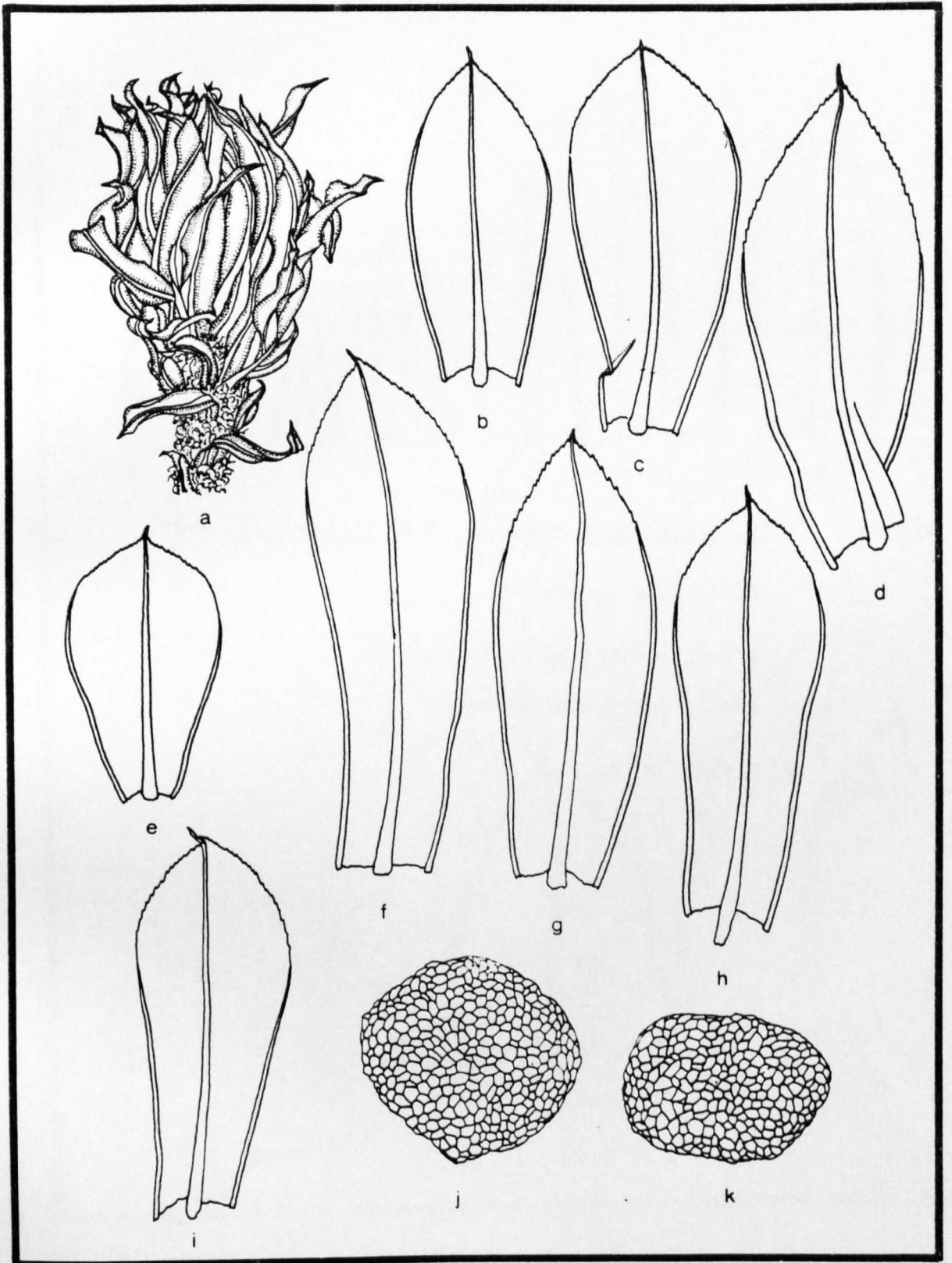
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ILLUSTRATIONS

Figure 1. B. billardieri Schwaegr. var. billardieri, from
plant from a, New South Wales; b, Western
Australia; c, Queensland; d, type of B. angeiothecium
from Norfolk Island; e,i, New Zealand; f,j, Tasmania;
g, Galapagos Islands; h,k, Chile.
a, dry plant; b - i, leaves; j,k, tubers.
a, x 7.5; b - i, x 15; j,k, x 50.



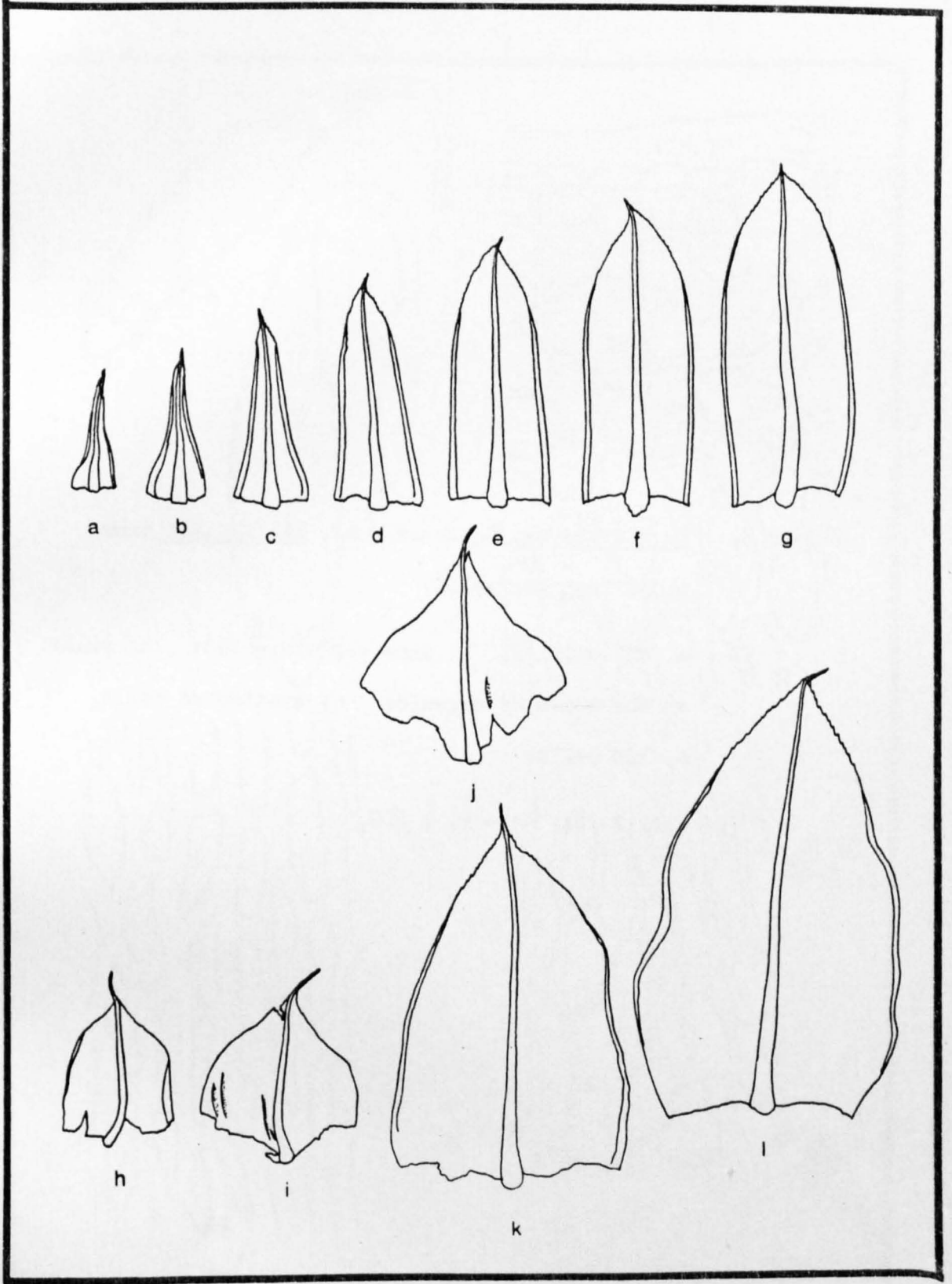
B. billardieri var. billardieri

Figure 2. B. billardieri Schwaegr. var. billardieri, from
plant from Australia.

a - g, perichaetial leaves;

h - l, perigonial leaves.

a - l, x 15.

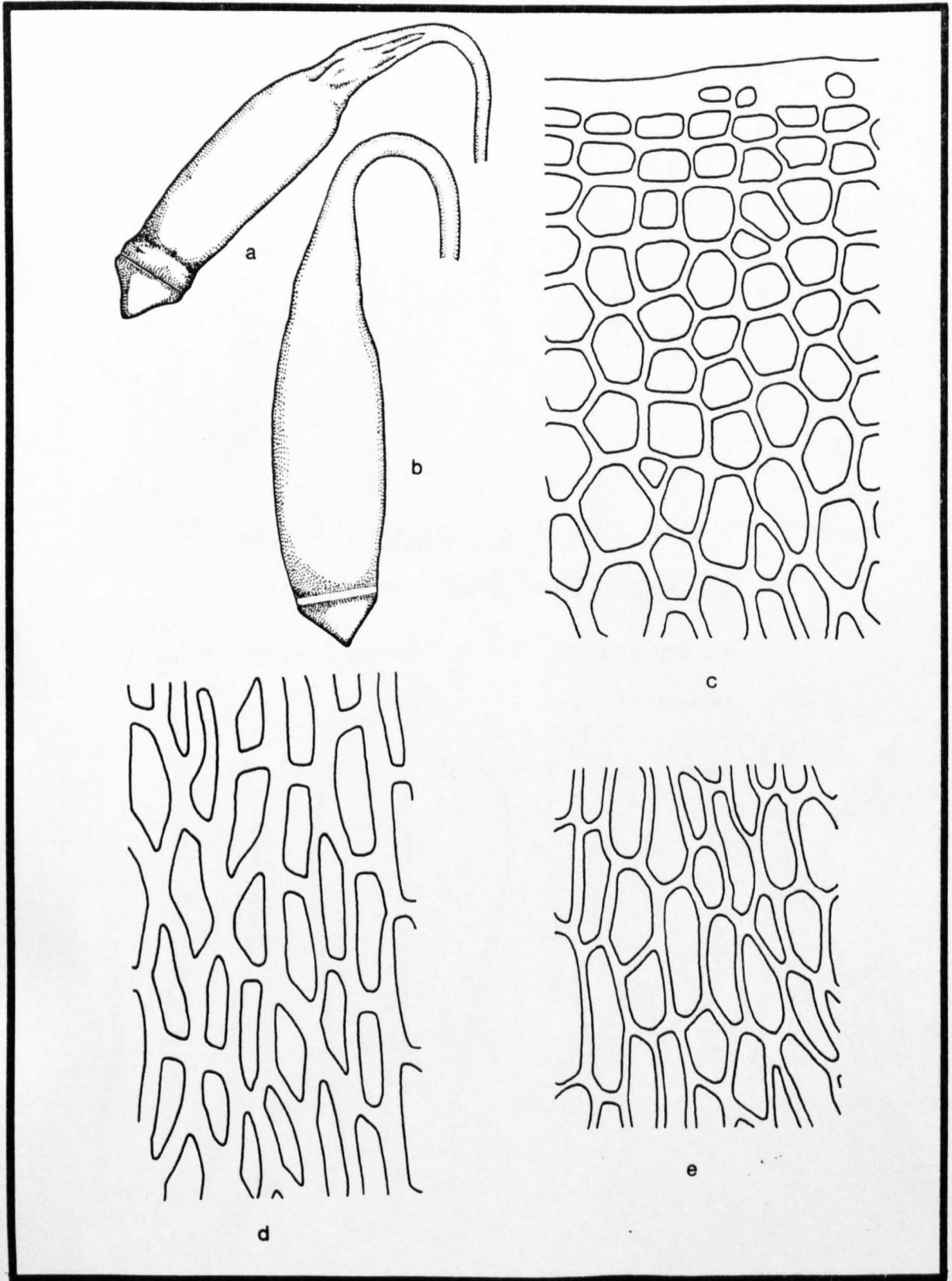


B. billardieri var. billardieri

Figure 3. B. billardieri Schwaegr. var. billardieri, from
plant from Australia.

a, dry capsule; b, same capsule moist; c, cells
at the mouth of capsule; d, exothecial cells;
e, lid cells.

a,b, x 15; c - e, x 200.

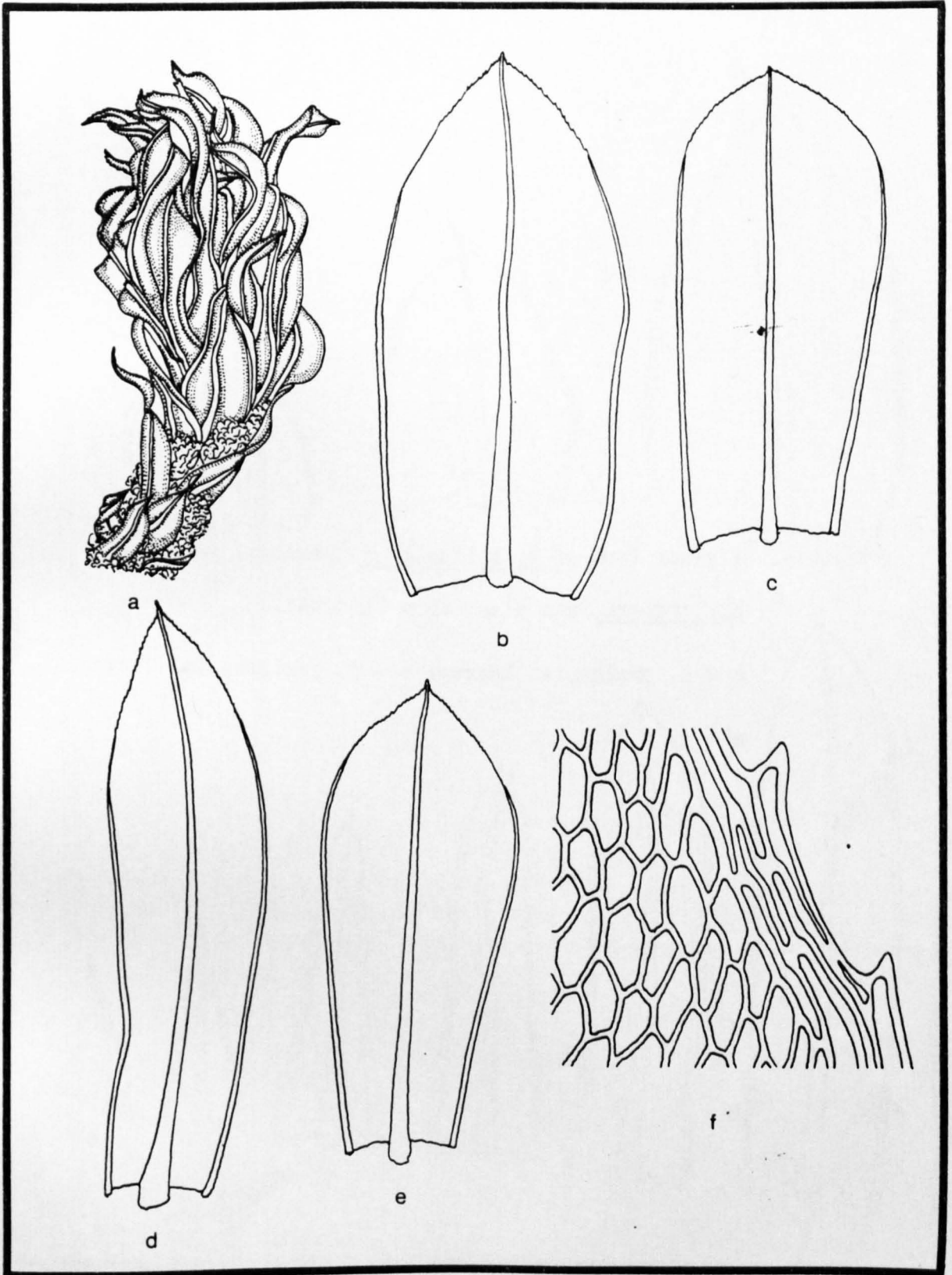


B. billardieri var. billardieri

Figure 4. A giant form of B. billardieri Schwaegr. var. billardieri, from plant from Victoria.

a, dry plant; b - e, leaves; f, cells at margin of leaf.

a, x 7.5; b - e, x 15; f, x 200.



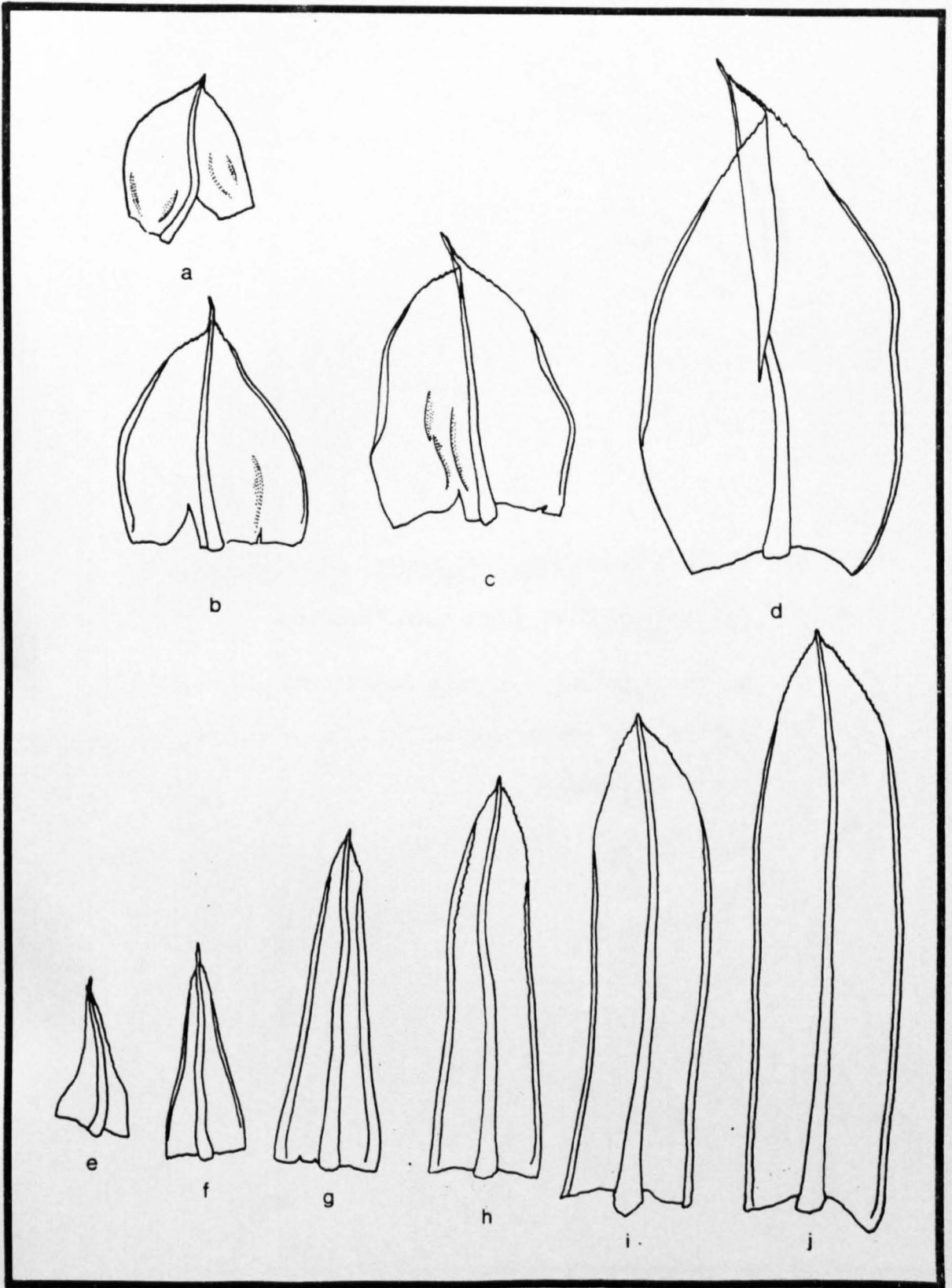
B. billardieri var. billardieri

Figure 5. A giant form of B. billardieri Schwaegr. var.

billardieri, from plant from Victoria.

a - d, perigonial leaves; e - j, perichaetial leaves.

a - j, x 15.

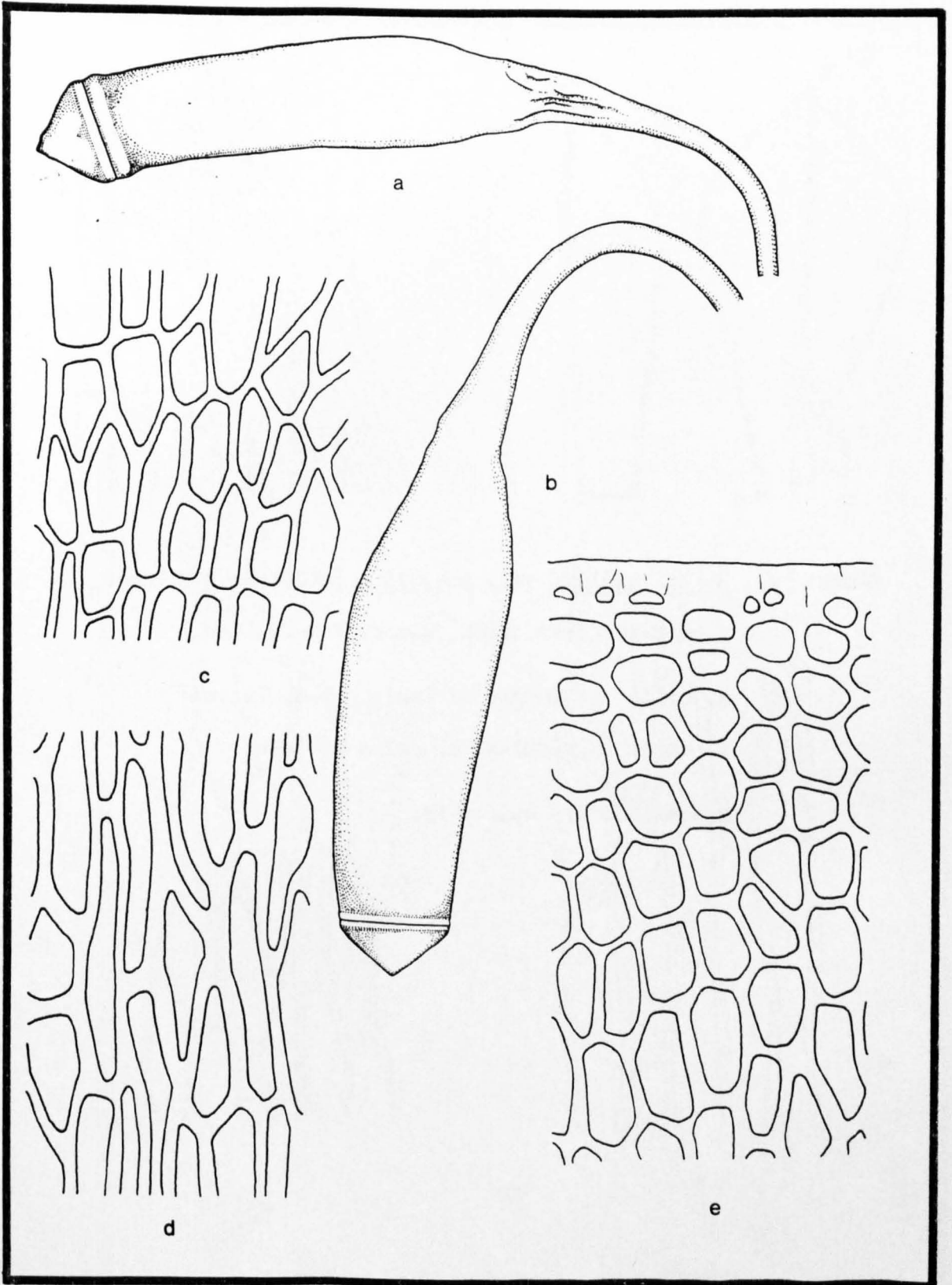


B. billardieri var. billardieri

Figure 6. A giant form of B. billardieri Schwaegr. var. billardieri, from plant from Victoria.

a, dry capsule; b, same capsule moist; c, lid cells; d, exothecial cells; e, cells at mouth of capsule.

a,b, x 15; c - e, x 200.

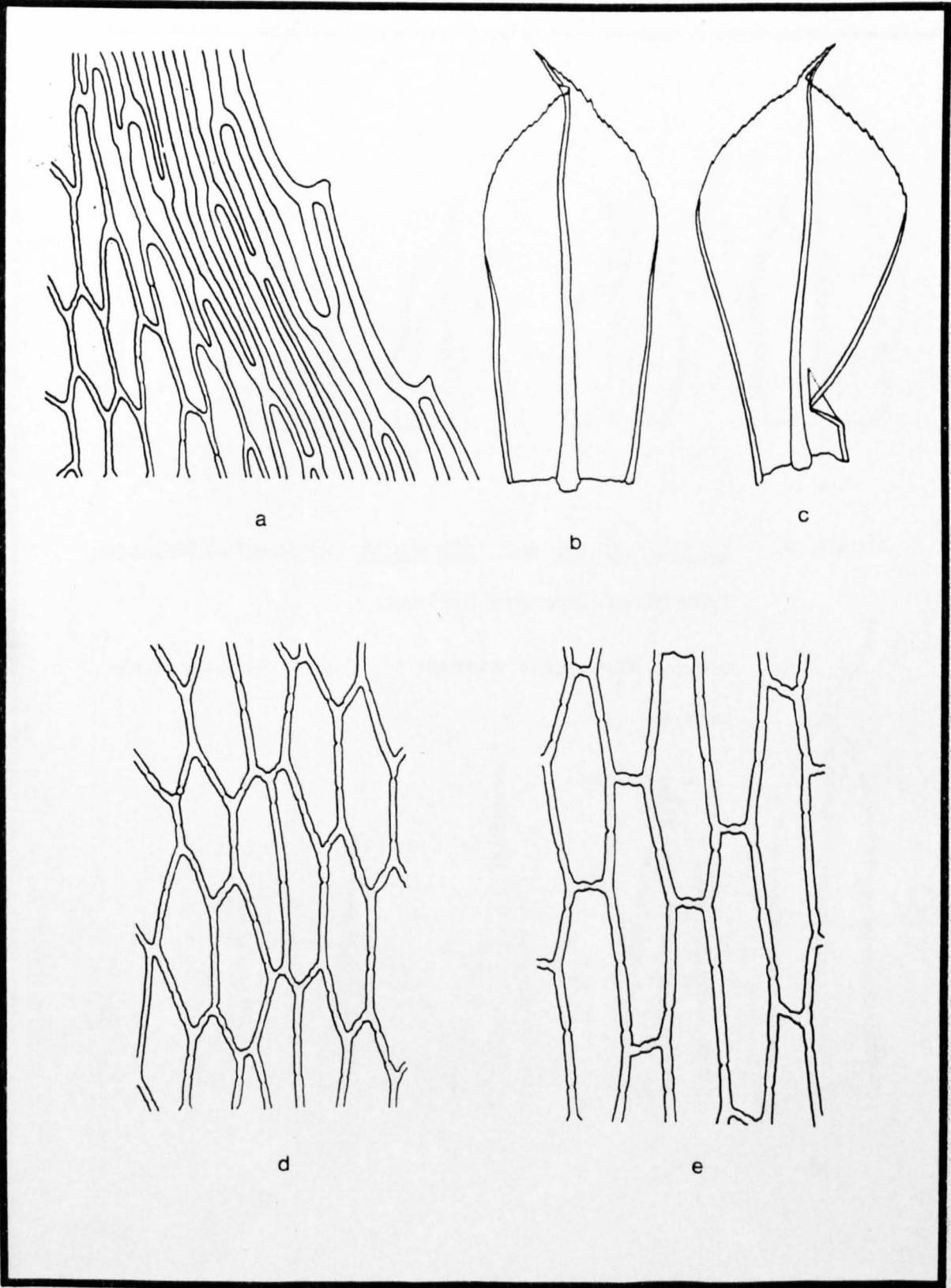


B. billardieri var. billardieri

Figure 7. B. billardieri var. platyloma (Schwaegr.) Mohamed,
from plant from South Island, New Zealand.

a, cells at margin of leaf; b,c, leaves;
d, cells in middle; e, cells at base.

a,d,e, x 200; b,c, x 15.

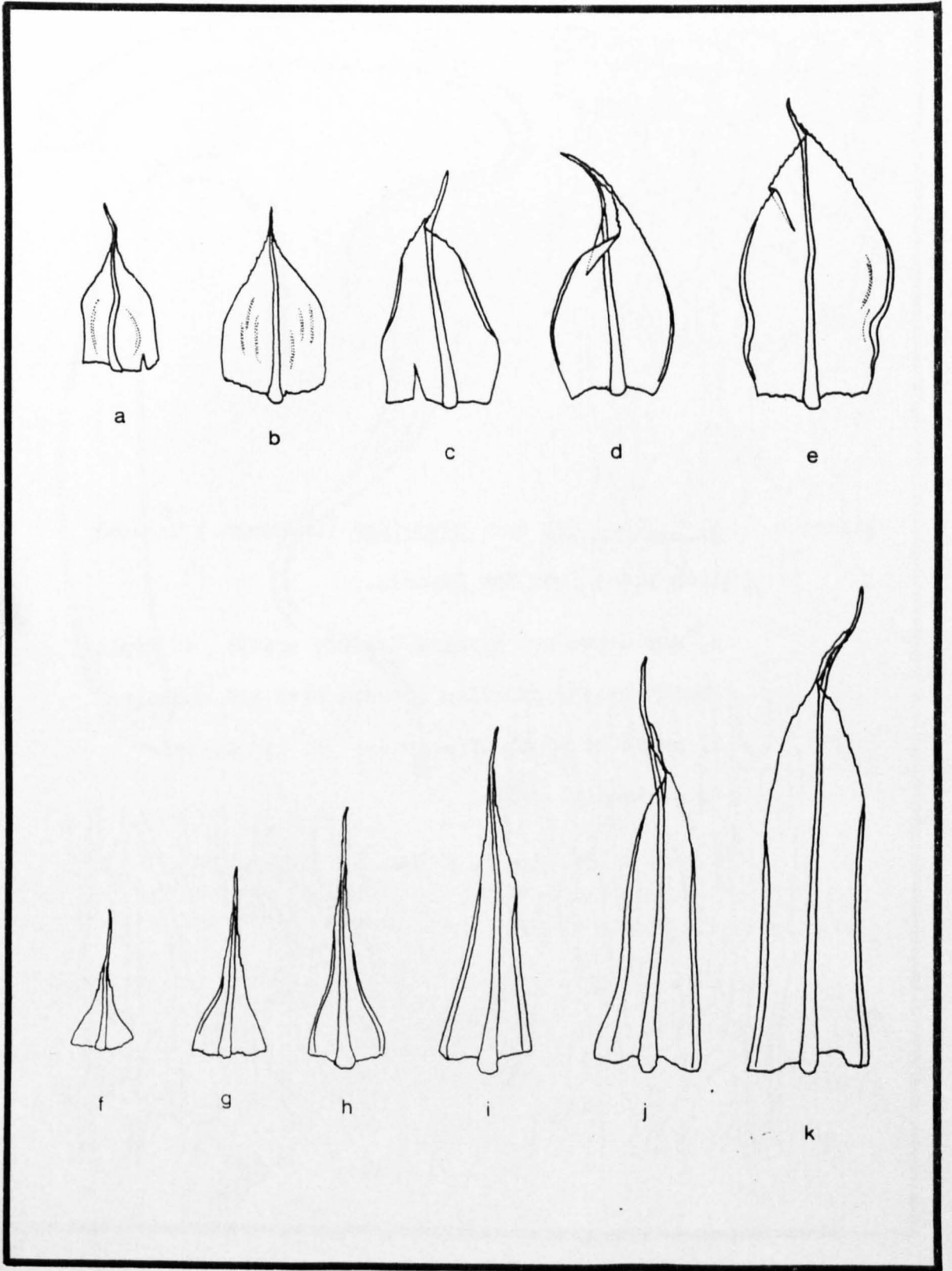


B. billardieri var. platyloma

Figure 8. B. billardieri var. platyloma (Schwaegr.) Mohamed,
from plant from New Zealand.

a - e, perigonal leaves; f - k, perichaetial
leaves.

a - k, x 15.

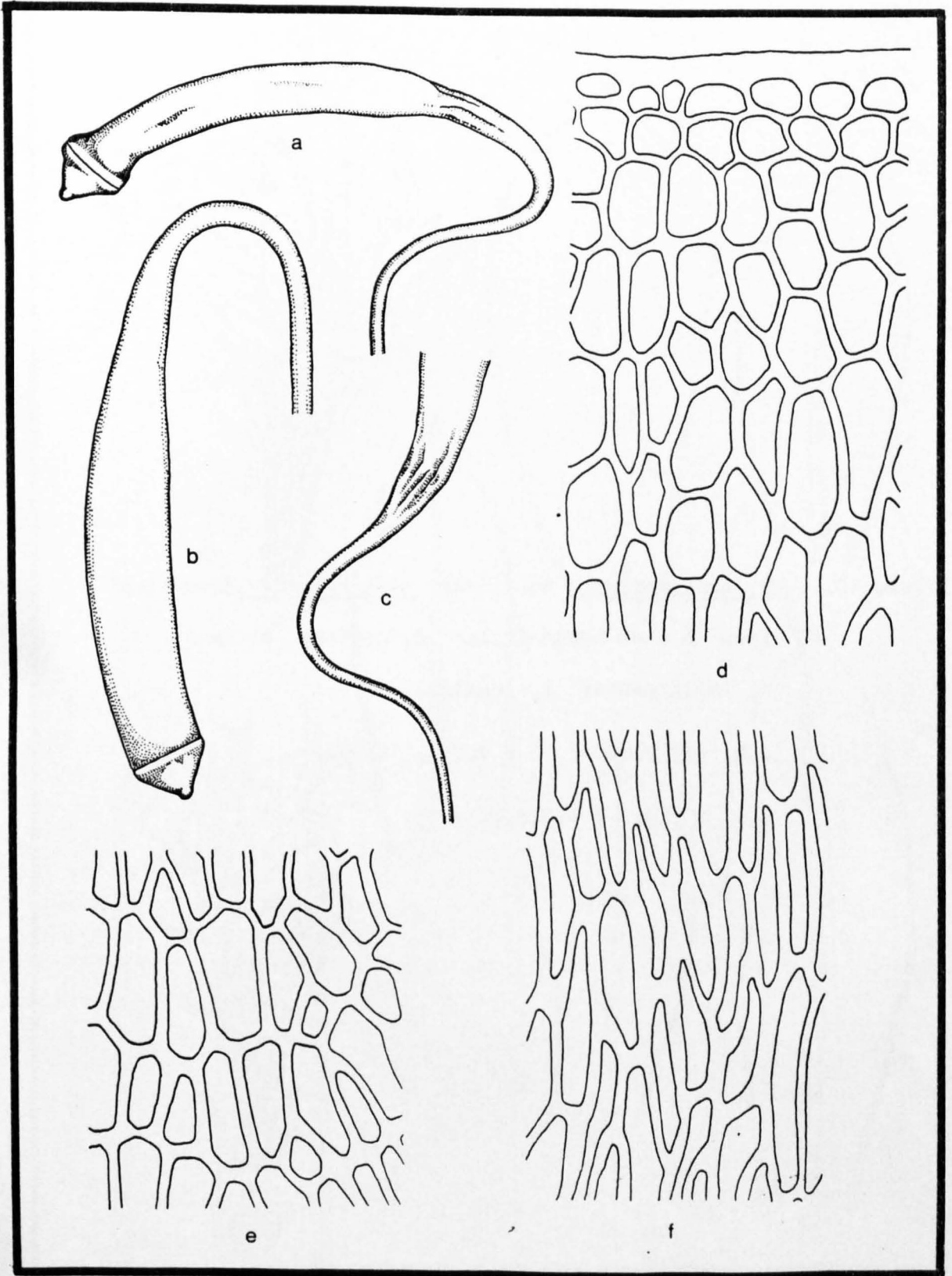


B. billardieri var. platyloma

Figure 9. B. billardieri var. platyloma (Schwaegr.) Mohamed,
from plant from New Zealand.

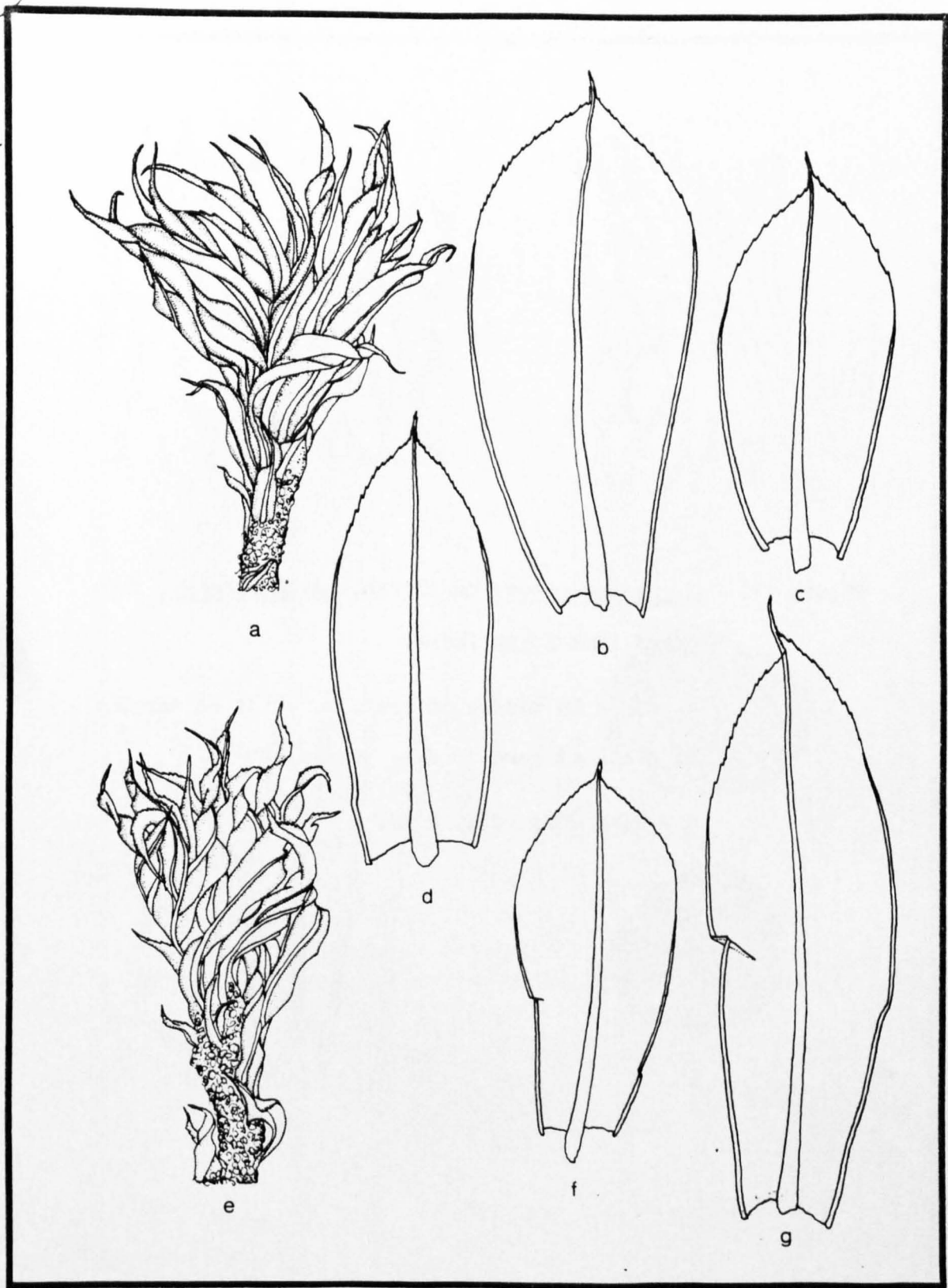
a, dry capsule; b, same capsule moist; c, typical
'hook' at the junction between seta and capsule;
d, cells at mouth of capsule; e, lid cells;
f, exothecial cells.

a - c, x 15; d - f, x 200.



B. billardieri var. platyloma

Figure 10. B. neelgheriense Mont. var. neelgheriense, from plant
from a - c, South India; d, Ceylon; e, Java;
f, Philippines; g, Sumatra.
a,e, dry plants; b - d,f,g, leaves.
a,e, x 7.5; b - d,f,g, x 15.

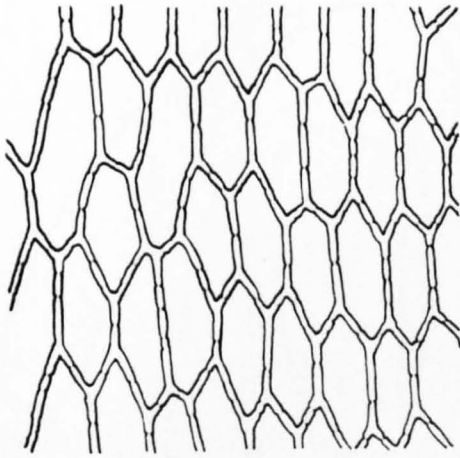


B. neelgheriense var. neelgheriense

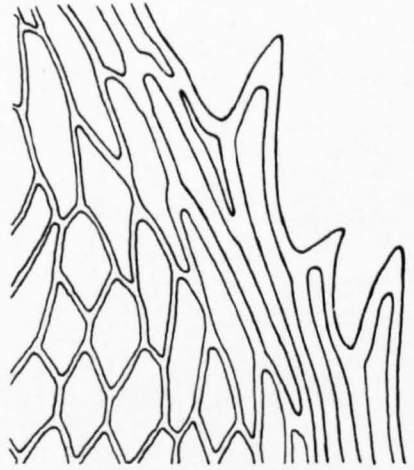
Figure 11. B. neelgheriense Mont. var. neelgheriense, from
plant from South India.

a, cells in middle of leaf; b, cells at margin;
c, cells at base; d,e, tubers.

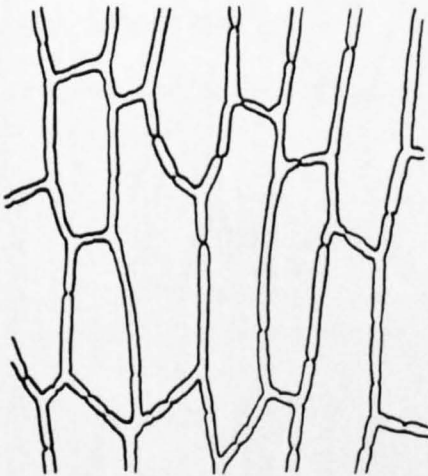
a - c, x 200; d,e, x 50.



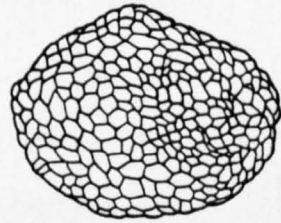
a



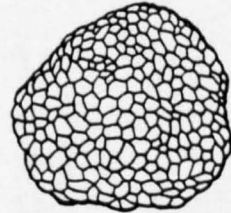
b



c



d

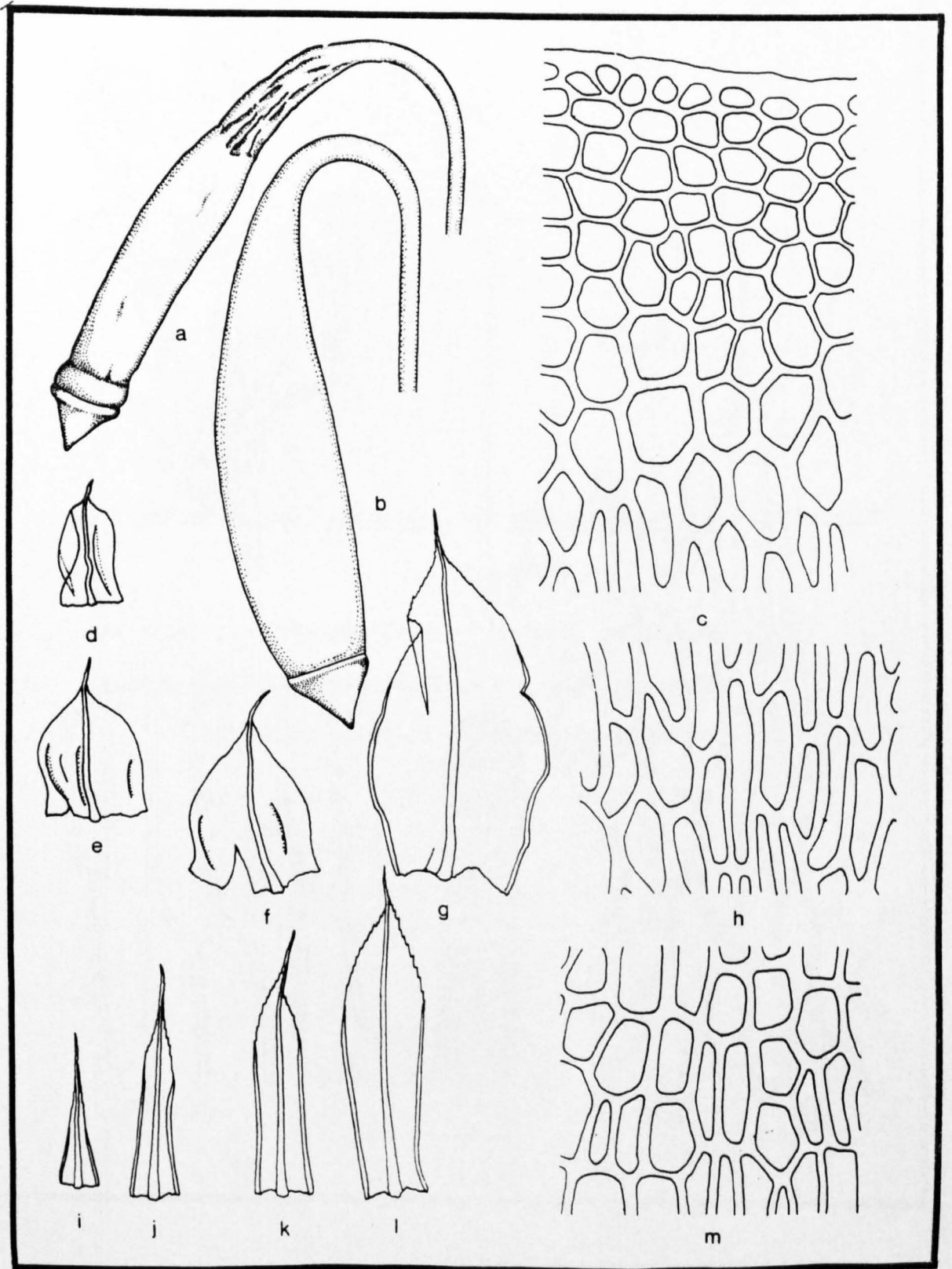


e

Figure 12. B. neelgheriense Mont. var. neelgheriense, from
plant from South India.

a, dry capsule; b, same capsule moist; c, cells
at the mouth of capsule; d - g, perigonal leaves;
h, exothecial cells; i - l, perichaetial leaves;
m, lid cells.

a,b,d - g,i - l, x 15; c,h,m, x 200.

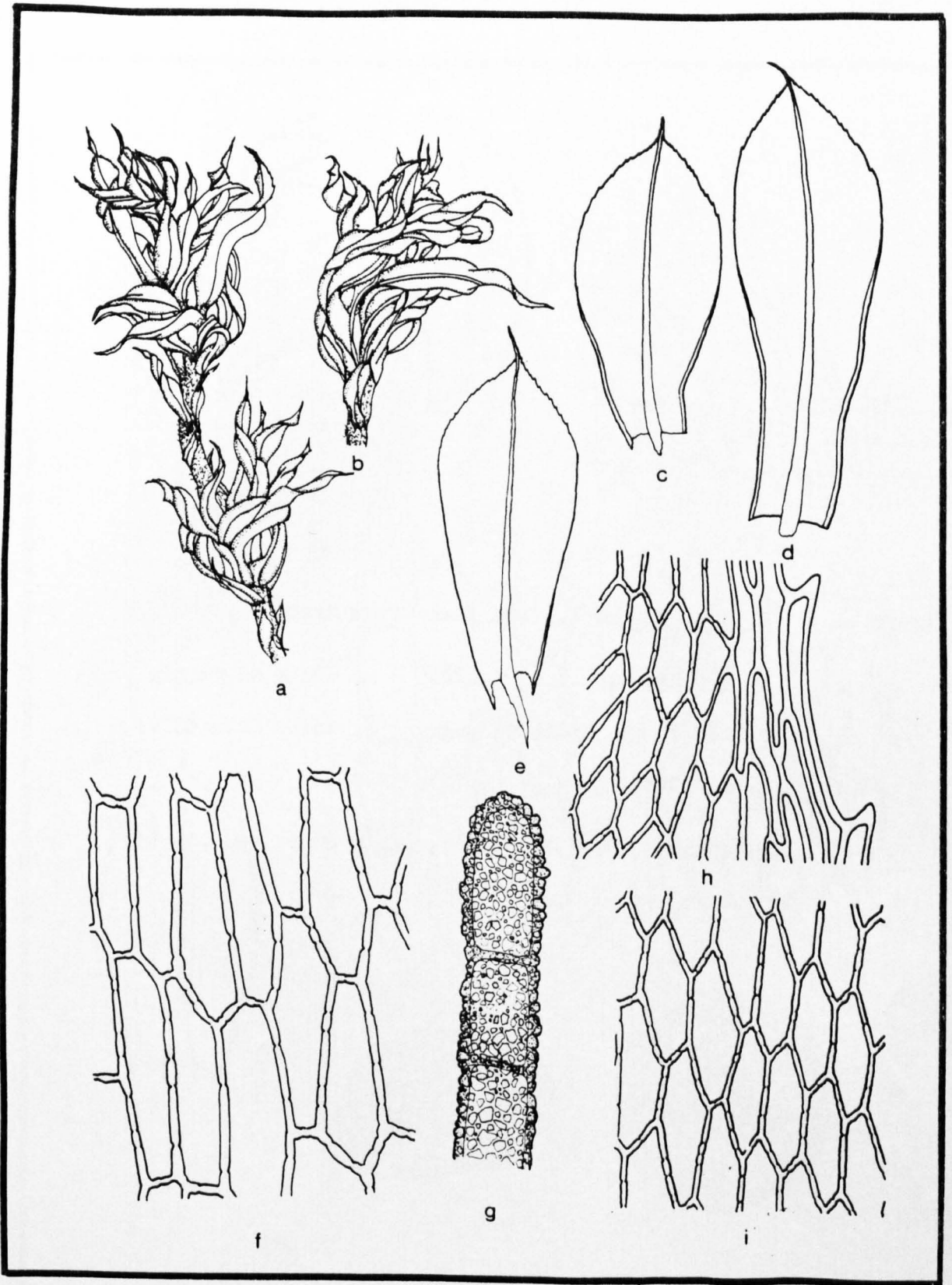


B. neelgheriense var. neelgheriense

Figure 13. B. neelgheriense var. wichurae (Mont.) Broth., from plant from Japan.

a,b, dry plants; c - e, leaves; f, cells at base of leaf; g, filamentous axillary gemma; h, cells at margin; i, cells in middle.

a,b, x 7.5; c - e, x 15; f - i, x 200.

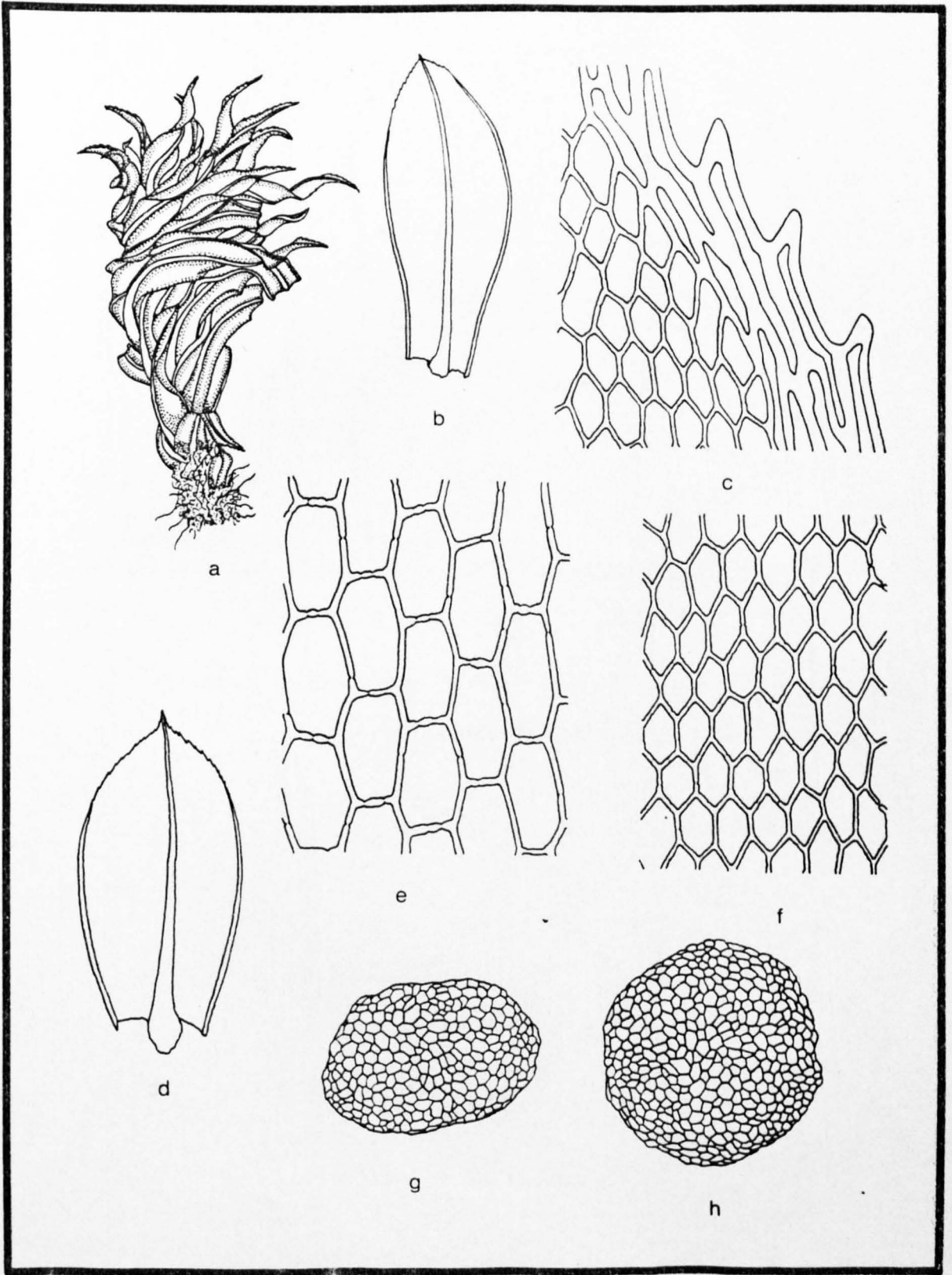


B. neelgheriense var. *wichurae*

Figure 14. B. andicola Hook., from plant from Mexico.

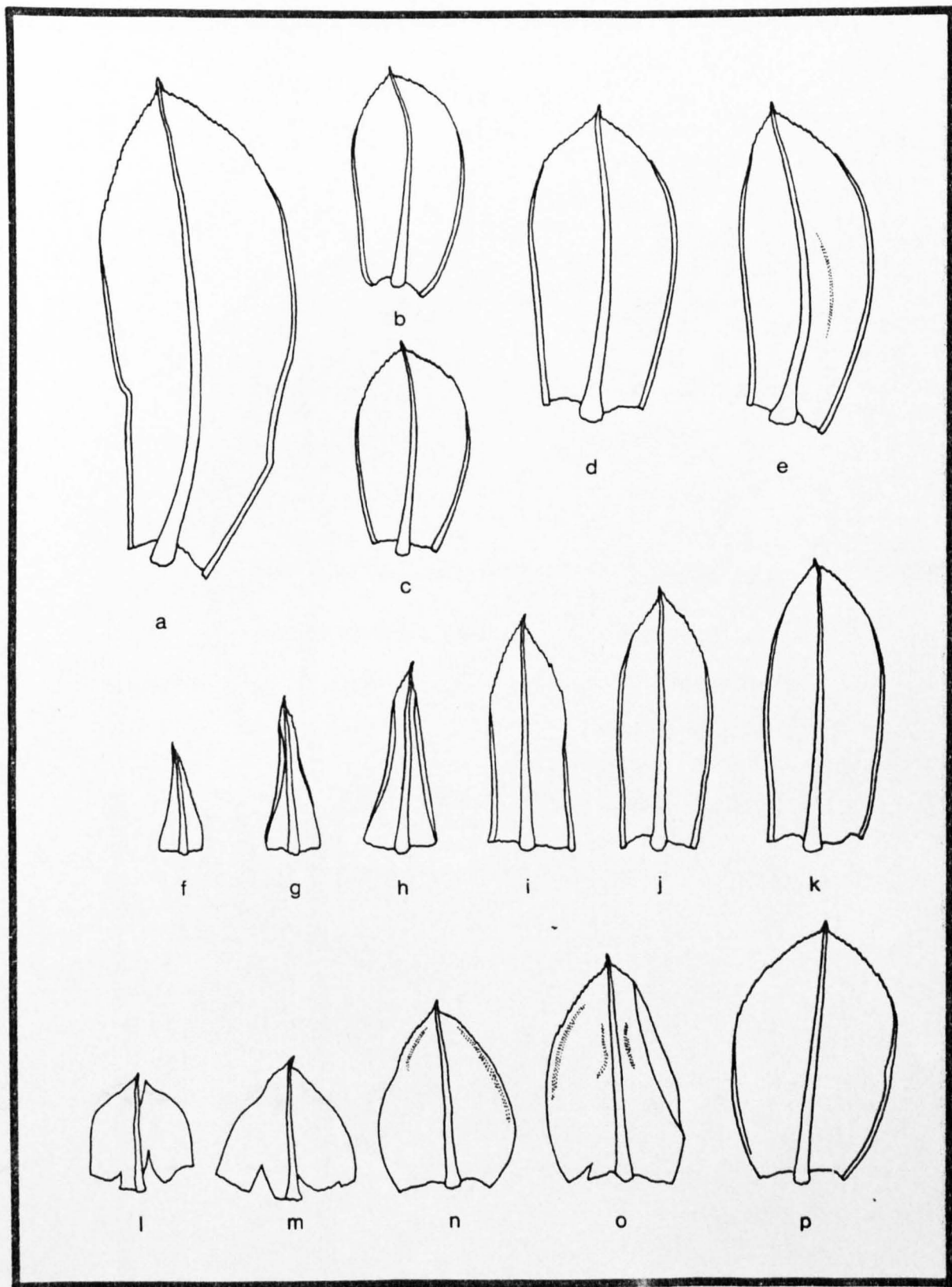
a, dry plant; b,d, leaves; c, cells at margin
of leaf; e, cells at base; f, cells in middle;
g,h, tubers.

a, x 7.5; b,d, x 15; c,e,f, x 200; g,h, x 50.



B. andicola

Figure 15. B. andicola Hook., from plant from a,e,f - p, Guatemala;
b, Tanzania; c, U.S.A; d, Malawi.
a - e, leaves; f - k, perichaetial leaves;
l - p, perigonal leaves.
a - p, x 15.

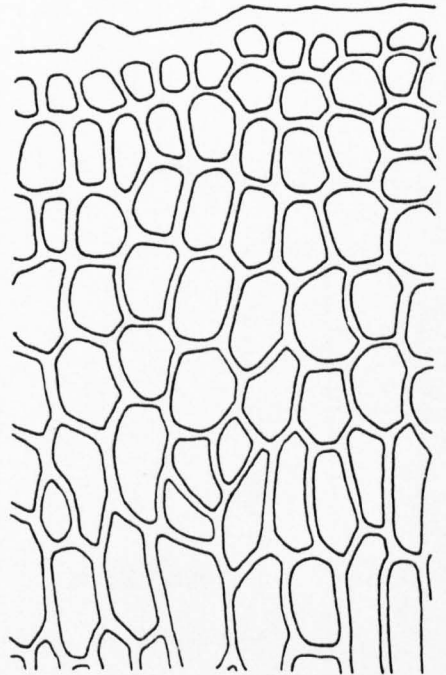
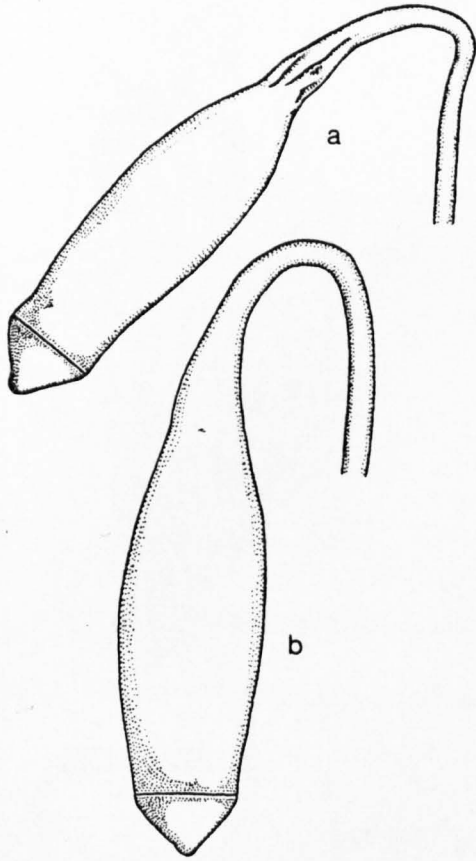


B. andicola

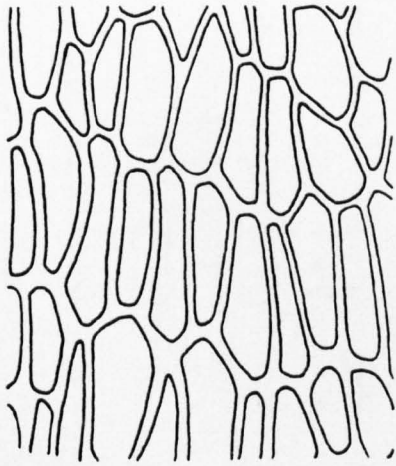
Figure 16. B. andicola Hook., from plant from Mexico.

a, dry capsule; b, same capsule moist; c, cells
at mouth of capsule; d, lid cells; e, exothecial
cells.

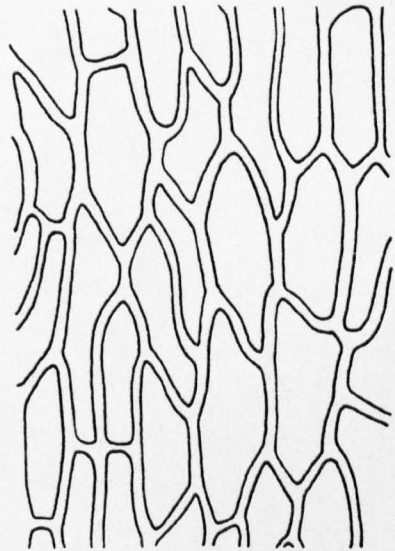
a,b, x 7.5; c - e, x 200.



c

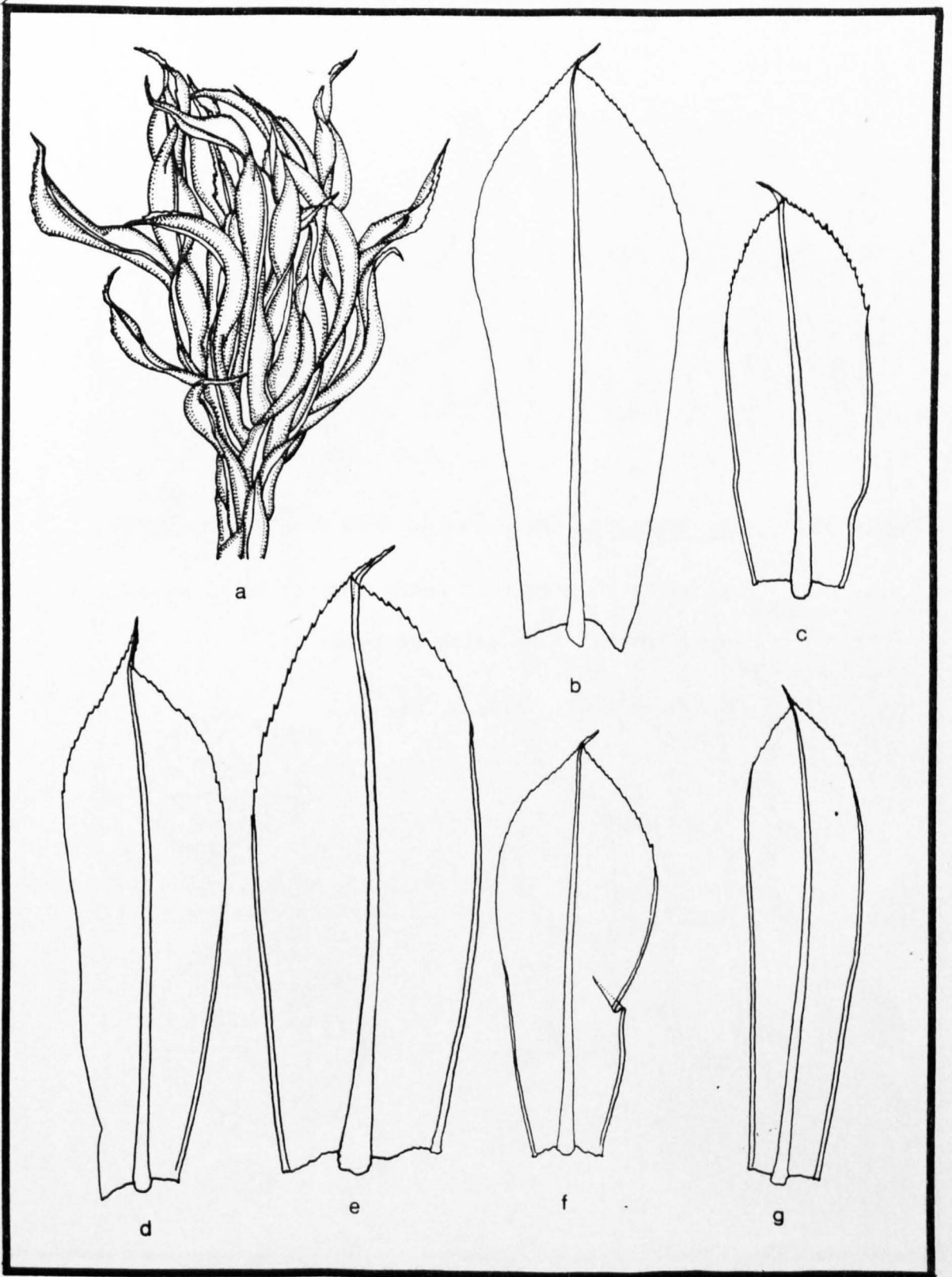


d



e

Figure 17. B. truncorum (Brid.)Brid., from plant from a, e - g, Réunion; b, type of B. albolimbatum Card., c, type of B. scariosum Ther., d, type of B. truncorum.
a, dry plant; b - g, leaves.
a, x 7.5; b - g, 15.



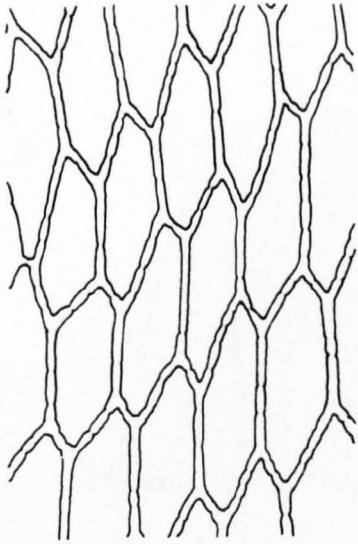
B. truncorum

Figure 18. B. trunctorum (Brid.)Brid., from plant from Réunion.

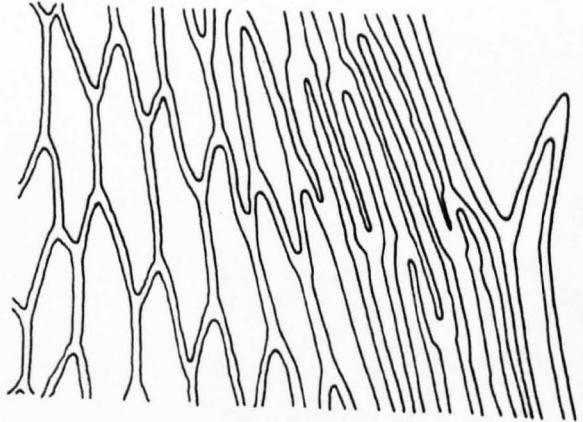
a, cells in middle of leaf; b, cells at margin;

c,d, tubers; e, cells at base.

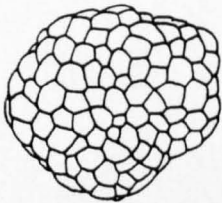
a,b,e, x 200; c,d, x 75.



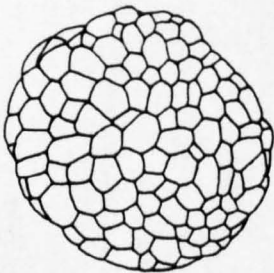
a



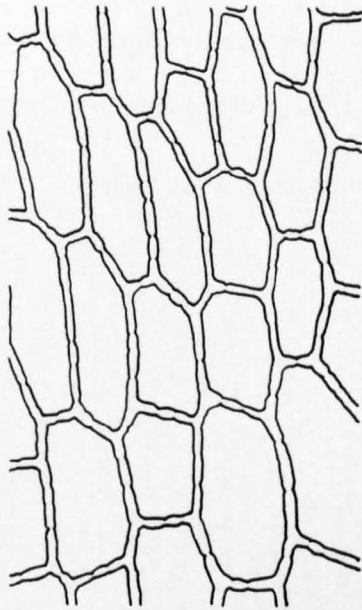
b



c



d

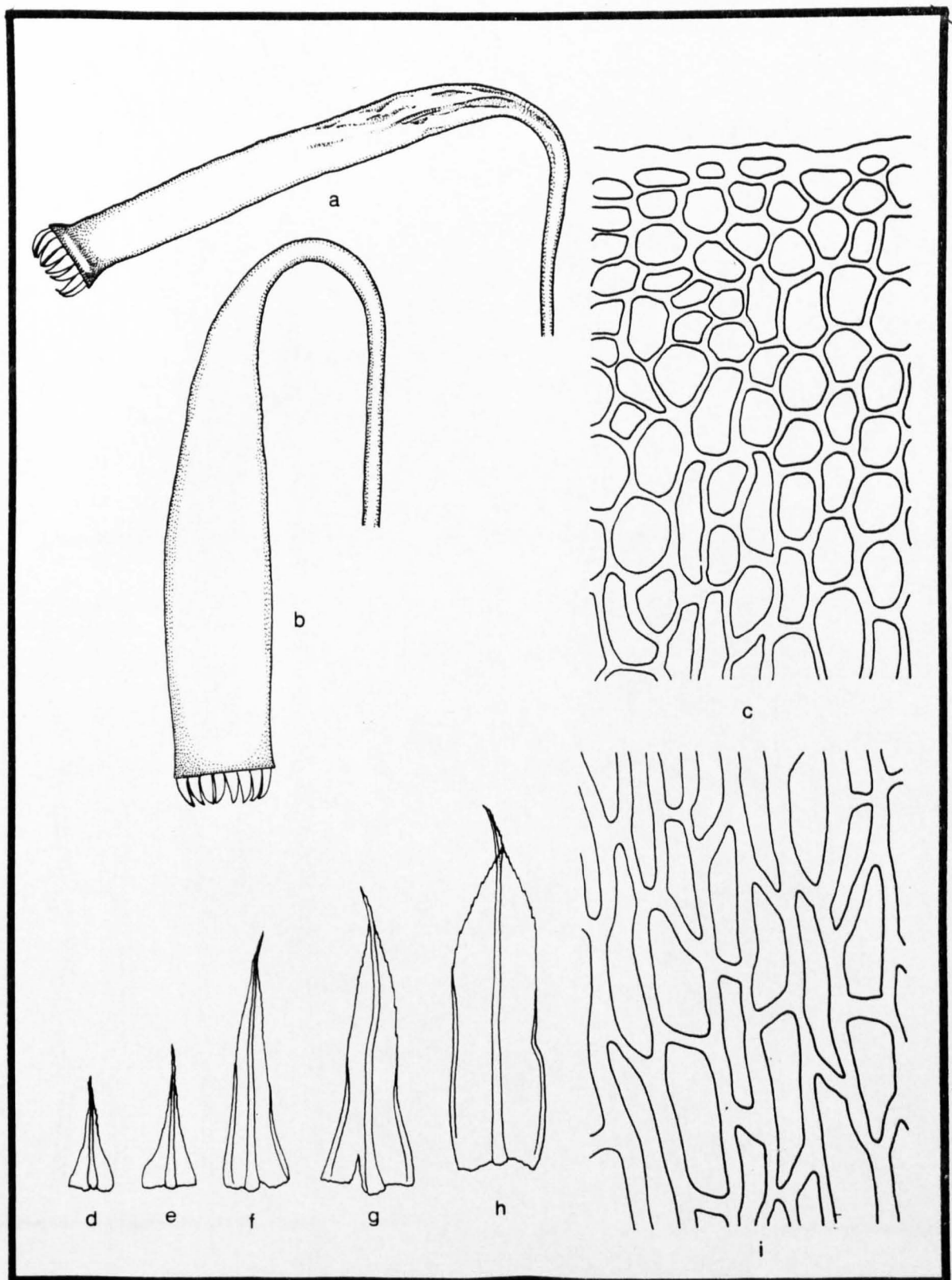


e

Figure 19. B. truncorum (Brid.)Brid., from plant from Réunion.

a, dry capsule; b, same capsule moist; c, cells at
mouth of capsule; d - h, perichaetial leaves;
i, exothecial cells.

a,b,d - h, x 15; c,i, x 200.

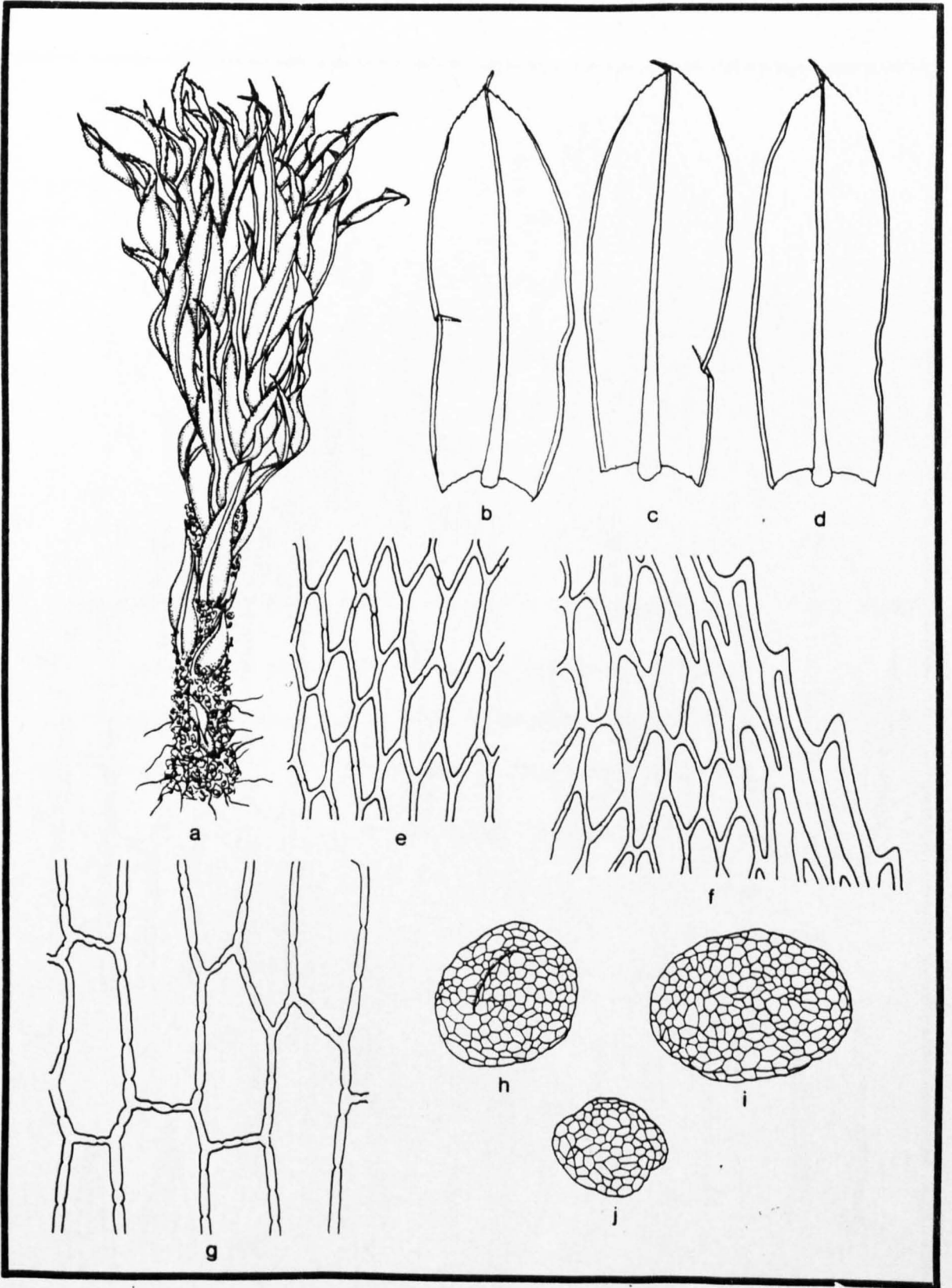


B. truncorum

Figure 20. B. erythrocaulon Schwaegr., from plant from Madagascar.

a, dry plant; b - d, leaves; e, cells in middle of
leaf; f, cells at margin; g, cells at base;
h - j, tubers.

a, x 7.5; b, - d, x 15; e - g, x 200; h - j, x 50.



B. erythrocaulon

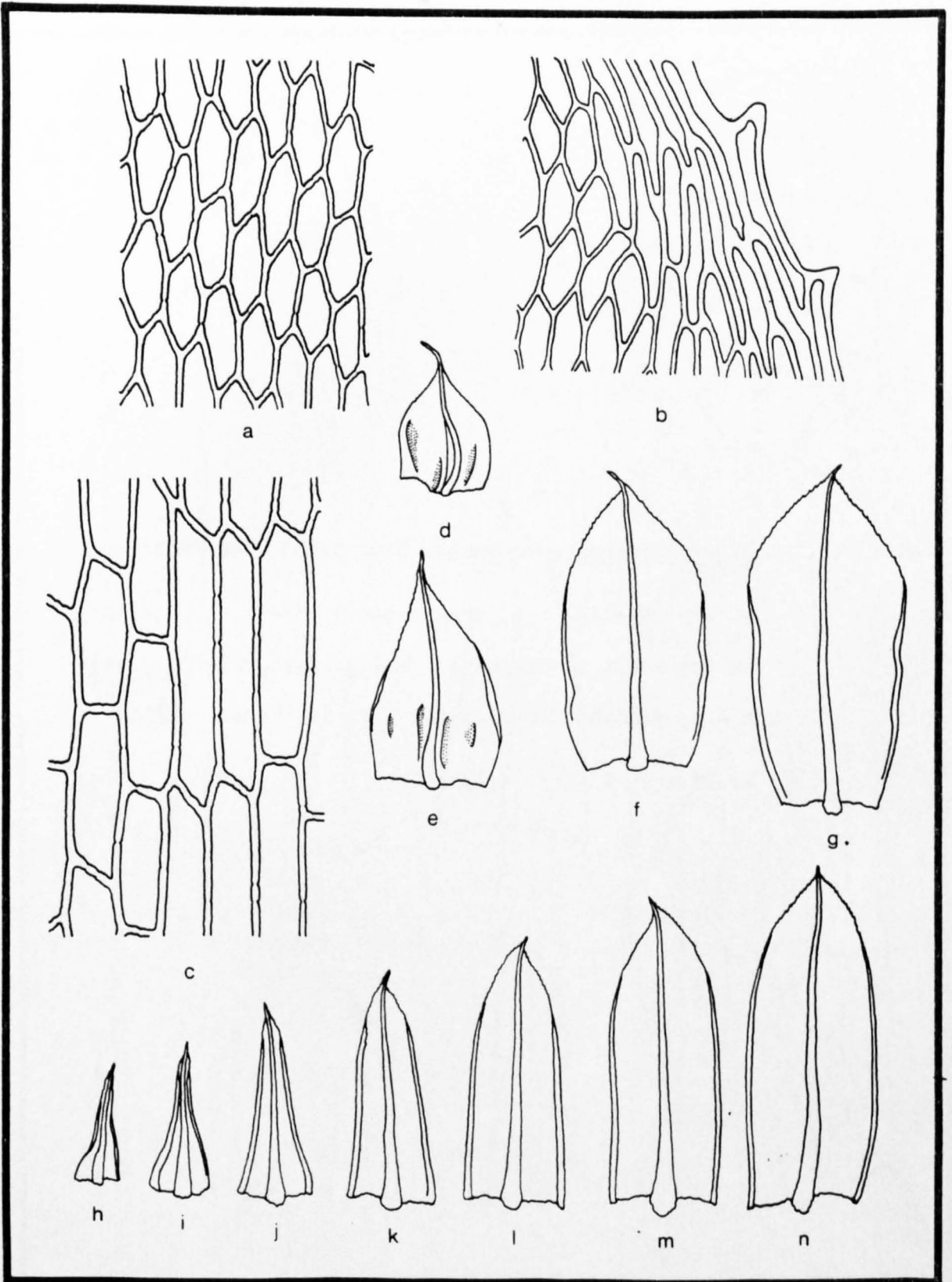
Figure 21. B. erythrocaulon Schwaegr., from plant from Madagascar.

a, cells in middle of leaf; b, cells at margin;

c, cells at the base; d - g, perigonial leaves;

h - n, perichaetial leaves.

a - c, x 200; d - n, x 15.

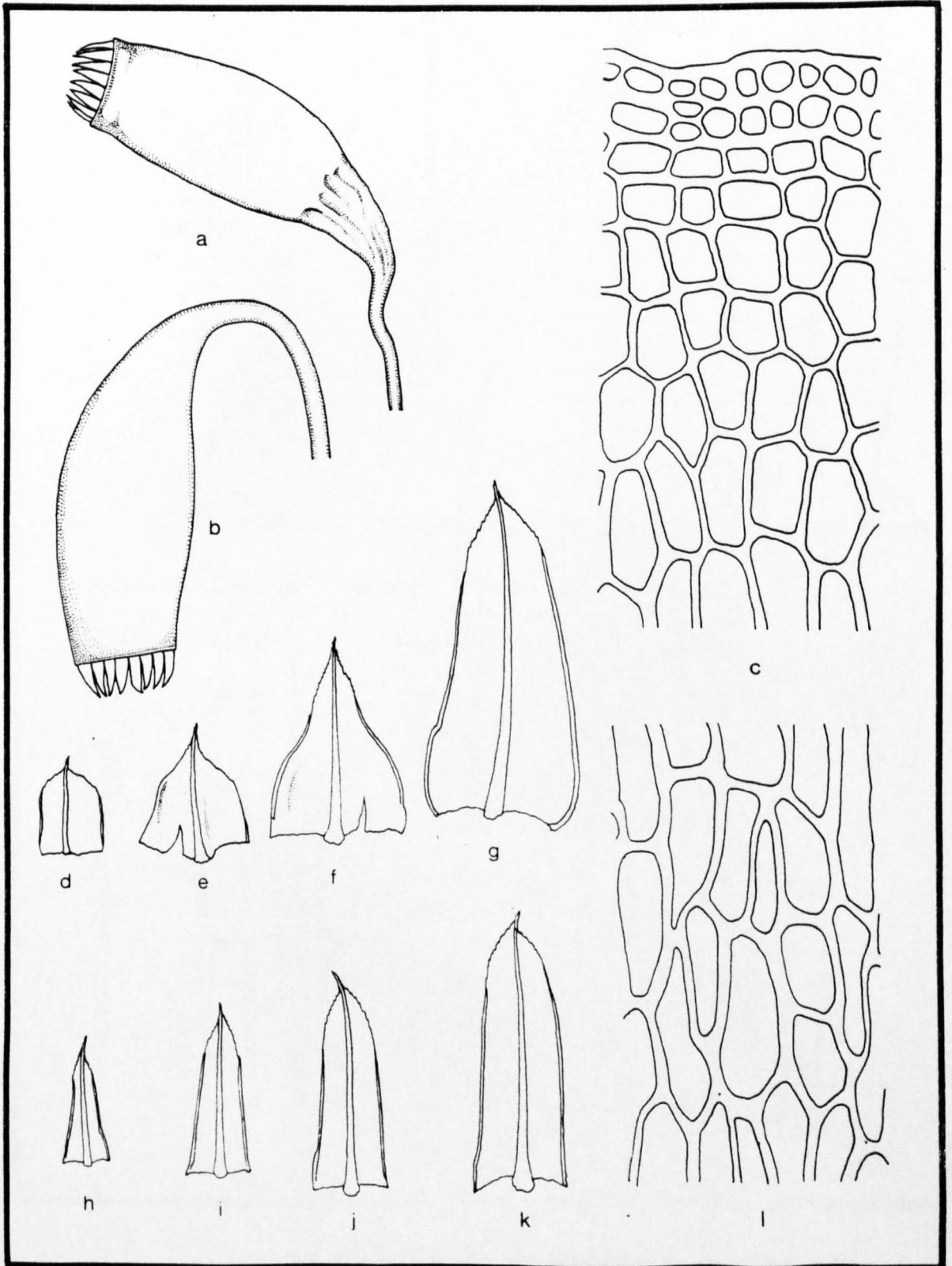


B. erythrocaulon

Figure 22. B. erythrocaulon Schwaegr., from plant from Madagascar.

a, dry capsule; b, same capsule moist; c, cells
at the mouth of capsule; d - g, perigonial leaves;
h - k, perichaetial leaves; i, exothecial cells.

a,b,d - k, x 15; c,i, x 200.



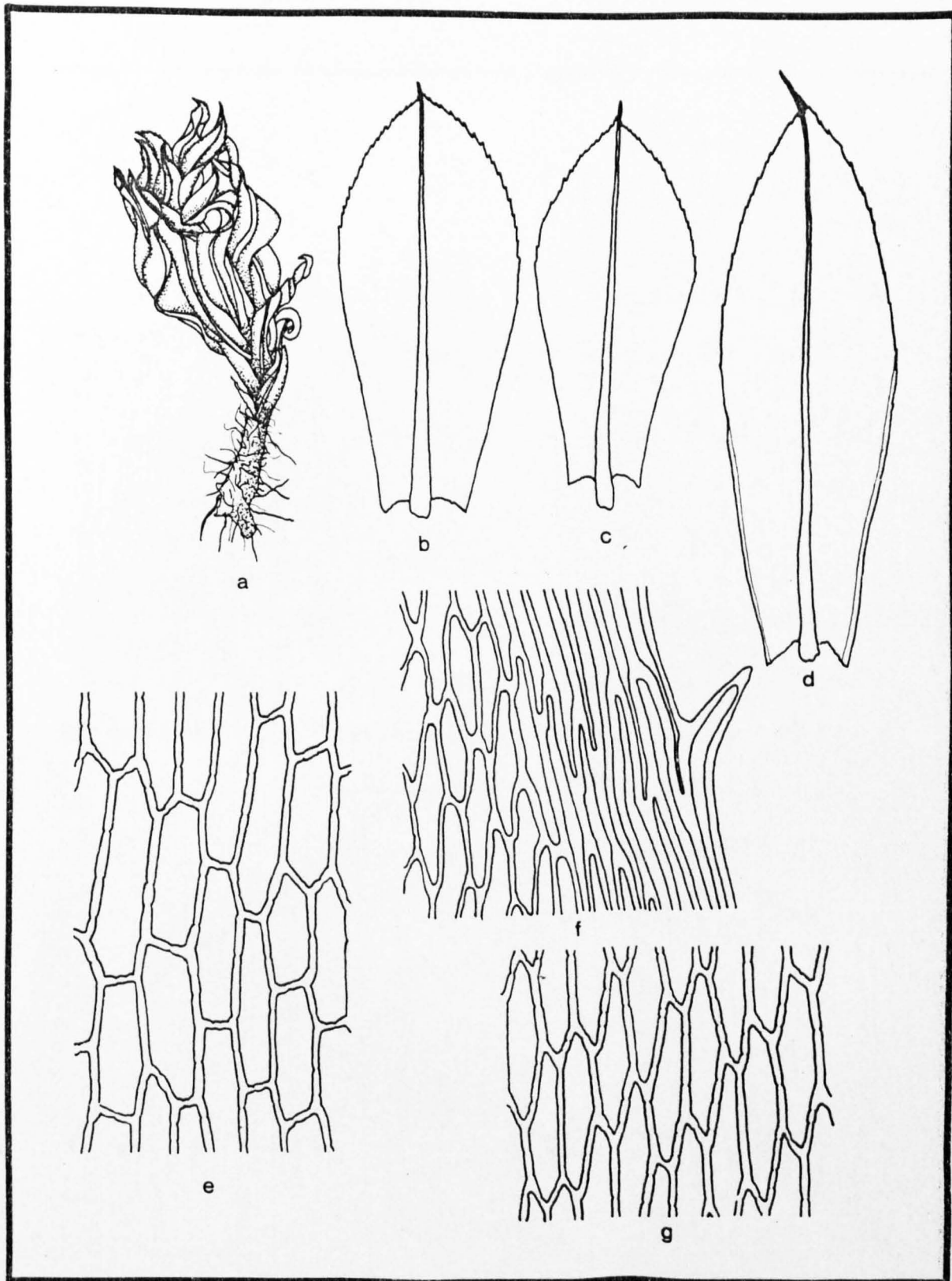
B. erythrocaulon

Figure 23.

B. ekmanii Ther., from plant from Cuba.

a, dry plant; b - d, leaves; e, cells at base of leaf; f, cells at margin; g, cells in middle.

a, x 7.5; b - d, x 15; e - g, x 200.

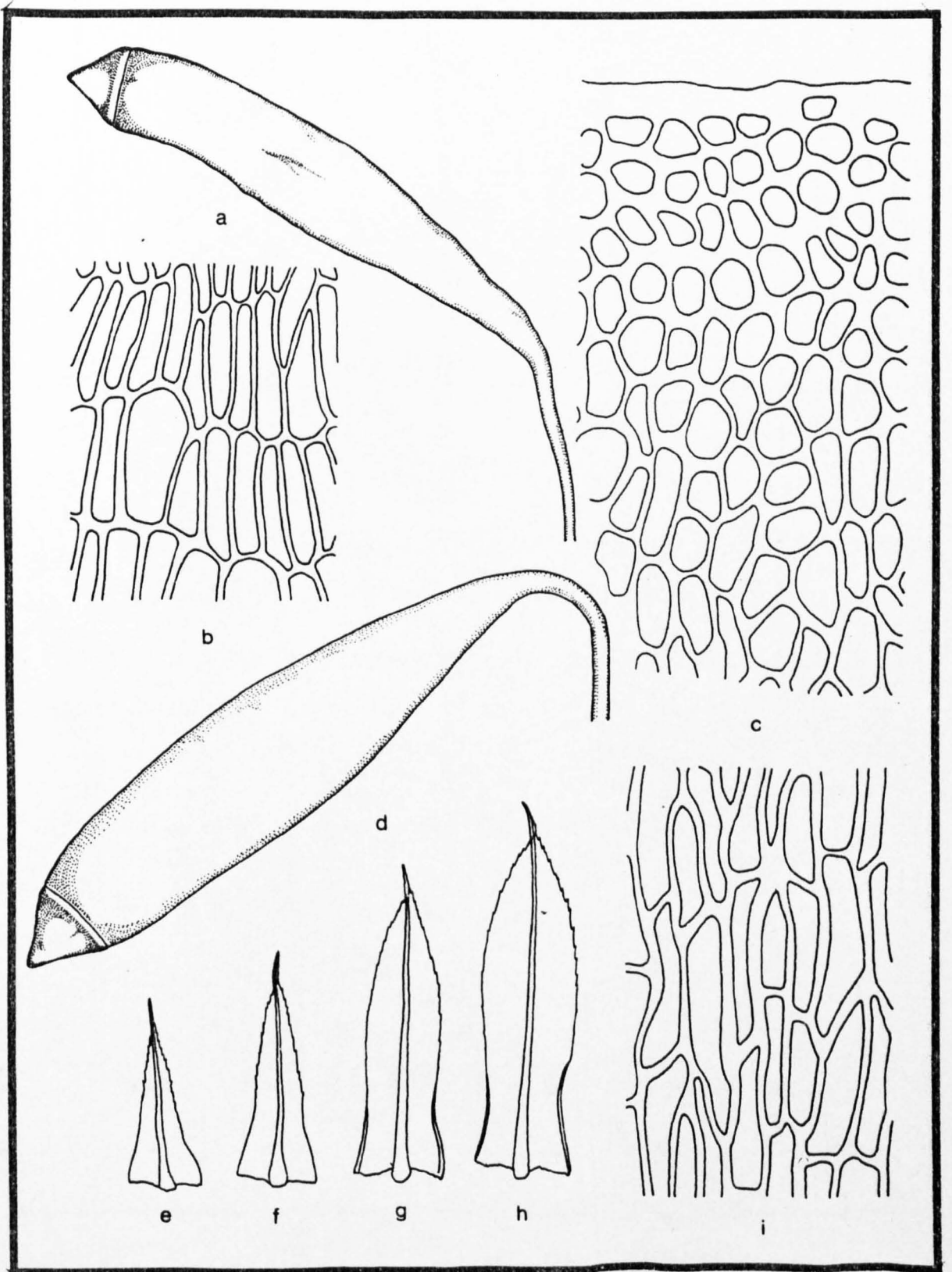


B. ekmanii

Figure 24. B. ekmanii Ther., from plant from Cuba.

a, dry capsule; b, lid cells; c, cells at mouth
of capsule; d, moist capsule; e - h, perichaetial
leaves; i, exothecial cells.

a,d,e - h, x 15; b,c,i, x 200.



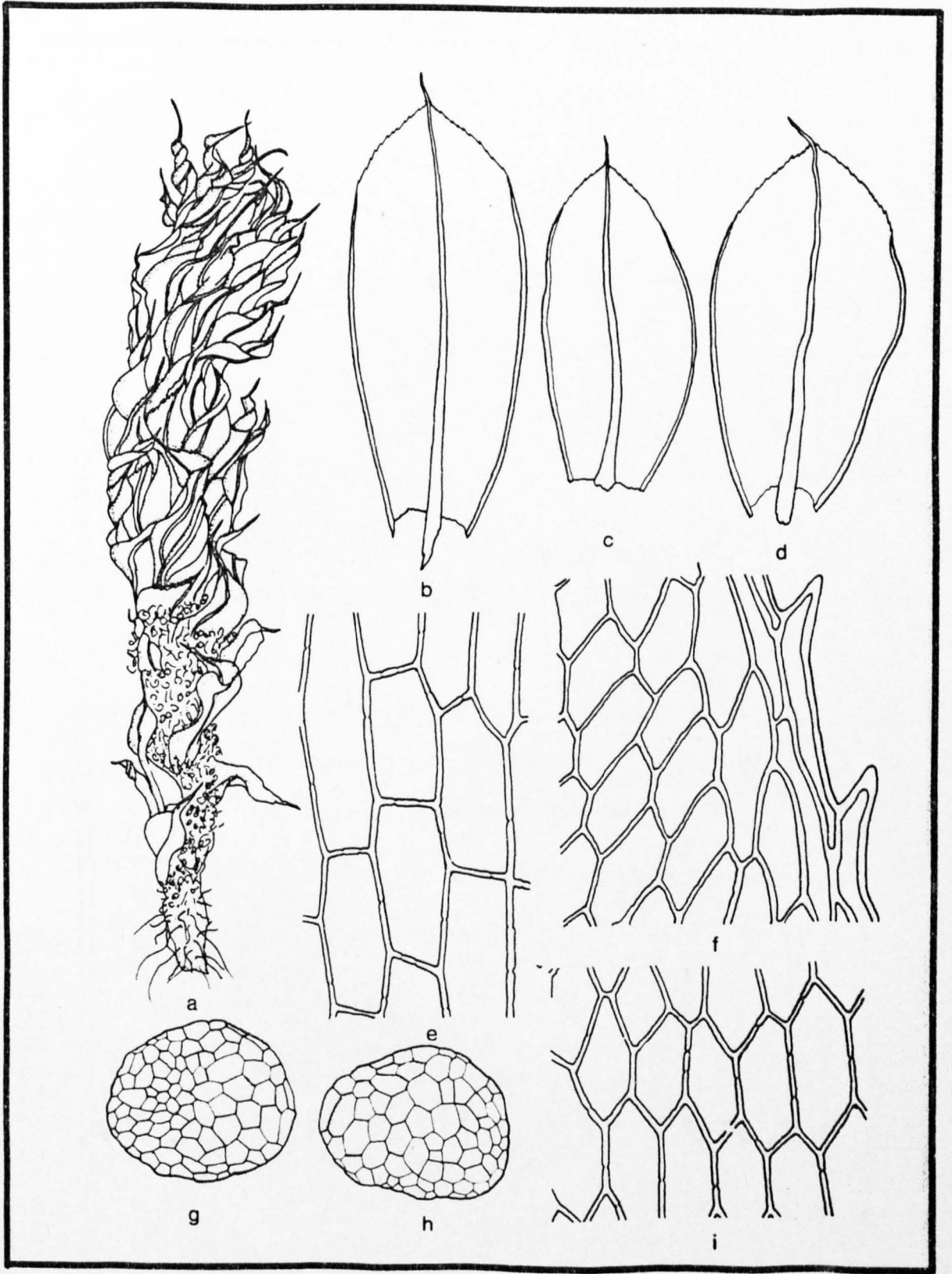
B. ekmanii

Figure 25.

B. ramosum (Hook.) Mitt., from plant from a, e - i,
Himalayas (India); c, Nepal; d, Yunnan, China.

a, dry plant; b - d, leaves; e, cells at base of
leaf; f, cells at margin; g, h, tubers; i, cells
in middle.

a, x 7.5; b - d, x 15; e, f, i, x 200; g, h, x 75.

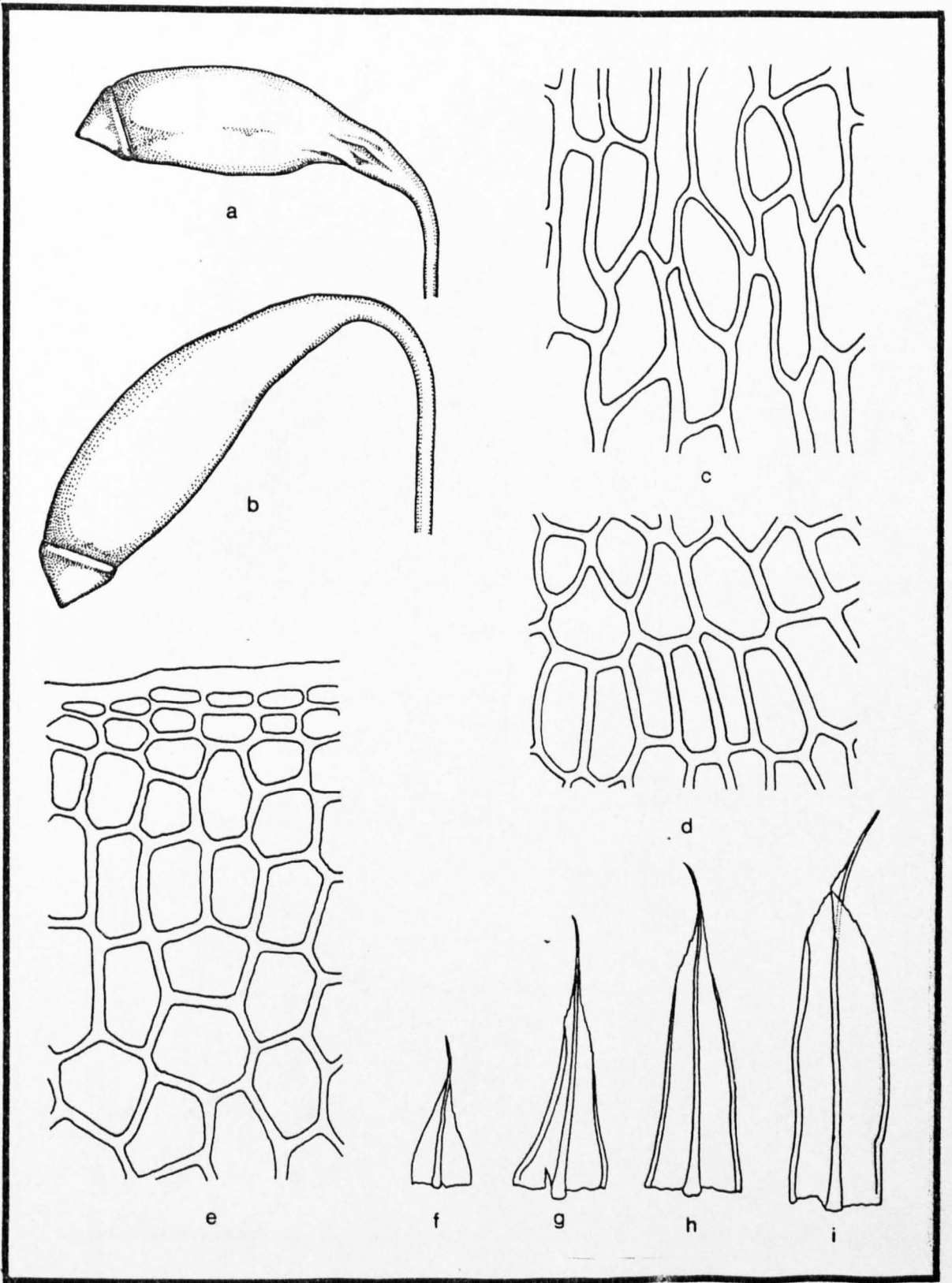


B. ramosum

Figure 26. B. ramosum (Hook.) Mitt., from plant from Himalayas
(India).

a, dry capsule; b, same capsule moist; c, exothecial
cells; d, lid cells; e, cells at mouth of capsule;
f - i, perichaetial leaves.

a - b, f - i, x 15; c - e, x 200.

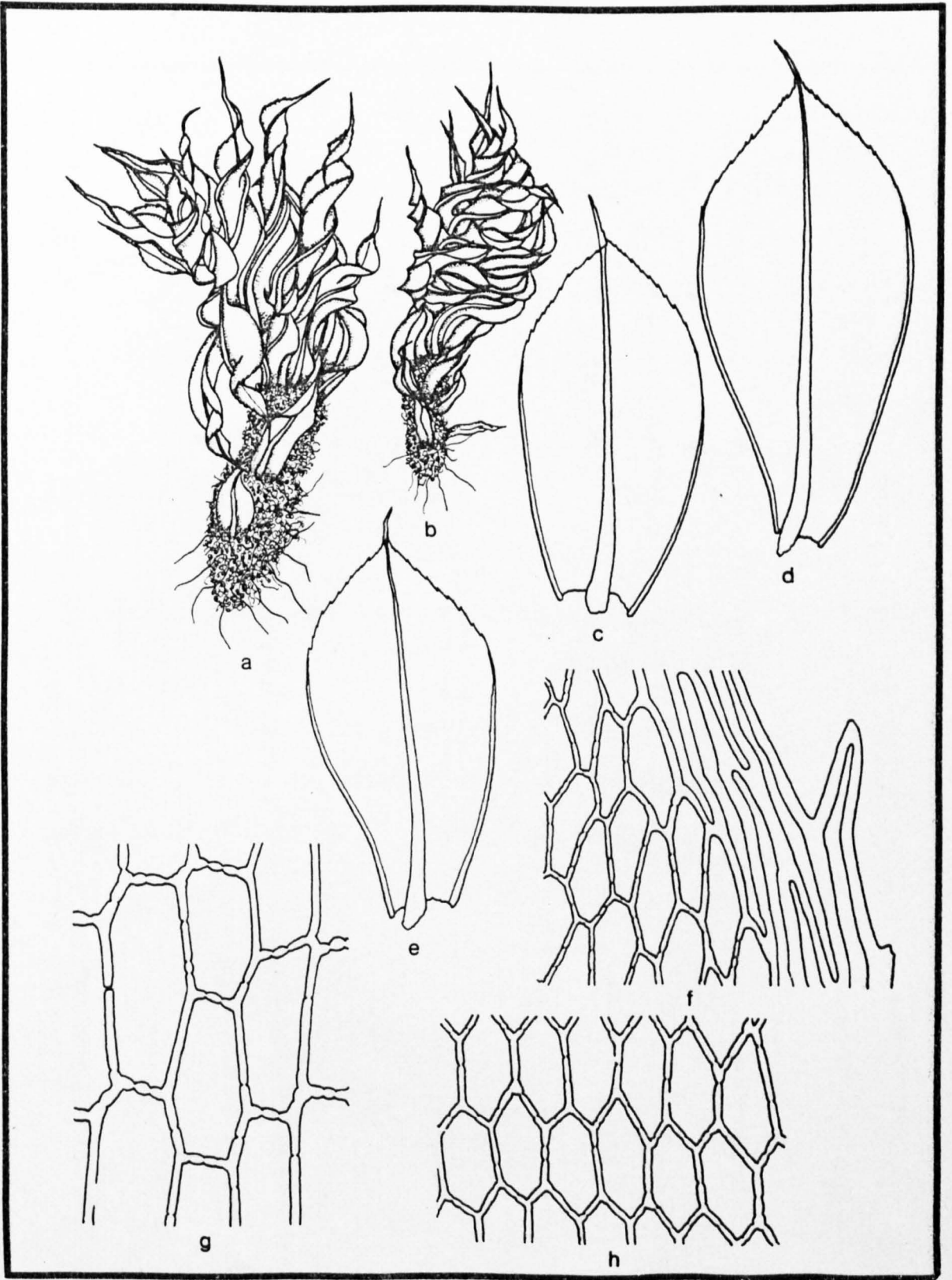


B. ramosum

Figure 27. B. pycnophyllum (Dix.) Mohamed, from plant from Republic of South Africa.

a,b, dry plants; c - e, leaves; f, cells at margin of leaf; g, cells at base; h, cells in middle.

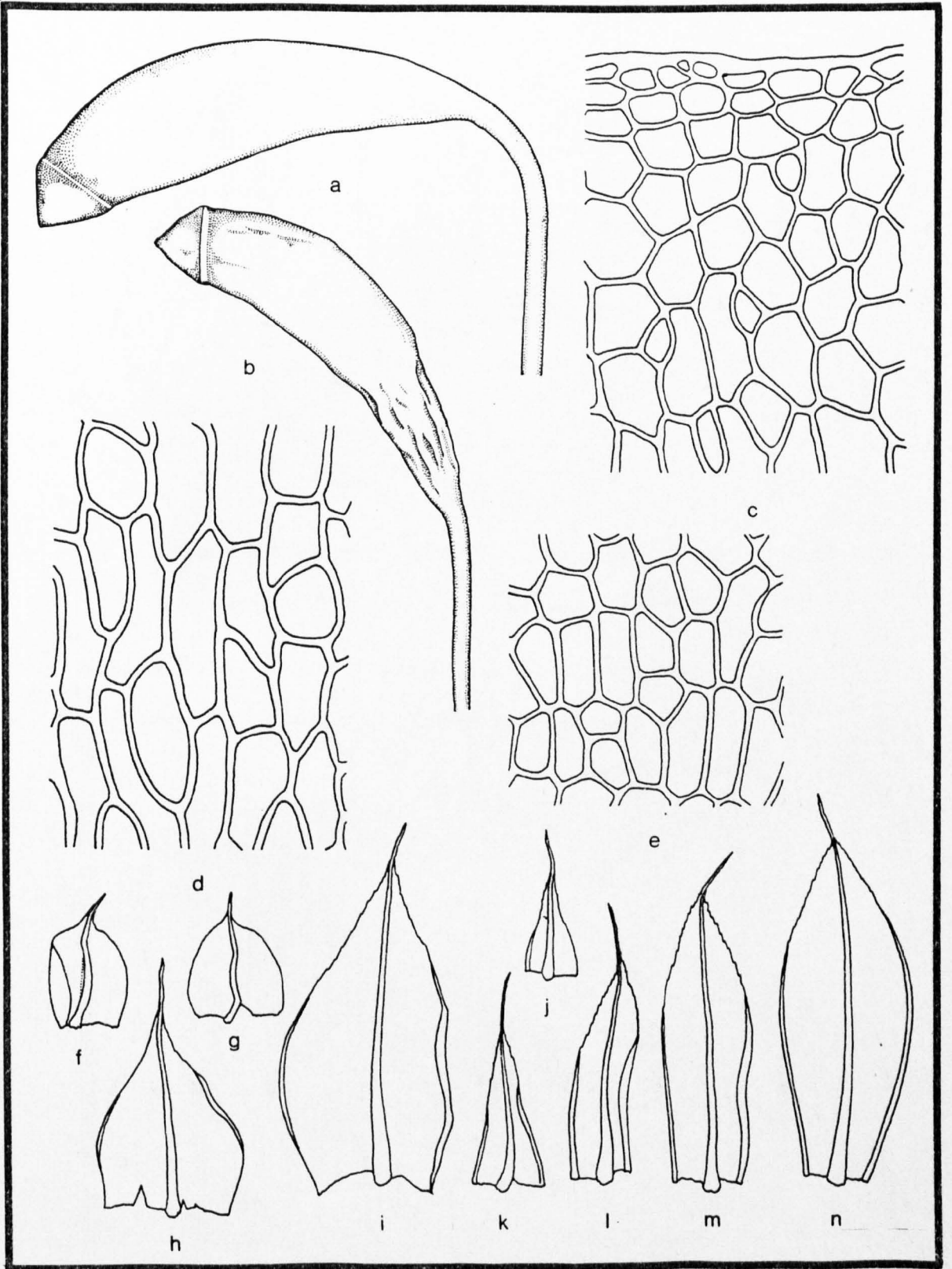
a,b, x 7.5; c - e, x 15; f - h, x 200.



B. pycnophyllum

Figure 28. B. pycnophyllum (Dix.) Mohamed, from plant from Republic of South Africa.

a, moist capsule; b, same capsule dry; c, cells at mouth of capsule; d, exothecial cells; e, lid cells; f - i, perigonial leaves; j - n, perichaetial leaves.
a, b, f - n, x 15; c - e, x 200.

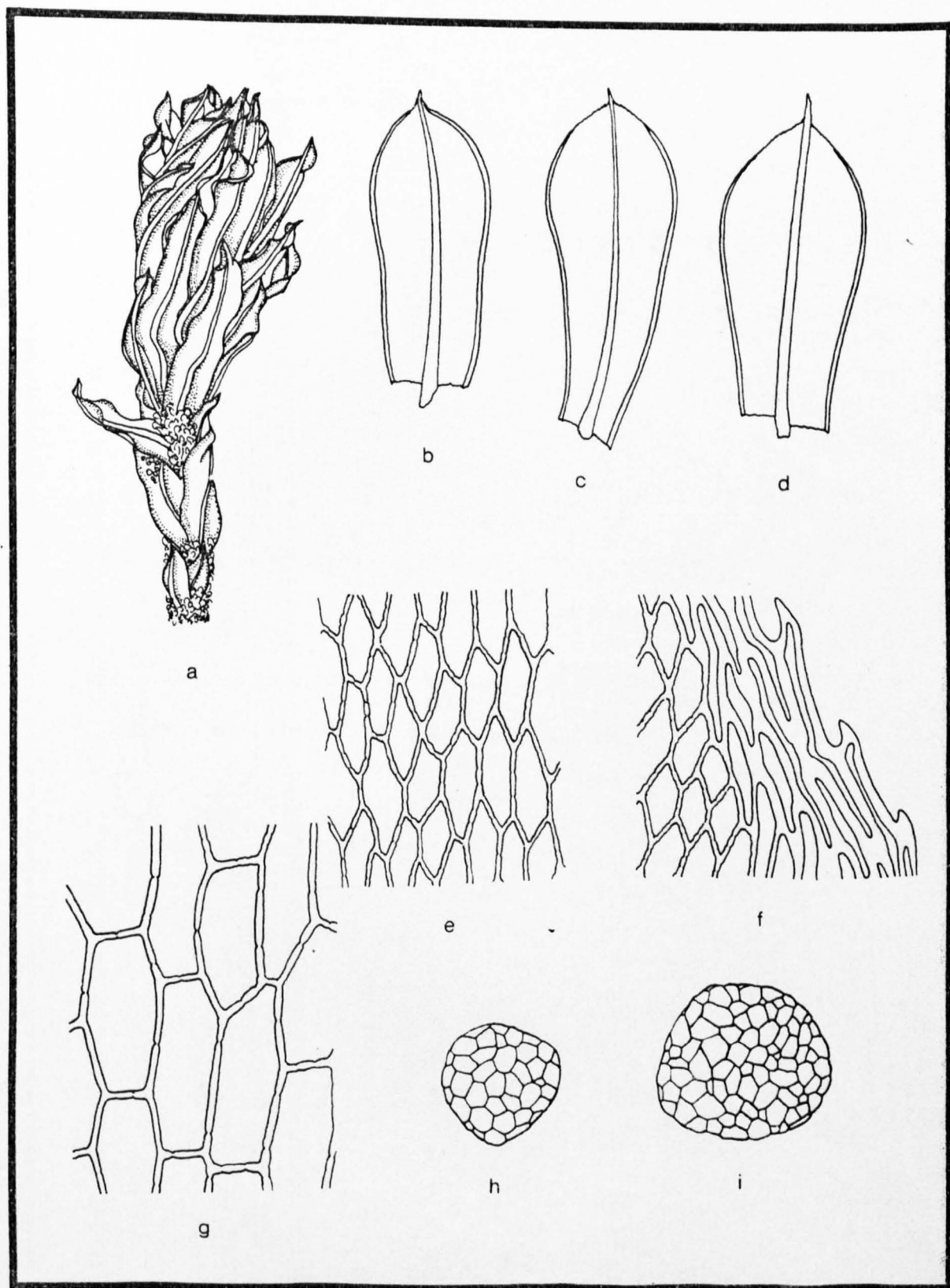


B. pycnophyllum

Figure 29. B. appressum Ren. et Card., from plant from a - c,
Madagascar; d, Republic of South Africa.

a, dry plant; b - d, leaves; e, cells in middle of
leaf; f, cells at margin; g, cells at base;
h,i, tubers.

a, x 7.5; b - d, x 15; e,f,g, x 200; h,i, x 75.

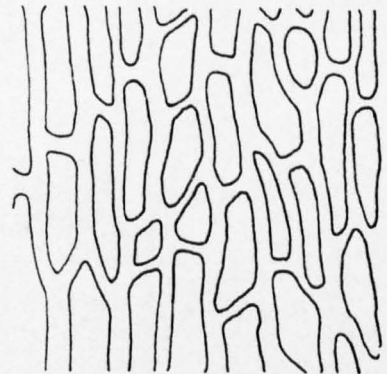
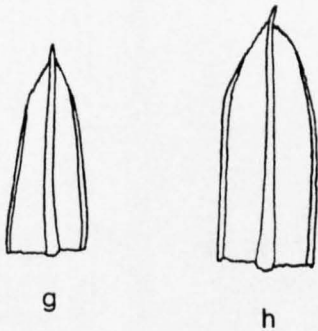
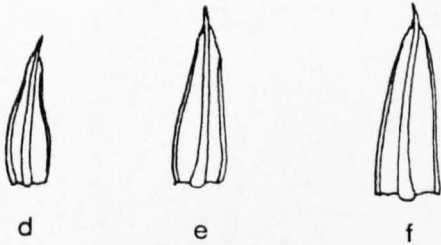
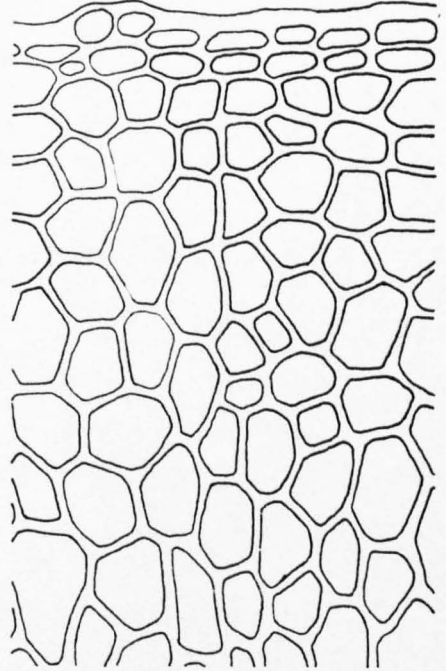
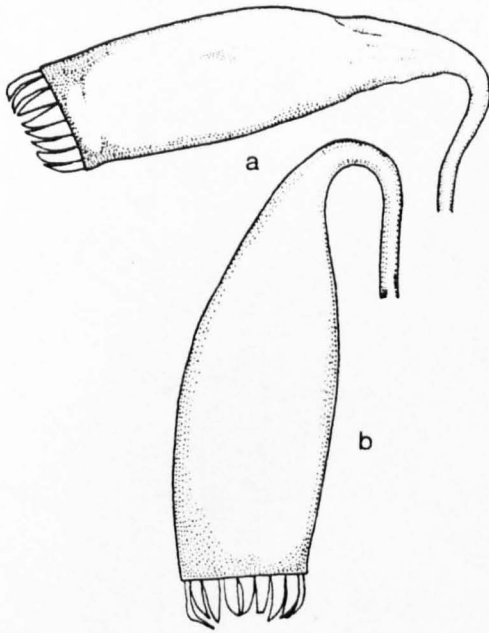


B. appressum

Figure 30. B. appressum Ren. et Card., from plant from Republic of South Africa.

a, dry capsule; b, same capsule moist; c, cells at mouth of capsule; d - l, perichaetial leaves; i, exothecial cells.

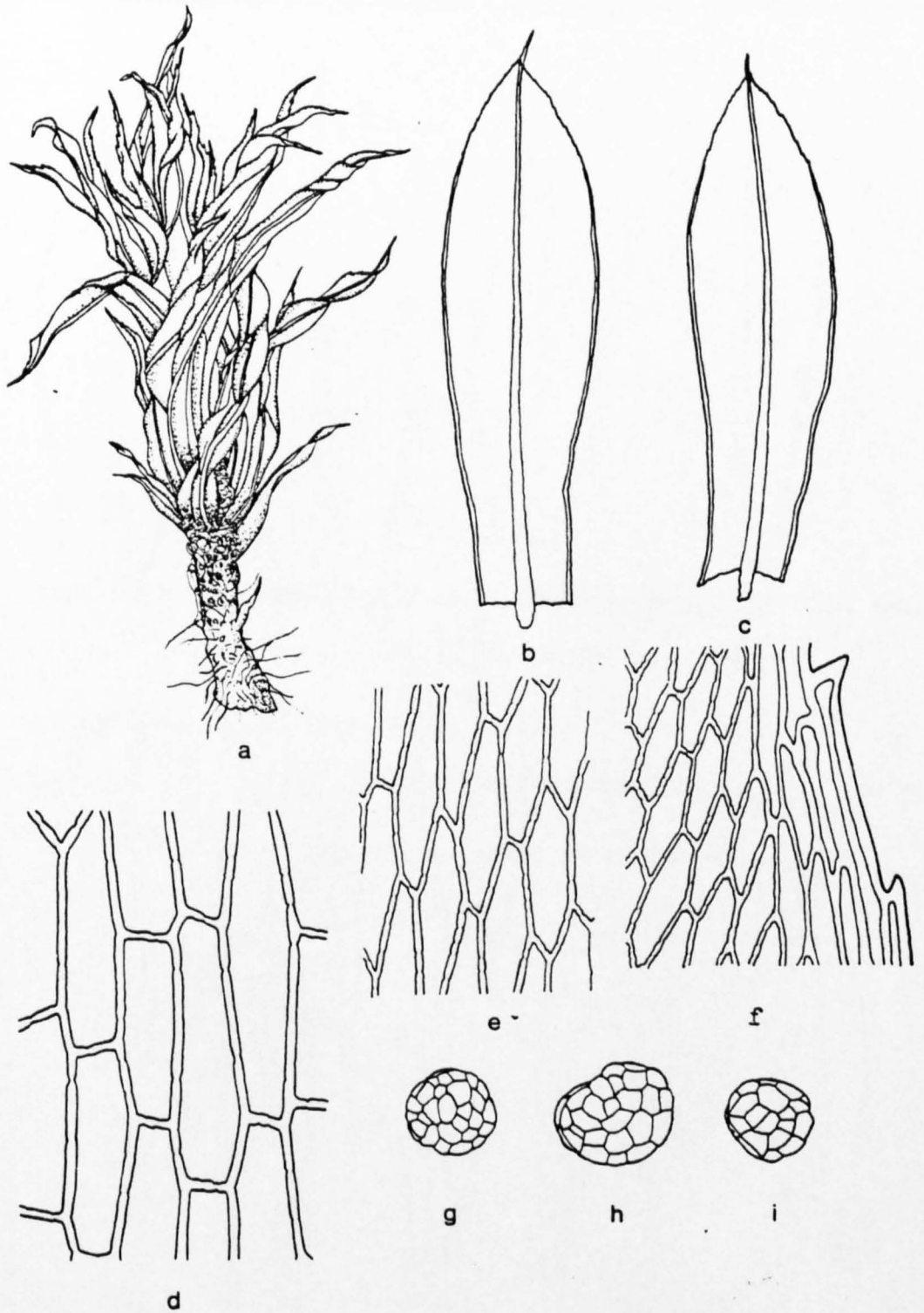
a,b, d - h, x 15; c,i, x 200.



B. appressum

Figure 31. B. sinense Mohd., from plant from Japan.

a, dry plant; b,c, leaves; d, cells at base of leaf;
e, cells in middle; f, cells at margin; g - i, tubers.
a, x 7.5; b,c, x 15; d - f, x 200; g - i, x 75.



B. sinense

Figure 32. B. sinense Mohd., from plant from a,c,g - k, Japan;

b,d - f, China.

a - d,f, leaves; f, cells of lid of capsule;

g - k, perichaetial leaves.

a - d, f - k, x 15; e, x 200.

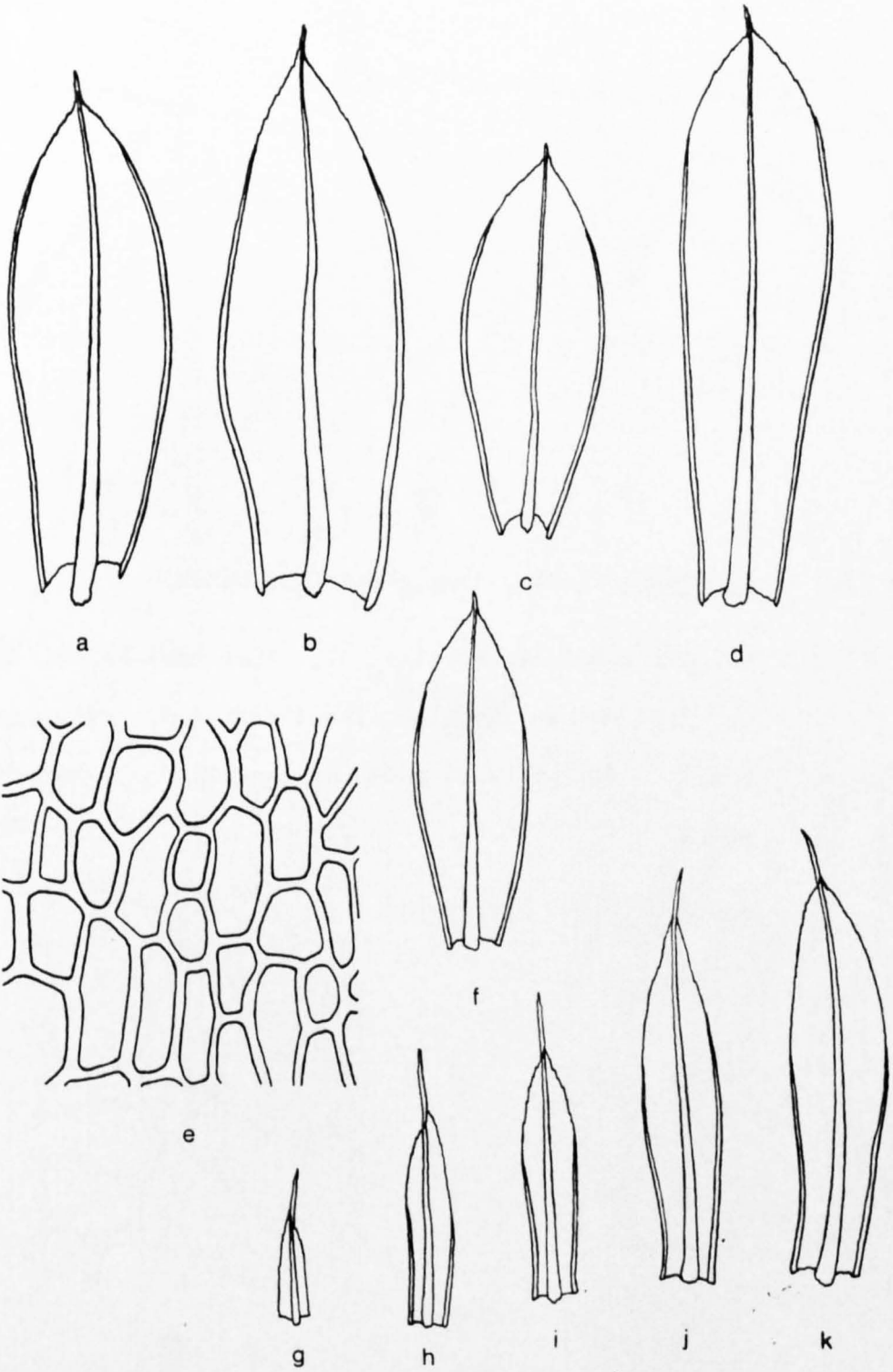
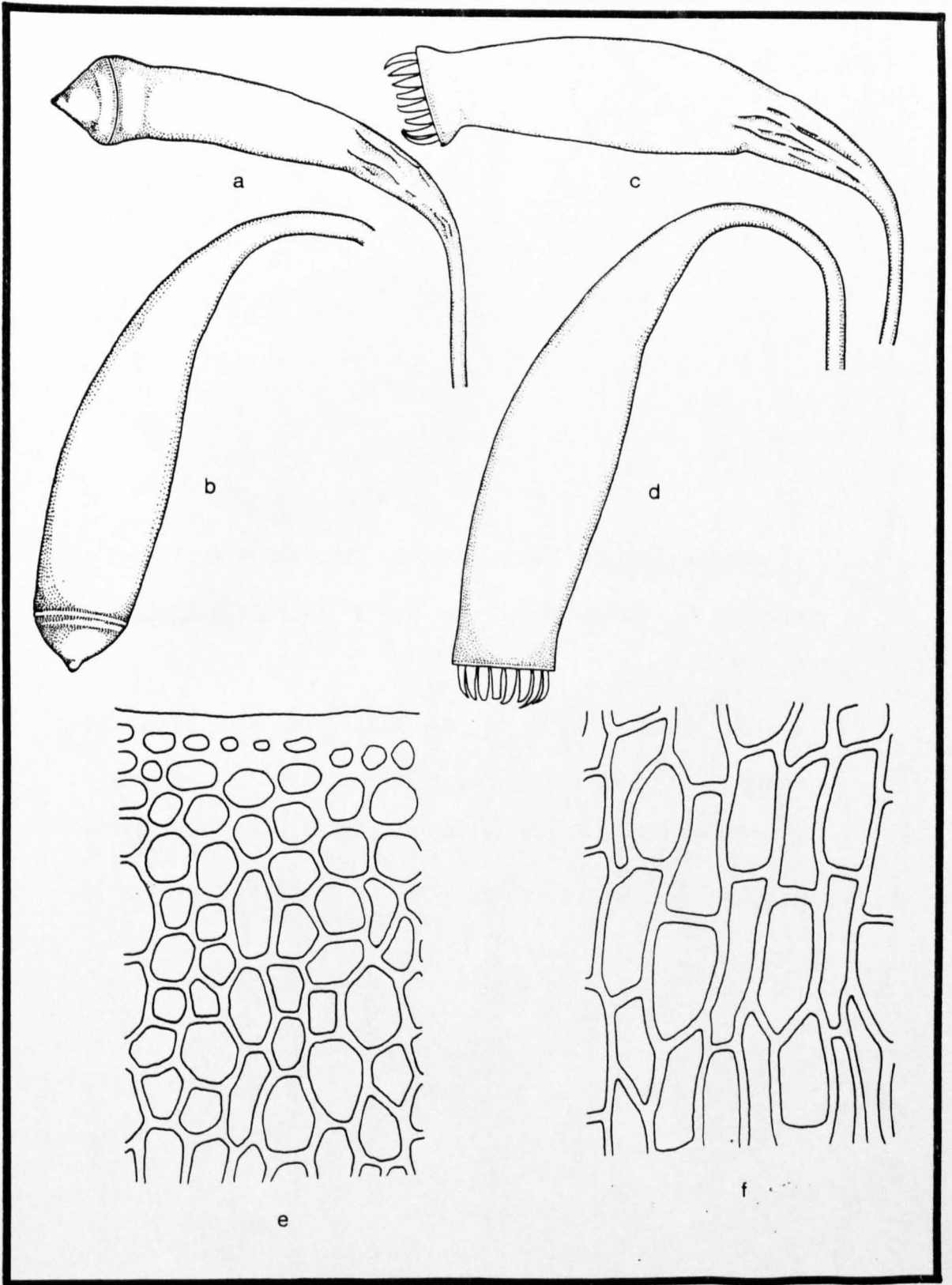


Figure 33. B. sinense Mohd., from plant from China.

a, dry immature capsule; b, same capsule moist;
c, dry mature capsule without lid; d, same capsule
moist; e, cells at mouth of capsule; f, exothecial
cells.

a - d, x 15; e,f, x 200.

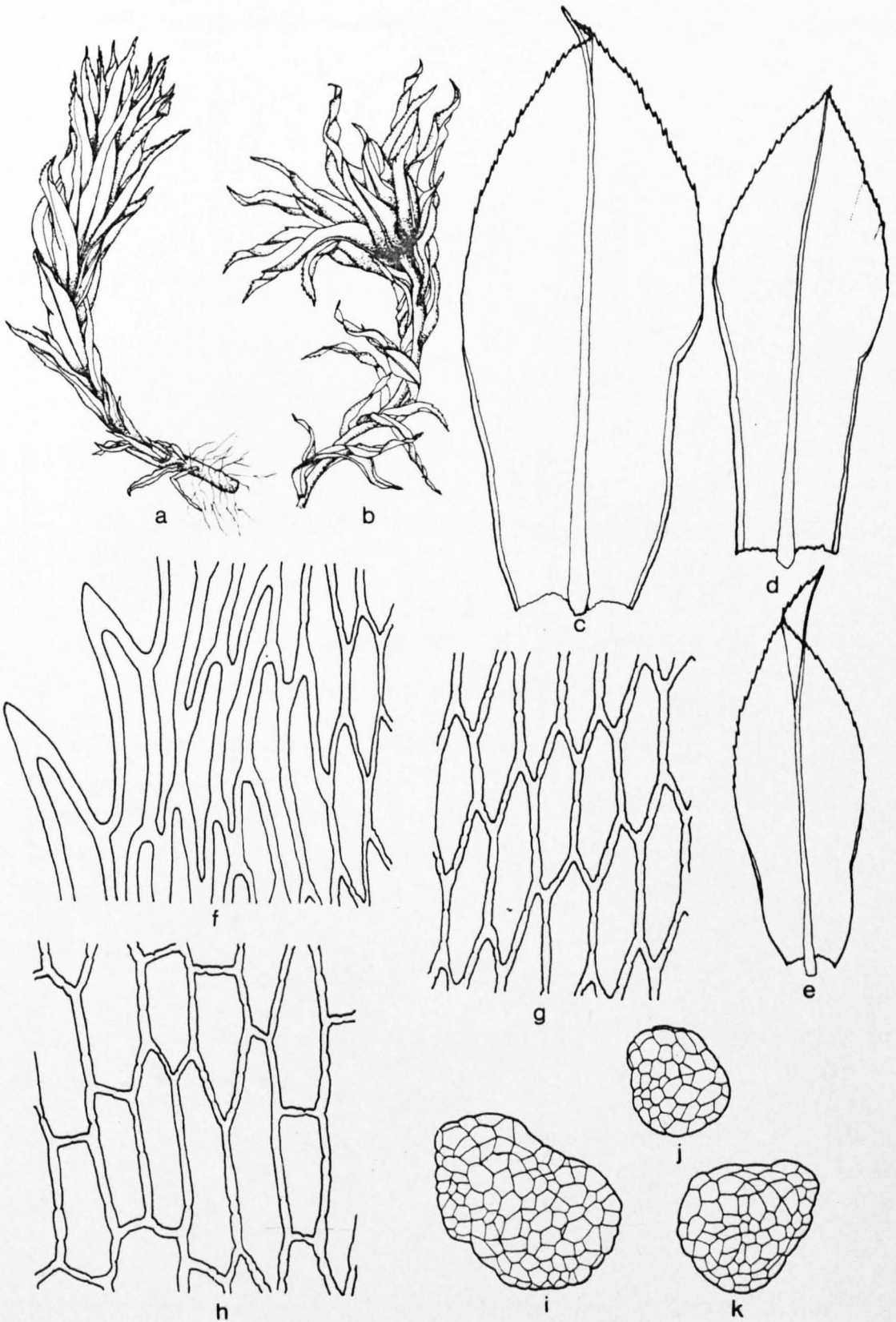


B. sinense

Figure 34. B. subfasciculatum (Hamp.) Mitt., from plant from
a,b,d - k, Queensland; c, type of B. dilatato-marginatum
C. Muell..

a, dry female plant; b, dry male plant with antheridial
head; c - e, leaves; f, cells at margin of leaf;
g, cells at base; h, cells in middle; i - k, tubers.

a,b, x 7.5; c - e, x 15; f - h, x 200; i - k, x 75.

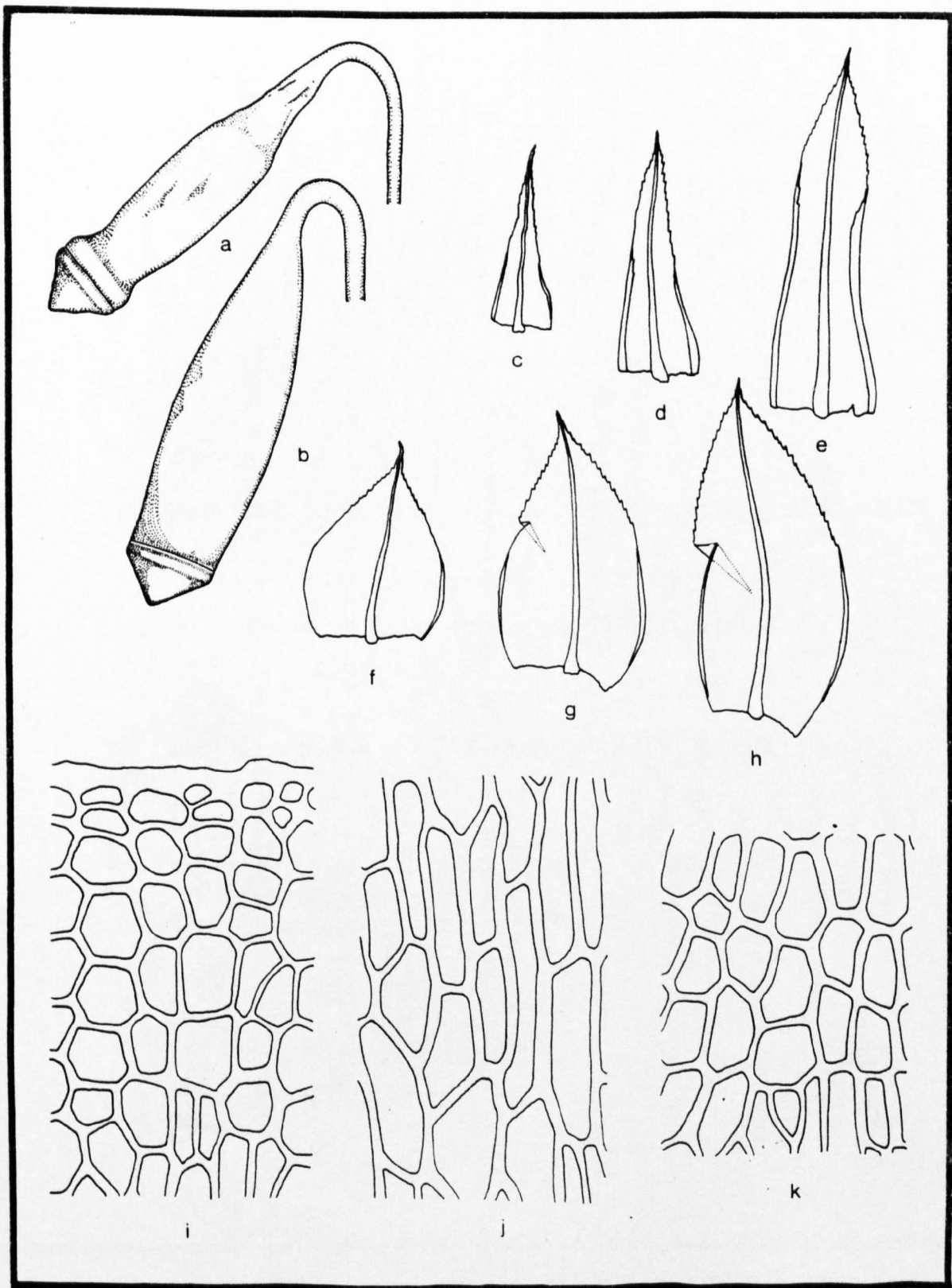


B. subfasciculatum

Figure 35. B. subfasciculatum (Hamp.) Mitt., from plant from Queensland.

a, dry capsule; b, same capsule moist; c - e, perichaetial leaves; f - h, perigonial leaves; i, cells at mouth of capsule; j, exothecial cells; k, lid cells.

a - h, x 15; i - k, x 200.

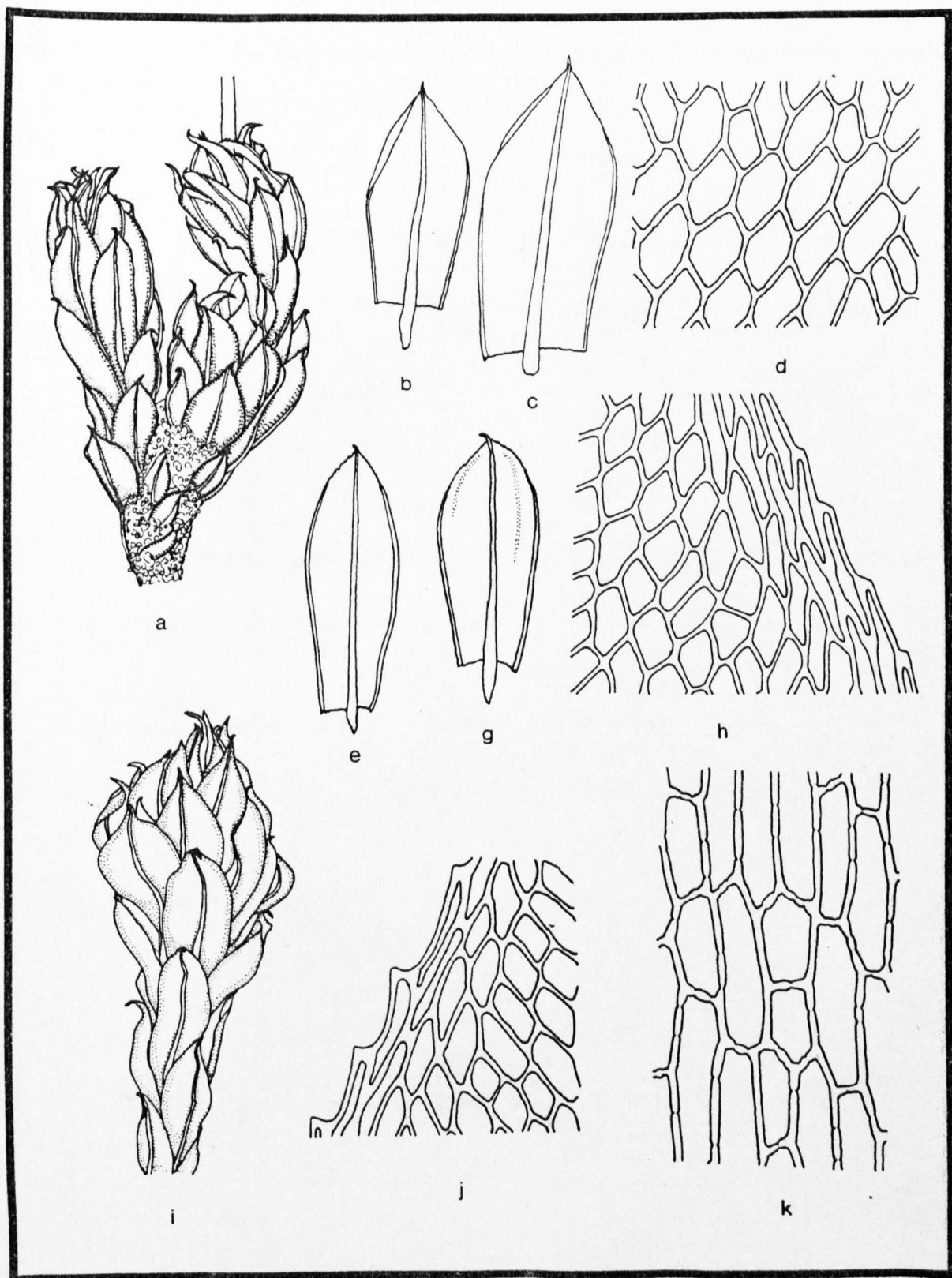


B. subfasciculatum

Figure 36. B. microrhodon C. Muell., from plant from Tasmania.

a,i, dry plants; b,c,e,g, leaves; d, cells
in middle of leaf; h,j, cells at margin; k, cells
at base.

a,i, x 7.5; b,c,e,g, x 15; d,h,j,k, x 200.



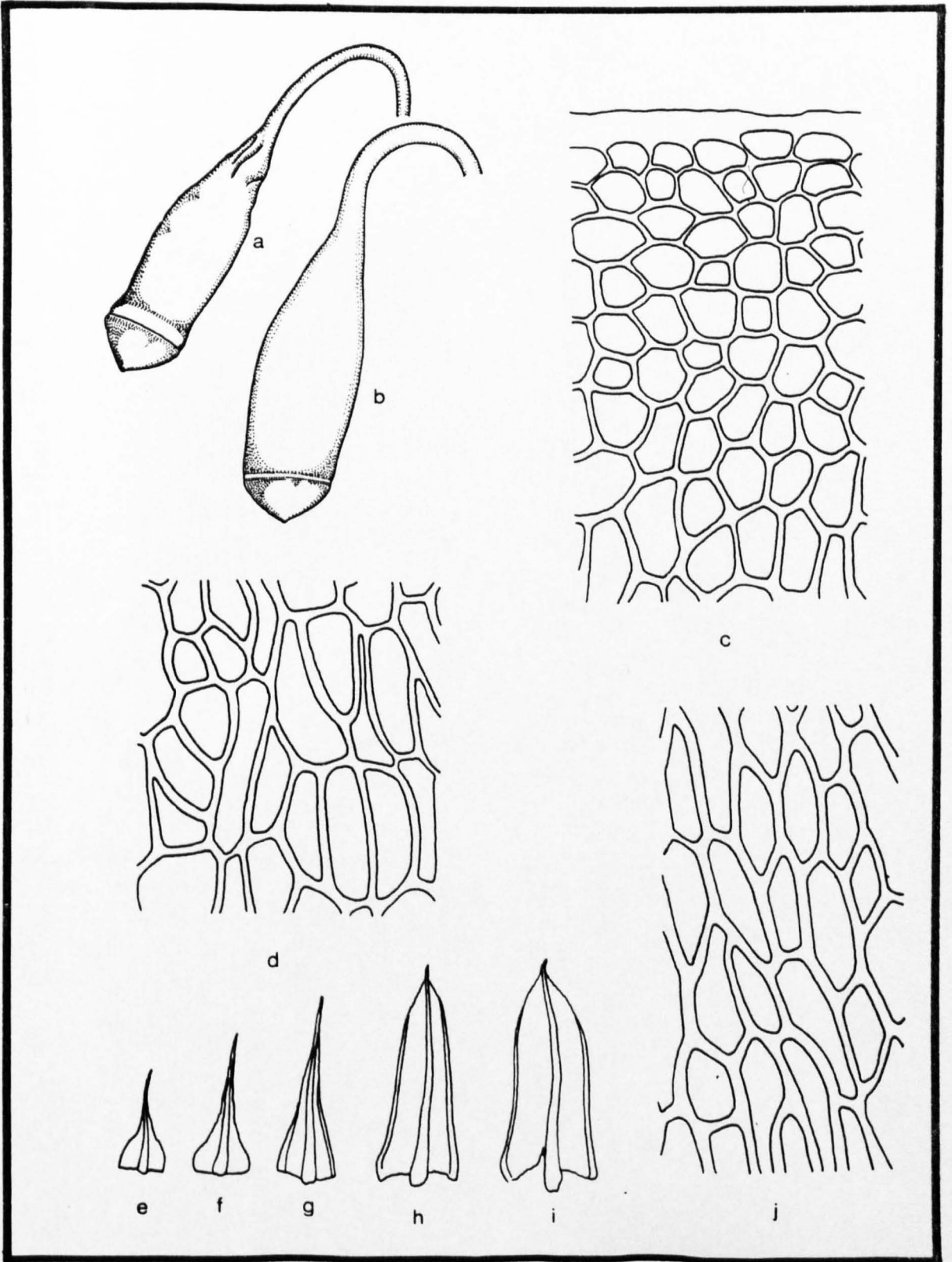
B. microrhodon

Figure 37. B. microrhodon C. Muell., from plant from Tasmania.

a, dry capsule; b, same capsule moist; c, cells
at the mouth of capsule; d, lid cells;

e - i, perichaetial leaves; j, exothecial cells.

a,b,e - i, x 15; c,d,j, x 200.



B. microrhodon

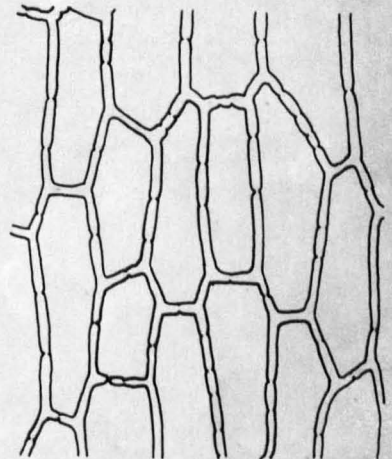
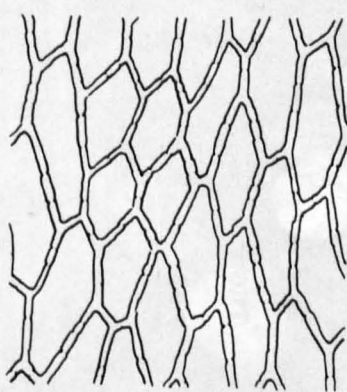
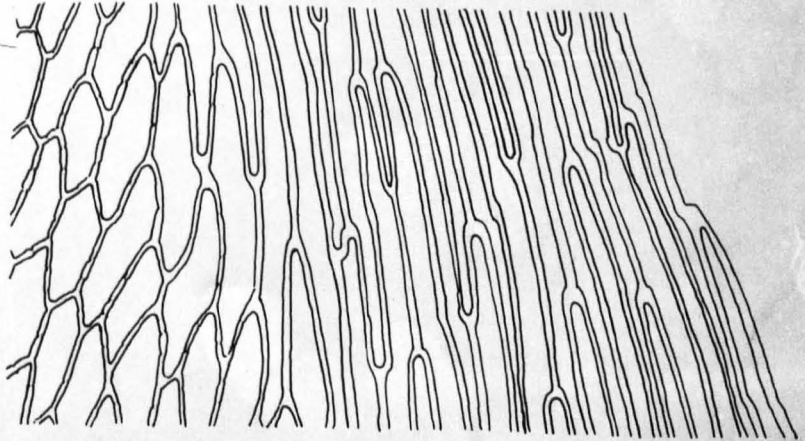
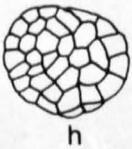
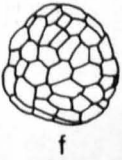
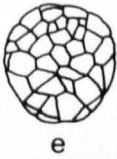
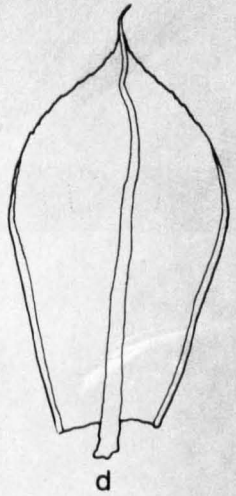
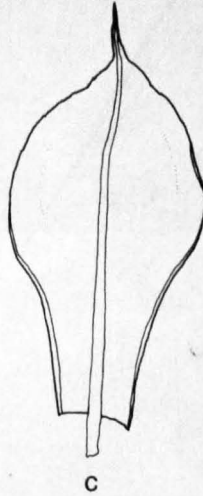
Figure 38. B. perlimbatum Card., from plant from New Zealand.

a, dry plant; b - d, leaves; e - h, tubers;

i, cells at margin of leaf; j, cells in middle;

k, cells at base.

a, x 7.5; b - d, x 15; e - h, x 75; i - k, x 200.

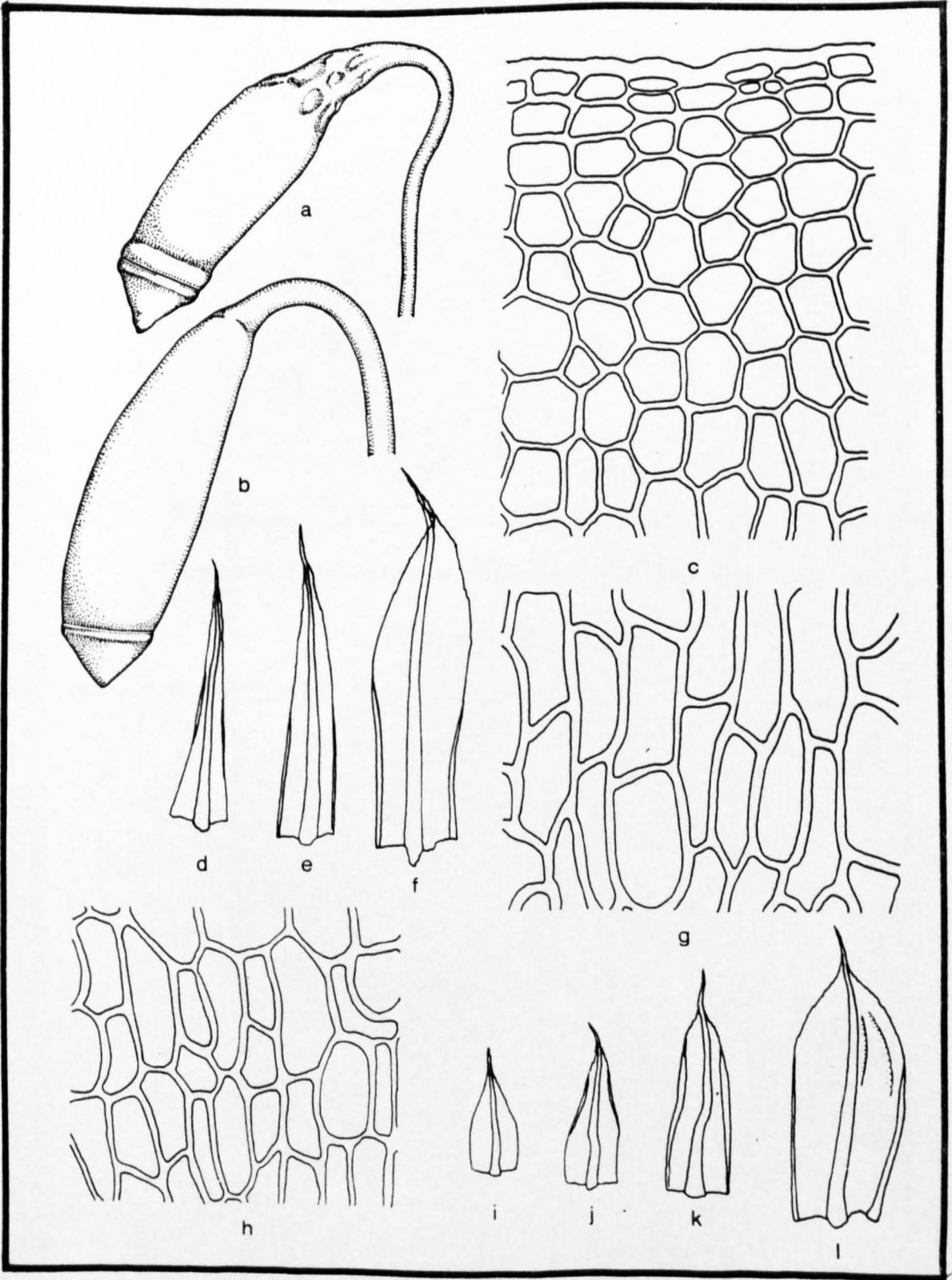


B. perlimbatum

Figure 39. B. perlimbatum Card., from plant from New Zealand.

a, dry capsule; b, same capsule moist; c, cells
at mouth of capsule; d - f, perichaetial leaves;
g, exothecial cells; h, lid cells;
i - l, perigonial cells.

a,b,d - f,i - l, x 15; c,g,h, x 200.

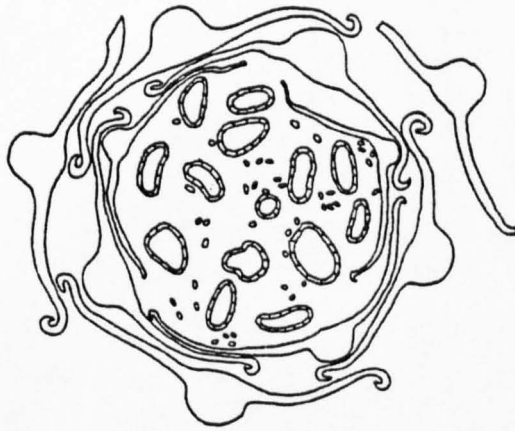


B. perlimbatum

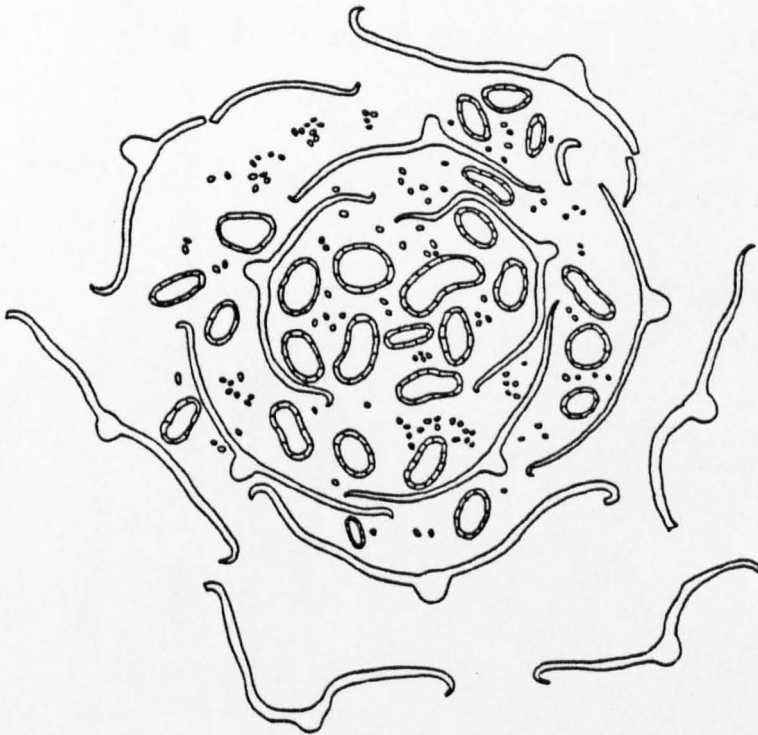
Figure 40. Cross sections of male heads to show arrangement of antheridia in relation to perigonial leaves.

A. B. perlimbatum Card.

B. B. billardieri var. platyloma (Schwaegr.) Mohd.



A



B

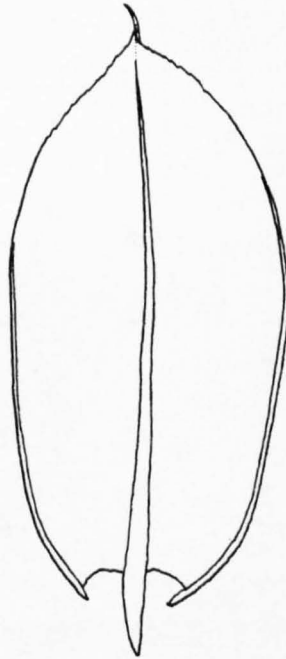
Figure 41. B. goudotii Hamp., from plant from Venezuela.

a, dry plant; b - c, leaves; d, cells at
base of leaf; e, cells at margin; f, cells
in middle.

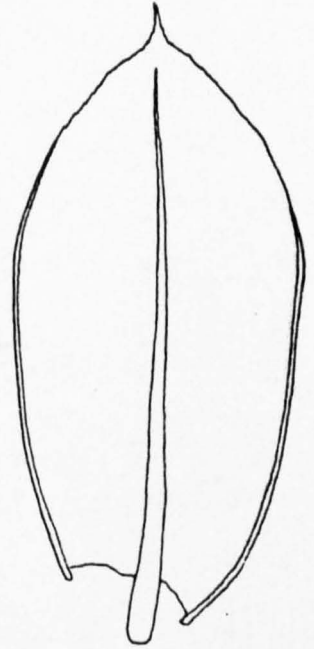
a, x 7.5; b,c, x 15; d - f, x 200.



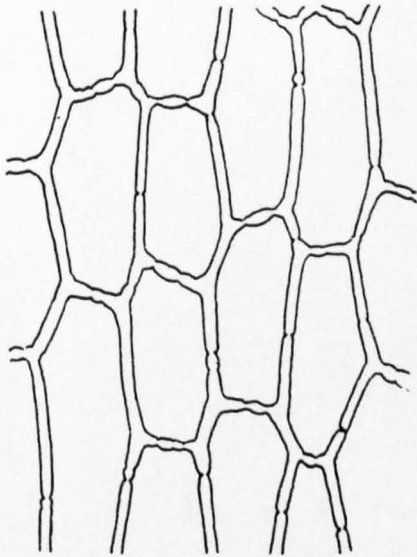
a



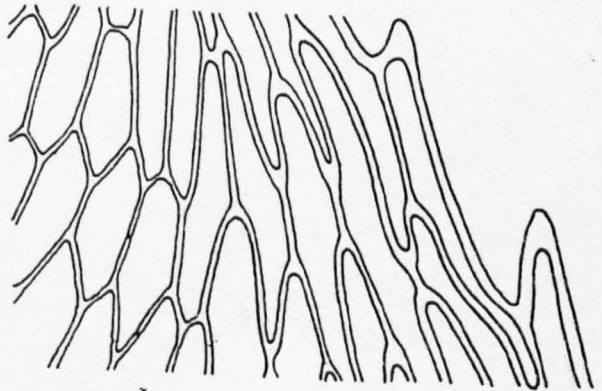
b



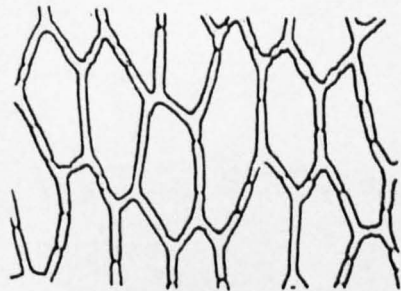
c



d



e



f

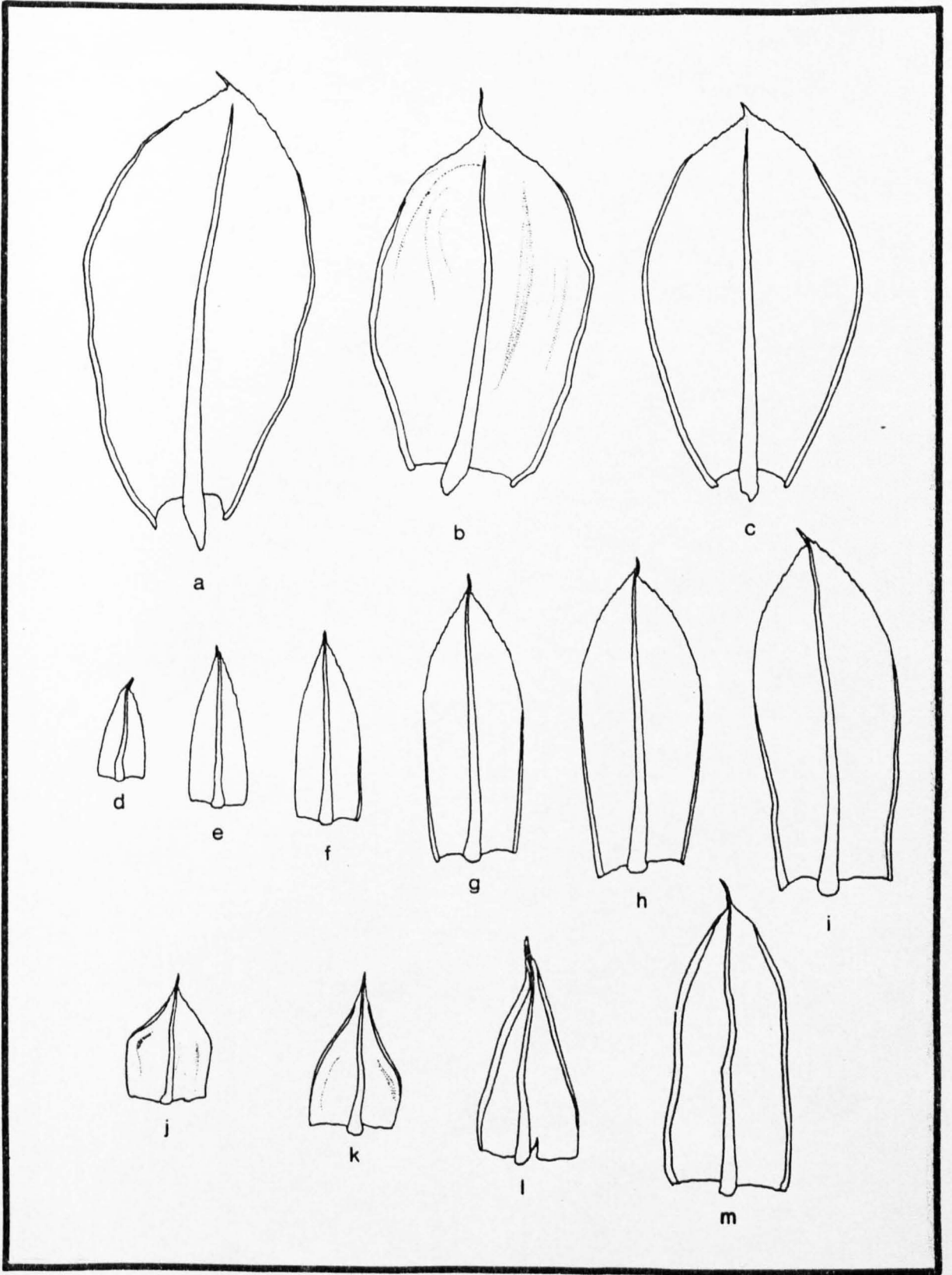
B. goudotii

Figure 42. B. goudotii Hamp., from plant from Venezuela.

a - c, leaves; d - i, perichaetial leaves;

j - m, perigonial leaves.

a - m, x 15.

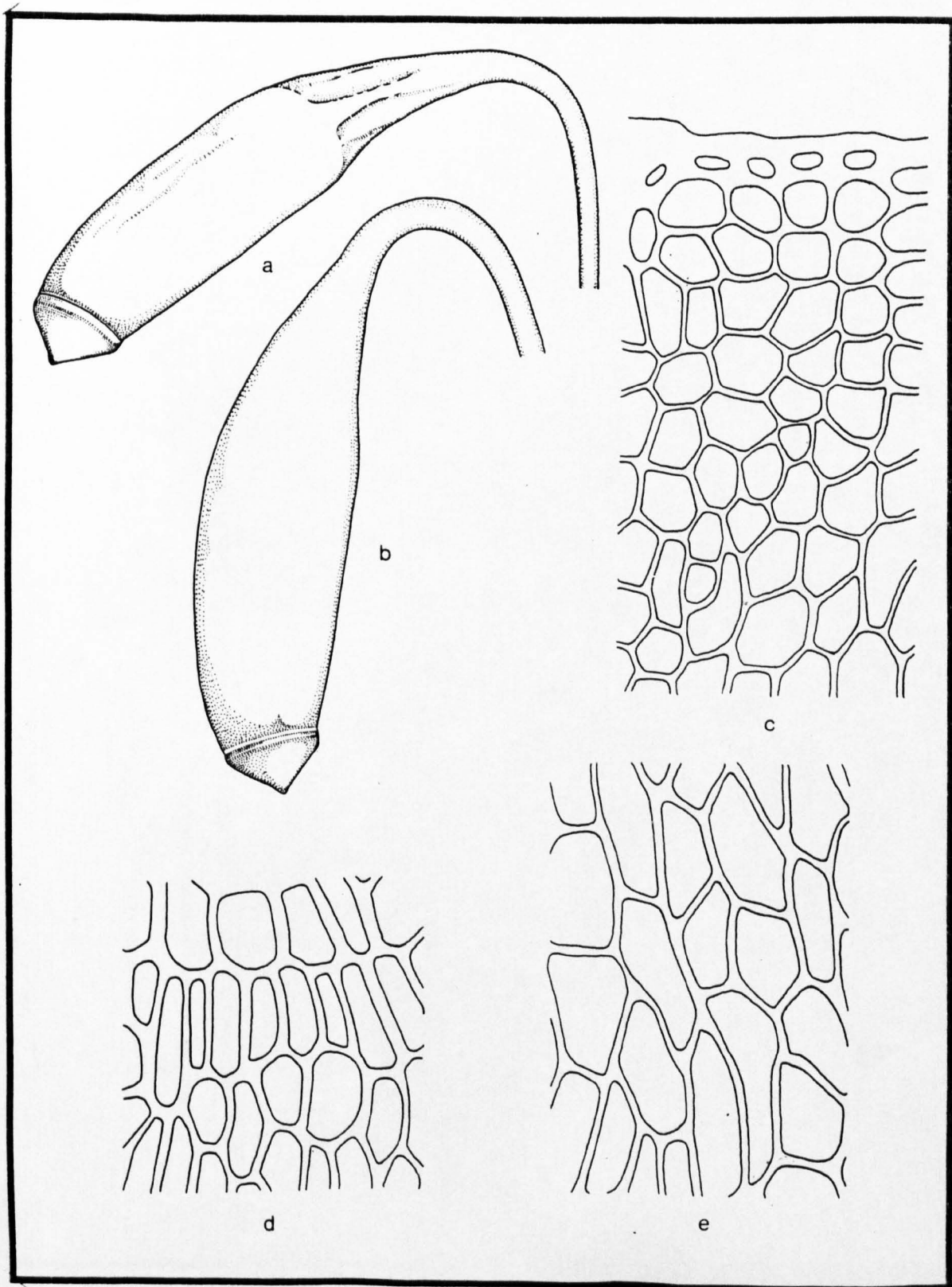


B. goudotii

Figure 43. B. goudotii Hamp., from plant from Venezuela.

a, dry capsule; b, same capsule moist; c, cells
at mouth of capsule; d, exothecial cells;
e, lid cells.

a,b, x 15; c,e, x 200.

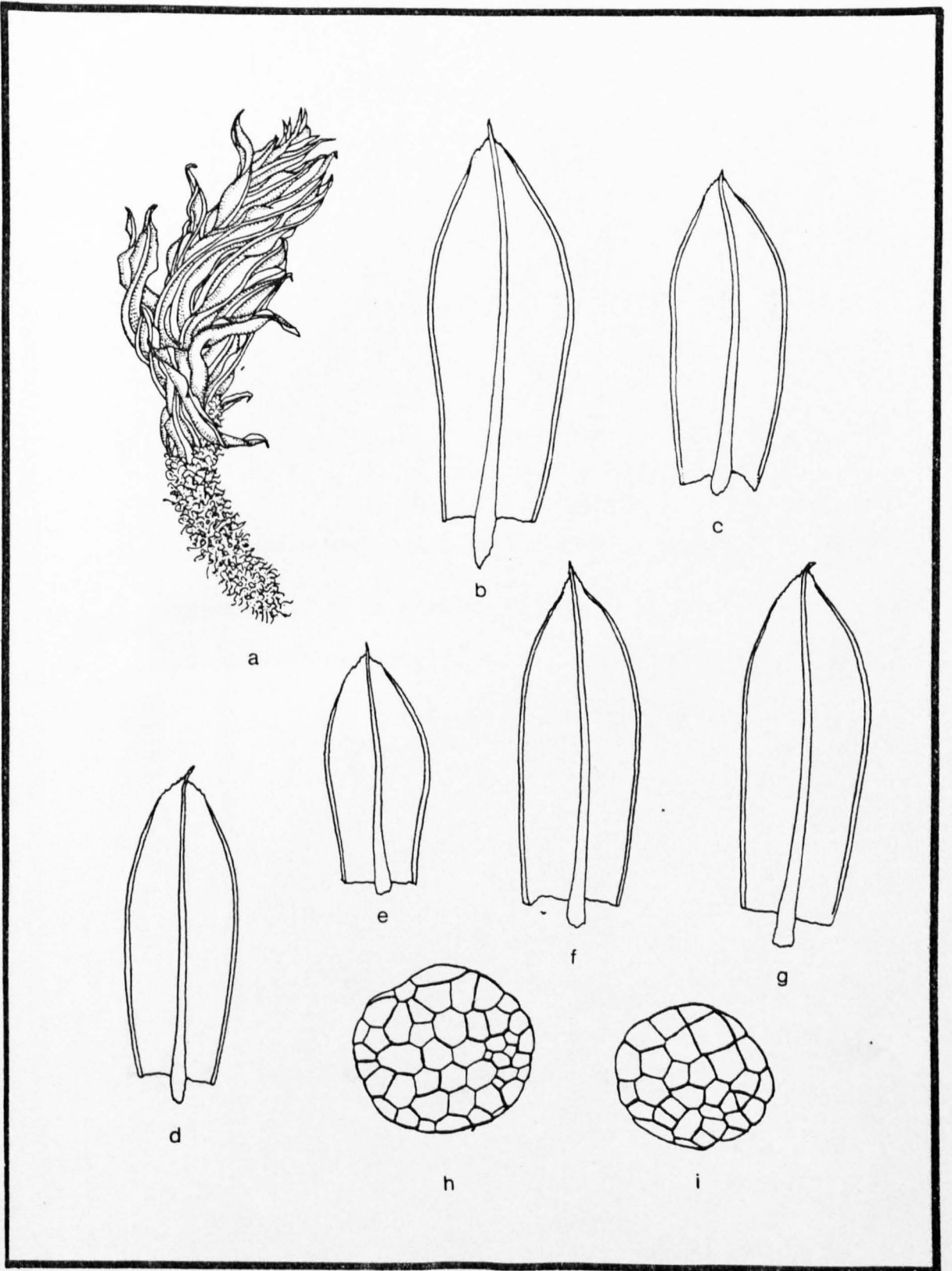


B. goudotii

Figure 44. B. torquatum Mohd., from plant from Jamaica.

a, dry plant; b - g, leaves; h,i, tubers.

a, x 7.5; b - g, x 15; h,i, x 75.



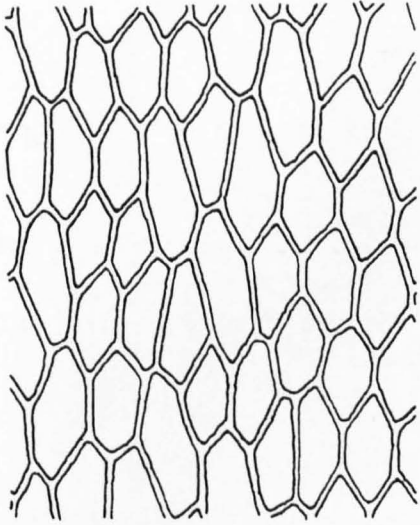
B. torquatum

Figure 45. B. torquatum Mohd., from plant from Jamaica.

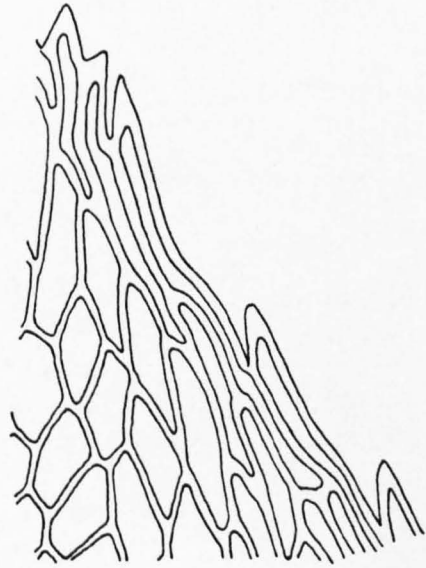
a, cells in middle of leaf; b, cells at margin;

c, cells at base; d - h, perichaetial leaves.

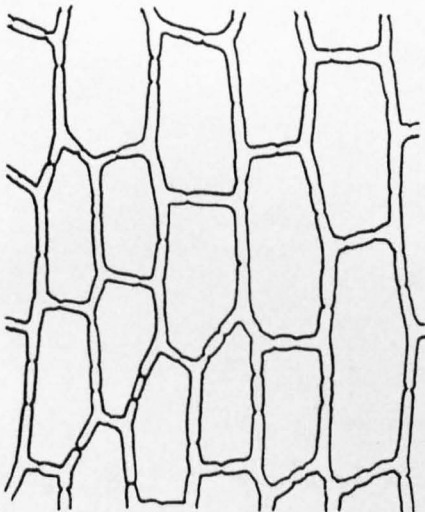
a - c, x 200; d - h, x 15.



a



b



c



d



e



f



g

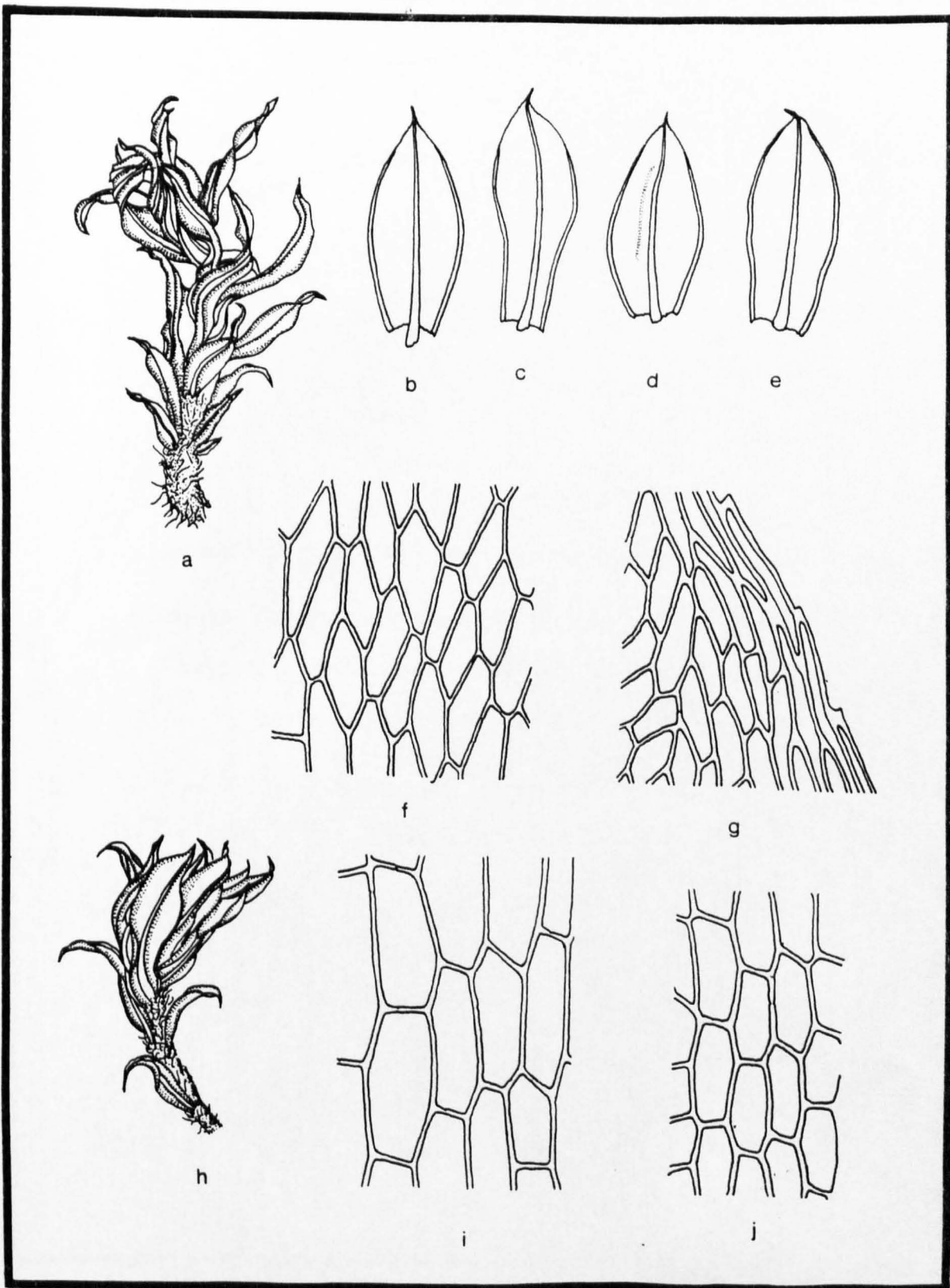


h

Figure 46. B. lagarocarpum Mohd., from plant from Guatemala.

a,h, dry plants; b - e, leaves; f, cells in middle of leaf; g, cells at margin; i,j, cells at base.

a,h, x 7.5; b - e, x 15; f - j, x 200.

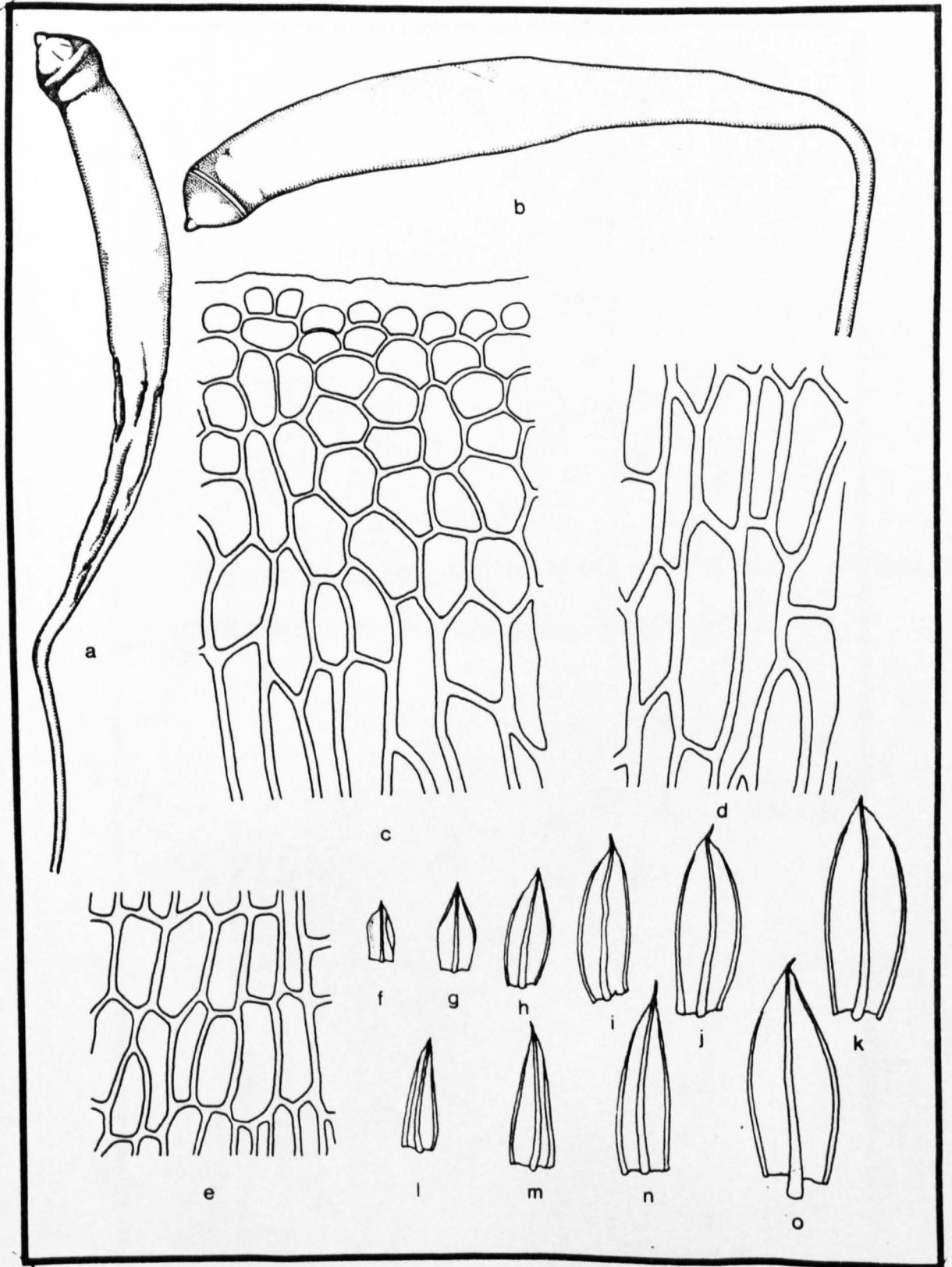


B. lagarocarpum

Figure 47. B. lagarocarpum Mohd., from plant from Guatemala.

a, dry capsule; b, same capsule moist; c, cells
at the mouth of capsule; d, exothecial cells;
e, lid cells; f - k, perigonial leaves;
l - o, perichaetial leaves.

a,b,f - o, x 15; c - e, x 200.



B. lagarocarpum

Figure 48. Map showing the distribution of B. billardieri,
B. andicola, B. perlimbatum and B. neelgheriense.

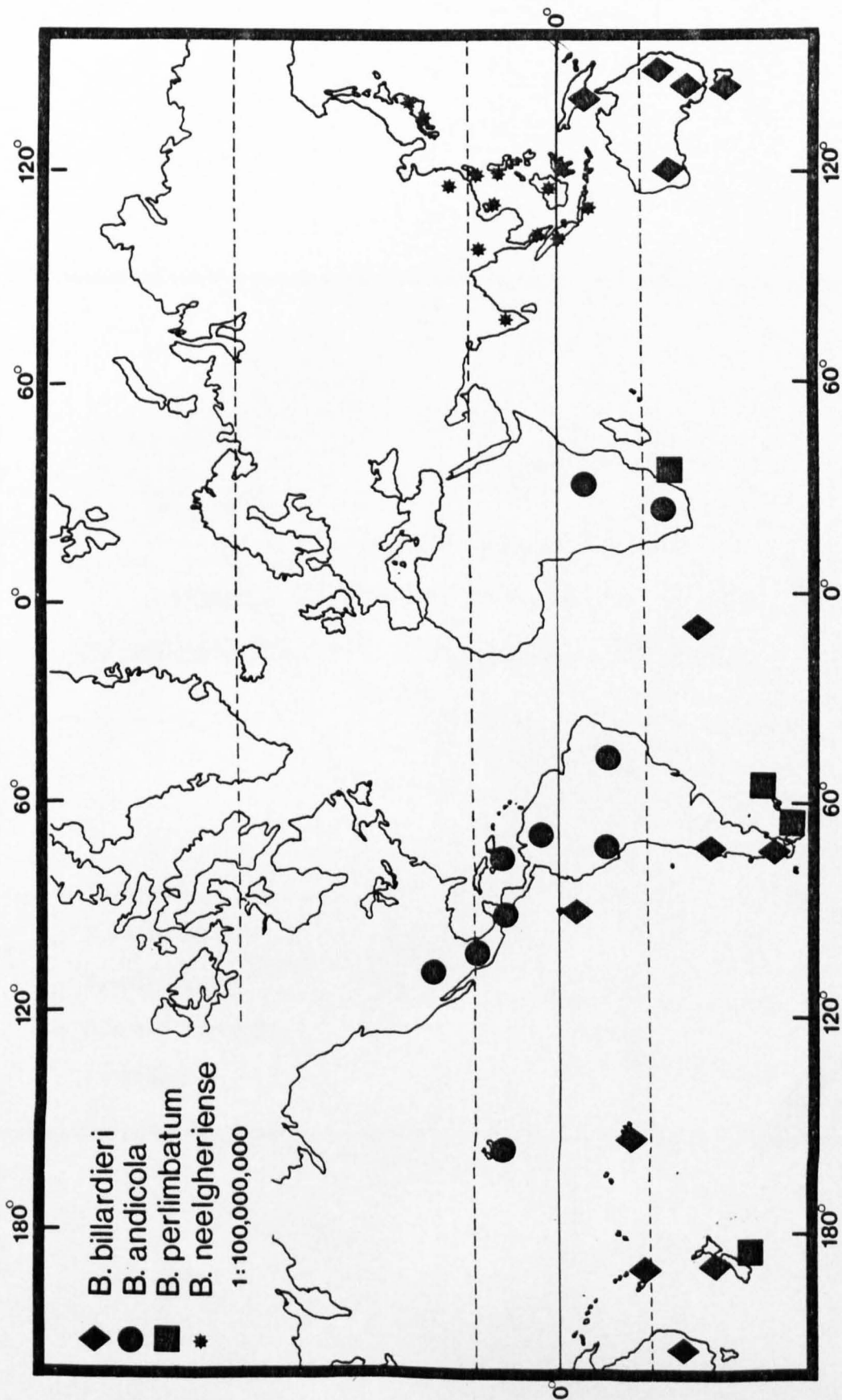


Figure 49. Map showing the distribution of B. sinense,
B. ramosum, B. microrhodon and B. subfasciculatum.

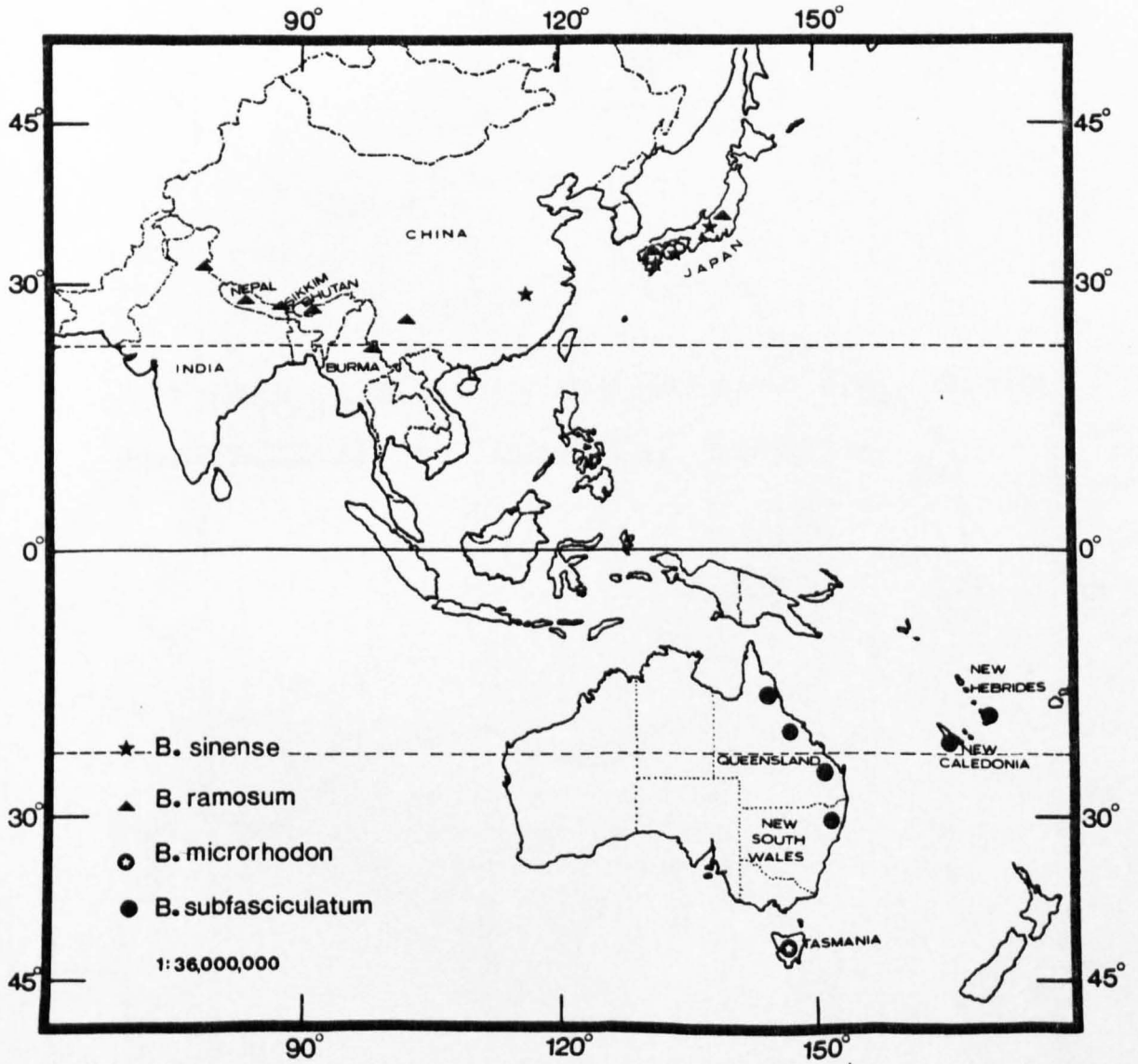


Figure 50. Map showing the distribution of B. truncorum,
B. appressum, B. pycnophyllum and B. erythrocaulon.

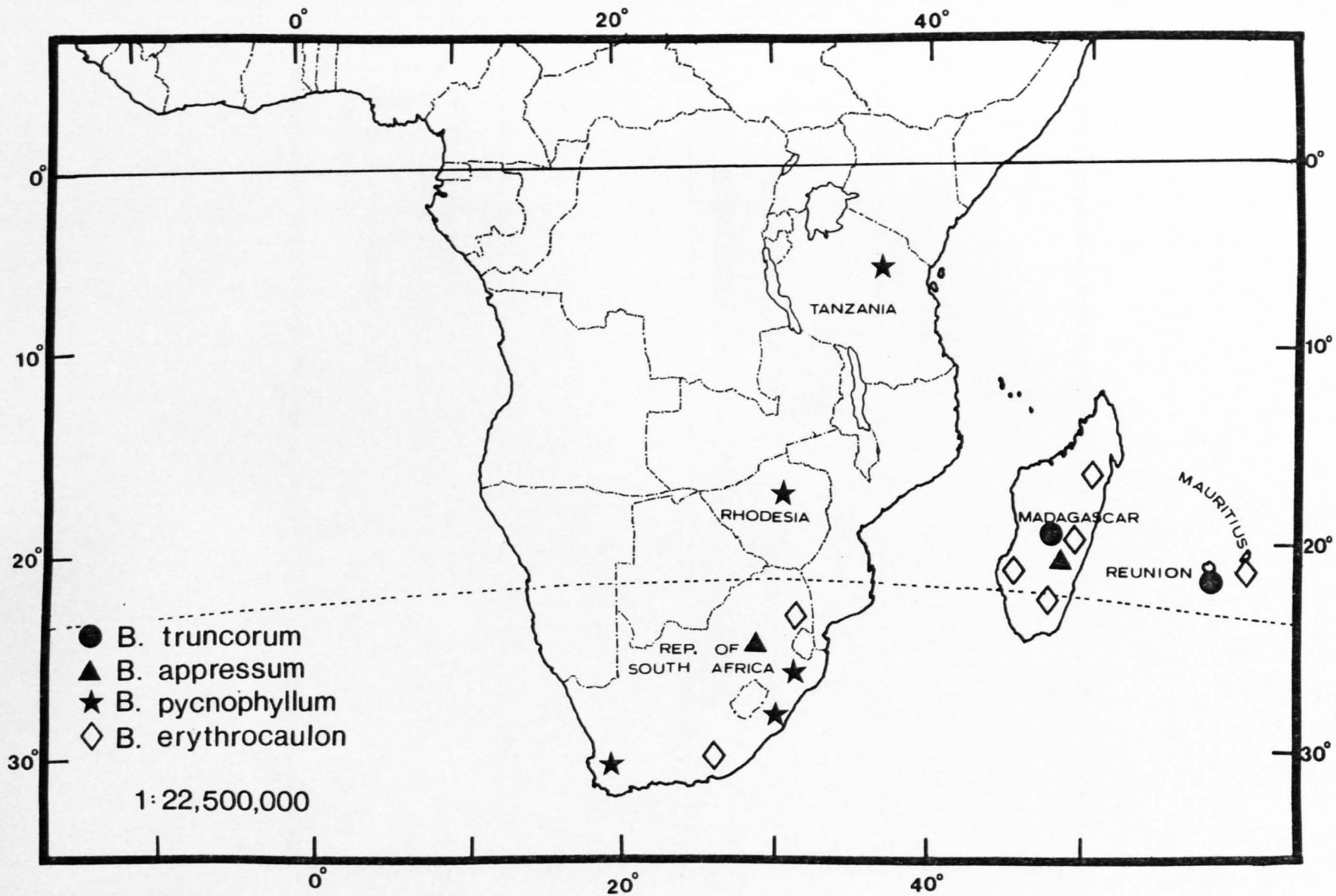


Figure 51. Map showing the distribution of B. torquatum,
B. ekmanii, B. goudotii, and B. lagarocarpum.



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