A TAXONOMIC REVISION OF THE HYPNODENDRACEAE (MUSCI)

A. TOUW
Rijksherbarium, Leiden

CONTENTS

SUMMARY

A revision is made of the genera *Hypnodendron* and *Braithwaitea*. *Mniodendron* and *Sciadocladus* are reduced to *Hypnodendron*, *Limbella* is excluded from the *Hypnodendraceae*, and *Dendro-Hypnum* is considered to be not validly published. *Hypnodendron rigidum* Mitt. is transferred to *Pterobryella*. The species of *Hypnodendron* are grouped into nine sections. Five of these are monotypic, viz. *Leiocarpos* Dix. and four new ones: *Lindbergiodendron* (including *H. arcuatum*), *Tristichophyllum (H. diversifolium)*, *Mniodendropsis (H. milnei)*, and *Pseudomniodendron (H. fusco-mucronatum)*. The circumscription of the family also needs revision, but has been maintained unchanged for the time being in the absence of information regarding assumedly related families.

A number of morphological and other characters are discussed. *Hypnodendron* is thought to be of pleurocarpous descent; Meusel's derivation of the growth-form of *Hypnodendron* from that of the acrocarpous genera *Mnium* and *Philonotis* is rejected. Rejuvenation takes place by means of basal innovations, and in a number of erect species also by distal ones. The umbellate and palmate fronds are assumed to have been derived from a pinnate type. The *Hypnodendraceae* are distributed in the Indo-Pacific and Australasian regions and in southern South America. *Hypnodendron* is centred in Melanesia and New Zealand.

26 species are recognized, 9 of which are divided into subspecies or varieties; 5 taxa are reinstated *(H. colensoi, H. comatum, H. comosum* var. *sieberi, H. spininervium* ssp. *spininervium* and ssp. *archeri)* and 1 is described as new *(H. vitiense* ssp. *australe)*. Identification keys are provided, and for each taxon are given: synonymy together with pertinent literature and typification, misinterpretations and misidentifications, description, geographical distribution, ecology, and notes on various subjects. Each species is illustrated, and a list is given of specimens examined, mostly accompanied by a distribution map.

INTRODUCTION AND ACKNOWLEDGEMENTS

The *Hypnodendraceae* are among the most handsome and striking Indo-Pacific and Australasian mosses. Their beautiful umbrella-shaped fronds have caught the eye of many visitors to the forest, and they are among the first bryophytes brought to Europe from that part of the world. The proportionally large number of available collections made the group more suitable for a monographic revision than most other families of tropical bryophytes. Several local treatments exist (Fleischer 1923, Dixon 1929, Bartram 1939, Sainsbury 1955), but neither the family nor any of the genera has ever been revised monographically, though two attempts have been made. Lindberg (1861) announced a monograph of *Hypnodendron*, *Mniodendron*, *Sciadocladus*, and *Phoenicobryum*, but published only a survey of the Malesian species in 1866. Between 1946 and 1949 van Borssum Waalkes prepared an (unpublished) provisional revision of the Malesian species, but had no opportunity to extend this to the revision of the family he had in mind.

In the present publication the circumscription of the family has not been revised. In the present state of affairs it is not well possible to draw the line between the *Hypnodendraceae* and supposedly related families in the *Eubryales* and *Isobryales*, as the latter have not yet been the subject of a critical examination and appear to be vaguely defined.

The genera Fleischer and Brotherus included in the *Hypnodendraceae* are *Braithwaitea*, *Hypnodendron*, *Mniodendron*, and *Sciadocladus*. The last three genera are ill-defined, and the characters used to separate them are unsuitable. They have been united here into *Hypnodendron*, and their species have been rearranged into nine sections, five of which are monotypic. The retention of *Braithwaitea* in the *Hypnodendraceae* is questionable as it differs from *Hypnodendron* in many characters, and has only a few in common with it.

About 3500 dried collections have been examined. Further observations have been made on living plants of 13 species.

I wish to express my deep gratitude to Prof. Dr. H. J. Lam and Prof. Dr. C. G. G. J. van Steenis, former and present Directors of the Rijksherbarium respectively, who encouraged and facilitated my bryological work, and all those staff members of the Rijksherbarium who assisted me with this thesis. Furthermore, I am much indebted to Dr. P. A. Florschütz for valuable comment and advice, to the Directors, Curators, and owners of herbaria for the loan of their specimens during an often considerably longer period than was anticipated, to Mr. K. W. Allison also for information concerning untraced New Zealand localities, to the Director of the Botanic Garden of the University of Leiden for providing culture facilities, to Dr. J. van Borssum Waalkes for putting the results of his provisional revision of the Malesian species at my disposal, to Mr. D. J. W. Kreulen for many stimulating discussions and technical assistance and for putting the results of his spore countings in *Hypnodendron* at my disposal, to Miss E. E. van Nieuwkoop for the typing of the final version of the manuscript, to Mr. H. P. Nooteboom and Dr. B. O. van Zanten for sending living specimens from Borneo, New Guinea, Guadalcanal, Australia, and New Zealand, and to Mr. E. Vijsma for drawing the illustrations published here. I am most grateful to Mrs. I. den Hartog-Adams for correcting the English text.

GENERAL PART

PRESENTATION OF DATA

Throughout the present publication sections of *Hypnodendron* have been understood as circumscribed here, unless stated otherwise.

Names and combinations given in the synonymy are immediately followed by the citation of the publication in which they were first validly published. Of papers containing

not validly published names or combinations only the oldest one has been indicated as such. Unpublished names have been left out. Publications containing new information have been listed as completely as possible under the lowest taxon distinguished. Literature records of which the pertaining specimens have not been examined have been inserted only in the bibliography at the end of the present publication.

Strongly deviating specimens have not been included in the descriptions. The stipe leaves examined were always observed at a point between about $\frac{1}{4}$ and $\frac{1}{3}$ of the length of the stipe below the frond; branch leaves were always observed at the basal and middle part of the main branches. Inner lamina cells were examined at a point about $\frac{1}{3}$ of the length of the leaf below its apex, or (in narrowly acuminate leaves) just below the acumen. Cell measurements relate to the lumen only. Bistratose borders in sect. *Phoenicobryum*, *Mniodendropsis*, and *Comosa* were examined at the base of the narrowed apical part of the leaf. The abbreviation L/W stands for length/width.

Herbarium specimens have been examined from the following herbaria listed in the Index Herbariorum (ed. 5, 1964): B, BM, BO, BP, CANB, CANTY, CHR, FH, GRO, H, JE, K, KAG, L, MEL, MO, NICH, NY, PNH, PC, SING, S-PA, SYD, US, W, and from the following ones not given in it:

Allison — Mr. K. W. Allison, Dunedin, New Zealand;

EGER — Department of Botany, Teachers College, Eger, Hungary.

The specimens are cited geographically under the lowest taxon distinguished. The preparation of a list of collectors' numbers of all specimens examined was considered impractical, as a large amount of detailed information gets lost in that way, and because a large part of the material was not numbered. Collections without a number have been left unmentioned if numbered ones from the same collector and locality were available. Unchecked records in literature have been neither listed nor mapped. Specimens from unknown localities have also been left unmentioned. If more than five collections originated from the same locality these have not been listed separately, unless only a few collections from other localities were available. Collections of which the collecting locality has been only very roughly indicated ('Australia', 'Fiji', etc.) have been listed separately when only a few collections from more precisely indicated localities were available.

The ecological data given here are lamentably inaccurate as they had to be composed from the few and often ambiguous annotations on the labels.

The illustrations have been prepared from moistened herbarium material, with the exception of those of open capsules.

MORPHOLOGY

a. General shape, ramification, and innovations

Plants belonging to the *Hypnodendraceae* are differentiated into an unbranched basal part (stipe) and a more or less strongly branched distal part (frond). As in many other rain-forest bryophytes the branches and often the leaves as well are mostly placed in a single plane oriented at roughly a right angle to the average direction of incident light. Most bryophytes showing this type of ramification grow on tree trunks, rock-faces, or other sloping objects. The stipe lies in the same plane as the mostly pinnate frond, and is clearly continued in the rhachis. This **pinnate** ramification is found in *Braithwaitea* and the sections *Phoenicobryum* and *Lindbergiodendron* of *Hypnodendron*. In *Hypnodendron* the basal part of the frond is always more strongly developed than the distal one, in *Braithwaitea* the reverse is often found to be true. Many *Hypnodendraceae* grow terrestrially,

or on the upper surface of rocks, decaying logs, or roots of trees. In these plants the frond is oriented often at a right angle to the erect stipe. At first the stips grows upwards, but at a certain moment it changes to a horizontal direction of growth, and the formation of side branches is started at the deflection. The frond is often unilateral and differs from the pinnate type only by the stronger development of the lower branches and their concentration at the base of the frond. Such fronds have been termed **palmate** and are most often found in sect. *Leiocarpos*, *Mniodendropsis*, and *Hypnodendron*. In other plants the rhachis and the lower branches are of about equal strength and point in all directions, resulting in a circular **umbellate** frond, which because of the often slightly drooping ends of the branches may resemble a small umbrella. Such umbellate fronds occur in sect. *Sciadocladus*, *Comosa*, *Pseudomniodendron*, *Hypnodendron*, and *Tristichophyllum*. As far as I know this highly derived growth-form occurs in mosses almost exclusively in *Hypnodendron* and *Hypopterygium* (*Hypopterygiaceae*). Giesenhagen (1910) gave an excellent description of the development of the umbellate frond in *H. dendroides*. My own observations on cultivated specimens of many species confirm his conclusions. He also reported many other interesting observations on the morphology, anatomy, and biology of *H. dendroides*. The distinctions between these three types of fronds are by no means sharp, and though one of them always predominates in each species, other forms can be found as well. In all species pinnate juvenile forms occur, and weakly palmate or subumbellate fronds have been found by way of exception in the usually pinnate species of sect. *Phoenicobryum*.

In taxonomic literature the *Hypnodendraceae* are invariably described as having a very short creeping ('primary') stem from which the stipes ('secondary stems') sprout. However, Meusel (1935) had already correctly pointed out that these plants do not have creeping stems but form basal innovations sprouting from the stipes. In other words, their innovations are sympodial and not monopodial. In this respect the *Hypnodendraceae* agree with the other dendroid mosses treated by Meusel. However, in most other mosses of this type the basal innovations first grow appressed to the substrate and abruptly bend away from it after some time. In *Hypnodendron* and *Braithwaitea* the creeping basal part is nearly always very short or absent; a long one has been found occasionally in *H. comatum* (sect. *Comosa*) and *H. diversifolium* (sect. *Tristichophyllum*). In *Hypnodendron* distal innovations occur as well. They are usually formed in the centre of the frond, which also contains the gametoecia, and Meusel (1935) considered them subfloral innovations. This, however, is incorrect, as no connection appears to consist between the positions of the gametoecia and the innovations. Under favourable circumstances the latter can arise from any branch primordium in the frond. In most species the distal innovations are much smaller than the plant from which they have sprouted, and they do not innovate themselves, but in several umbellate species belonging to sect. *Sciadocladus* and *Comosa* they become vigorous, and often plants have been found consisting of many tiers of superposed innovations. Distal innovations are absent (or nearly so) in *Braithwaitea* and the pinnate species of *Hypnodendron*, and are weakly developed in the palmate species of the latter. However, under exceptional circumstances strong distal innovations can be formed in species usually lacking them. This often happens after the frond has got buried by litter.

b. Stipe anatomy, branch primordia, pseudoparaphyllia, tomentum

In *Hypnodendron* the reddish to blackish stipe is circular to angular or elliptic in cross section (Fig. 1), and consists of a wide central strand (mostly measuring more than 10 cells across) composed of thin-walled cells which appear empty, and a many-layered cortical zone composed of large incrassate parenchymatous cells, which abruptly pass into 1 to *c.* 3 layers of small, extremely incrassate peripheral cells. In *Braithwaitea* the stipe

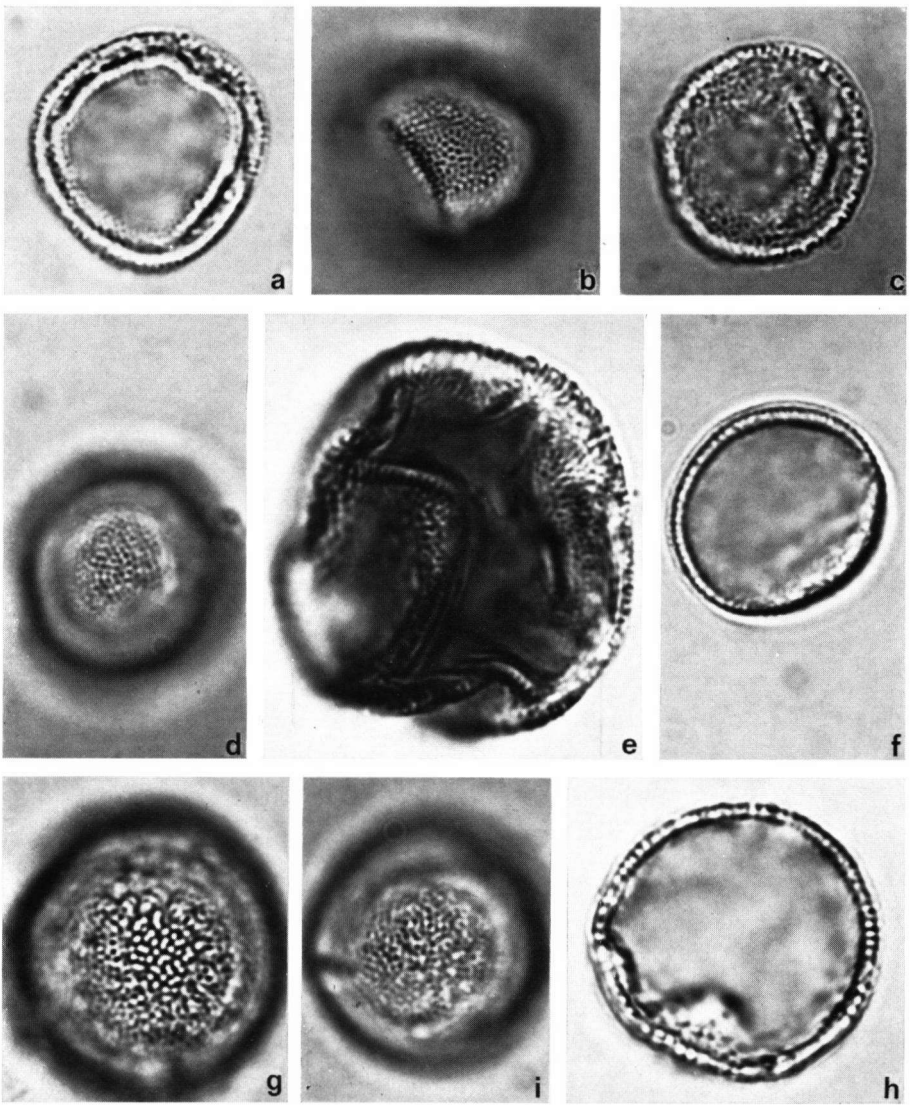

Plate I. Spores. — a, b: *Braithwaitea sulcata (unknown coll.6)*; c: *Hypnodendron junghuhnii (Robinson & Kloss 113)*; d: *H. diversifolium (Eddy 1709)*; e: *H. reinwardtii* ssp. *reinwardtii (Möller 197)*; f: *H. fusco-mucronatum* ssp. *chalmersii (van Zanten 682753)*; g, h: *H. auricomum* ssp. *auricomum (Vink 16939A)*; i: *H. dendroides (van der Wijk 391)*. All 2000 x.

mostly appears elliptic in cross section. The central strand is very narrow (measuring less than *c.* 10 cells across), and its thin-walled cells are almost always filled by a yellowish or brownish substance. The cells of the cortical and peripheral zones pass gradually into each other. A preliminary survey of stipe anatomy in supposedly related moss groups showed the *Hypnodendron* type (or types approaching it) to be present also in *Mniaceae*, *Bryaceae*, and *Rhizogoniaceae* (*Eubryales Acrocarpi*), and the *Braithwaitea* type (or types approaching it) in *Climaciaceae*, *Leucodontaceae*, and *Pterobryaceae* (*Eubryales Pleurocarpi*).

Though branches below the frond are very rare many branch primordia are present along the stipe. They are most numerous near the base and just below the frond. These dormant primordia (Fig. 1) form small to rather large green patches consisting of thin-walled chlorophyllose cells. They are often naked, but are sometimes surrounded by pseudoparaphyllia, tomentum, or both. The pseudoparaphyllia (Fig. 1) are small lacerate leaf-like organs, which are either spreading (in *Braithwaitea* and *Hypnodendron* sect. *Comosa* and *Tristichophyllum*) or appressed (in the remaining sections of *Hypnodendron*). They have rarely been mentioned before, which is not at all surprising, as the appressed ones are almost invisible and the spreading ones are often hidden in tomentum, which covers the stipe to a greater or less extent in *Hypnodendron* sect. *Comosa*, *Tristichophyllum*, and *Pseudomniodendron*. The primordia near the base of the stipe give rise to the basal innovations, the distal ones usually remain dormant and are developed under exceptional circumstances only (usually after the plant has become severely damaged). Dormant branch primordia also occur in the frond.

In most species tomentum is found only at the base of the stipe, the innovations, and the female gametoecia. In species having entirely tomentose stipes, these are also found to be naked at first, and gradually become more or less clad with tomentum after some time. The rhizoids constituting this tomentum arise from epidermal stipe cells which are shorter, wider, and less incrassate than the surrounding cells, and are situated at the leaf insertions (mostly at their basal side) and around the branch primordia. Many scattered rhizoid initials are found at the base of stipes and innovations. This distribution largely agrees with the situation in the *Mniaceae* as described by Koponen (1968). Though rhizoids sprouting from scattered initials are often somewhat less strong than those from elsewhere, no distinction could be made between micronema and macronema. Tomentose stipes are characteristic of the three sections mentioned before, but the stipes of plants belonging to species from other sections do occasionally bear scattered tufts of tomentum as well.

c. Leaves

In *Braithwaitea* and *Hypnodendron* the leaves are differentiated into stipe leaves and branch leaves, which have been described separately.

The stipe leaves display a greater diversity than the branch leaves, but in juvenile or poorly developed specimens they are often less clearly distinct than usual, which sometimes makes identification of such specimens difficult. Further, in *Hypnodendron* sect. *Phoenicobryum*, *Leiocarpos*, and exceptionally in sect. *Tristichophyllum* dwarfed forms occur which have caducous leaves. Several species which had been based on such atypical specimens are reduced in the present publication. The stipe leaves increase in size from the base of the stipe upwards. The rather abrupt transition into branch leaves starts just below the frond. Appressed stipe leaves are found in *Braithwaitea*, *Hypnodendron* sect. *Leiocarpos* and *Pseudomniodendron*, and in some of the species of the sect. *Hypnodendron*. In the remaining species of the sect. *Hypnodendron* the stipe leaves are weakly to rather widely spreading, and in all other sections of *Hypnodendron* they are widely spreading to squarrose-recurved. The appressed stipe leaves are narrowly triangular to broadly triangular-ovate and have a

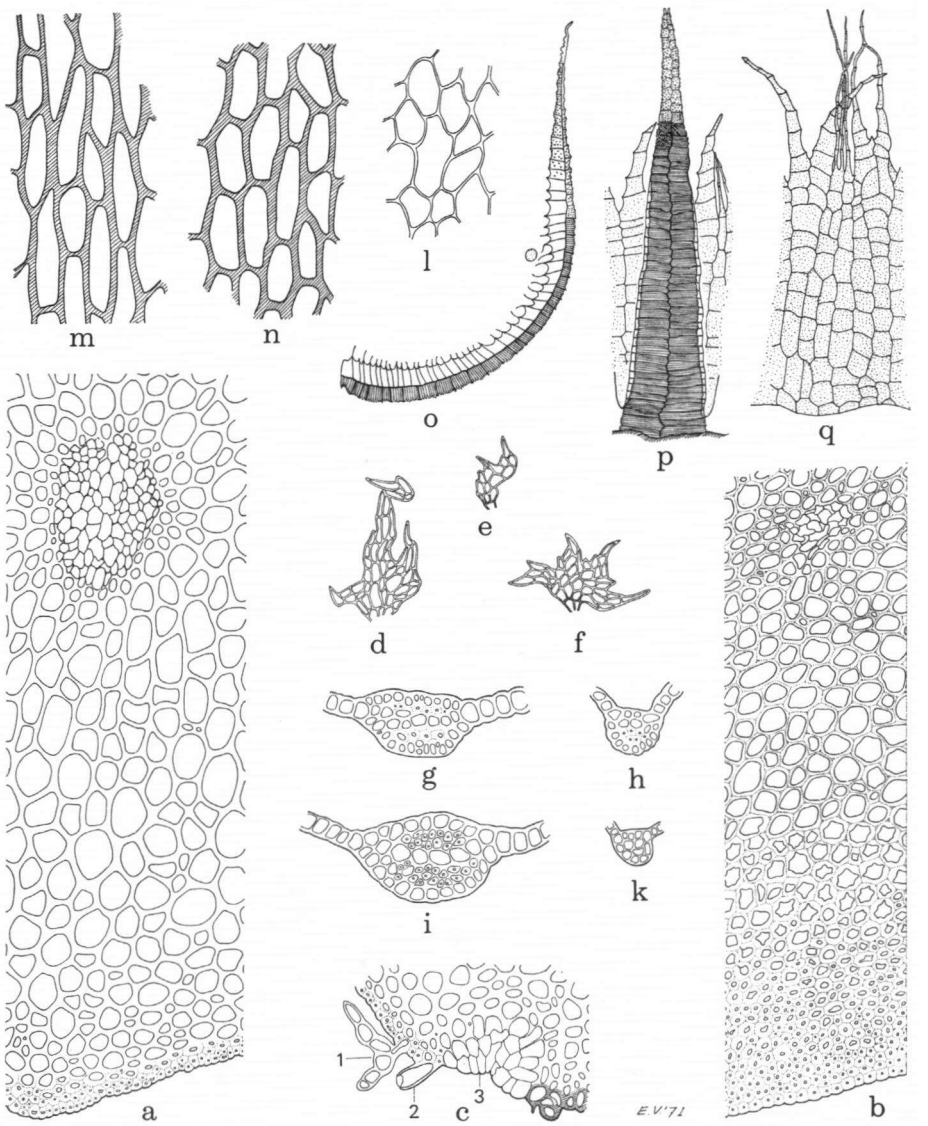

Fig. 1. a, b: Cross sections of stipes, × 260; c: cross section of small branch primordium, × 260 (1: pseudoparaphyllium; 2: base of rhizoid; 3: thin-walled cells of primordium); d—f: pseudoparaphyllia, × 95; g: cross section of costa of stipe leaf, × 260; h—k: cross sections of costae of branch leaves, × 260; l—n: exothecial cells, × 260; o: side view of exostome tooth, × 95; p: exostome, × 95; q: endostome, × 95. b, k, l: *Braithwaitea sulcata* (b: *Perrott s.n.*; k: *Wild s.n.*; l: *Whitelegge 399*); a, c, g, h, n: *Hypnodendron dendroides* (a, c, g: *van Zanten 683621*; h: *van Ooststroom 12913*; n: *van Heel s.n.*); d—f: *H. comatum (Berggren 198)*; i: *H. comosum* var. *sieberi (Davis 1209A)*; m: *H. auricomum* ssp. *auricomum (van Balgooy 760)*; o: *H. subspininervium* ssp. *arborescens (Holle s.n.)*; p—q: *H. vitiense* ssp. *australe (Tindale 10226)*.

straight insertion line, alar cells which are weakly or not at all differentiated from the other basal cells, flat, rarely decurrent margins, and acute to weakly acuminate apices. Spreading leaves are usually distinctly widened above a concave insertion, and often have strongly differentiated alar cells, shortly decurrent margins which are recurved above the insertion, and often narrowly acuminate apices. The shape of the stipe leaves and the length of their lamina cells are rather variable and appear to depend to some extent on the vigour of the plant, as leaves from thin stipes tend to be narrower and to have longer cells than those of thick stipes.

The size of the branch leaves decreases towards the branch apices, and side branches have smaller leaves than main branches. This decrease in size is coupled with a decrease in the proportional width and in the differentiation of teeth and borders. Comparatively narrow leaves and weakly differentiated teeth and borders are often found in depauperate specimens. In such plants of species with geminate teeth (which are always mixed with simple ones) these are often absent or few in number. The main branches of weakly ramified plants have larger leaves than those of more strongly branched ones.

In *Hypnodendron* sect. *Hypnodendron*, *Lindbergiodendron*, and *Tristichophyllum* the branches are very complanate and their leaves are to a greater or less extent anisomorphous: the dorsal leaves are smaller than the strongly asymmetrical laterally spreading ones. Descriptions given here have been based on the latter. *H. diversifolium* (the sole representative of sect. *Tristichophyllum*) deviates strongly in having tristichous branch leaves which are differentiated into a dorsal row consisting of small and ± symmetrical leaves and two rows of larger, asymmetrical latero-ventral ones. Poor specimens of that species sometimes have branches that are not complanate and have isomorphous and symmetrical leaves (especially near the branch apices). In all other *Hypnodendraceae* the phyllotaxis is mostly 2/5, 3/8, or 5/13, and this also holds true for the stipes of *H. diversifolium*.

In the costa of the leaves (Fig. 1) of *Hypnodendron* four to five different elements can be distinguished: adaxial and abaxial epidermis, large central guide cells, and between these layers there are rows of cells (of which the adaxial row is often absent) which are strongly incrassate stereids or rather thin-walled cells. In *Braithwaitea* the costa consists of cells which are not clearly differentiated into different types.

Geminate marginal teeth occur in *Hypnodendron* sect. *Phoenicobryum*, *Leiocarpos*, *Mniodendropsis*, and *Hypnodendron*. The occurrence of such teeth is by no means restricted to leaves having bistratose margins, as was suggested by Koponen (1968), and they are even absent in several species having such margins (*H. comosum*, *H. dendroides*). Geminate teeth are more numerous in branch leaves than in stipe leaves.

More or less bistratose borders have been found in *H. reinwardtii* and *H. flagelliferum* (both belonging to sect. *Phoenicobryum*), *H. milnei* (sect. *Mniodendropsis*), *H. comosum* and *H. dendroides* (sect. *Comosa*), and in *H. marginatum* (sect. *Hypnodendron*). In all except *H. marginatum* these borders are marginal and consist of cells that are either not different from the adjacent unistratose cells or somewhat shorter. In *H. marginatum* they are intramarginal and sharply defined by their very long cells.

In *Braithwaitea* and nearly all species of *Hypnodendron* the leaf cells bear a small papilla at their ends. These papillae are often observed with great difficulty (especially in plants having strongly incrassate cell walls) as they are situated over the walls of the adjacent cells. As a rule they are most strongly developed in the central part of the branch leaves and are absent or nearly so in basal, marginal, and apical cells.

d. Distribution of gametoecia

The gametophores are always unisexual, and the species are assumed to be dioecious,

though rhizautoecism may not be ruled out. This has to be found out by means of culture experiments, which I have not been able to carry out. In all species male plants seem to be far less common than female ones and are often smaller.On the other hand the male fronds bear many more gametoecia than the female ones. As a rule the male gametoecia are scattered over the frond, but in the species of *Hypnodendron* sect. *Comosa* they are often clustered in its centre.

In *Braithwaitea* the female gametoecia are situated along the distal main branches and the distal part of the rhachis. In pinnate species of *Hypnodendron* they are mostly found along the basal part of the rhachis and at the base of the main branches. In the palmate and umbellate species they are mostly clustered in the centre of the frond, as is the case with a number of palmate or umbellate species of *Hypopterygium* (*Hypopterygiaceae*). This is reminiscent of the situation in some acrocarpous mosses like *Mnium undulatum* and *Philonotis*, where subfloral branches radiate from the stem just below the gametoecia. Lindberg (1861) mistook *Mniodendron* for a genus of acrocarpous mosses, and so did Meusel (1935) for both *Hypnodendron* and *Mniodendron*, even though he noted their deviating characters. From the picture given above it will be clear that this likeness to some acrocarpous mosses is superficial only, and that the *Hypnodendraceae* like the *Hypopterygiaceae* form a derived group of pleurocarpous mosses.

e. Sporophytes

Hypnodendron and *Braithwaitea* both have long-exserted capsules, but in the former the seta is much longer than in the latter.

Many (*c.* 15—25) phaneroporous stomata are situated at the apophysis. They are conspicuous in dry empty capsules, in which they stand out as small pustules. In young turgescent capsules the apophysis often appears perfectly smooth. In a single collection of *H. milnei* ssp. *milnei* (*van Royen 3609*) the stomata were much more numerous than usual and scattered over the surface of the whole capsule.

In my opinion previous authors have overestimated the value of the structure of the capsule wall and the shape of the operculum as generic characters for separating *Sciadocladus* from *Hypnodendron* and *Mniodendron*. *Sciadocladus* has smooth capsules and shortly conical to shortly rostrate operculi. *Hypnodendron* is very variable in these respects. Though most of its species have sulcate capsules, smooth ones occur in sect. *Leiocarpos* and in several species of sect. *Phoenicobryum*, and sometimes the capsules vary from being smooth to sulcate within a single species. The operculum is always longer than in *Sciadocladus*, but varies from not or weakly rostrate (in sect. *Leiocarpos* and part of the plants belonging to species of the sections *Hypnodendron* and *Tristichophyllum*) to bluntly rostrate (in sect. *Lindbergiodendron* and most material belonging to sect. *Hypnodendron* and *Tristichophyllum*), or finely and sharply rostrate (in sect. *Phoenicobryum*, *Mniodendropsis*, *Comosa*, and *Pseudomniodendron*).

The peristome is very uniform throughout *Hypnodendron* (Fig. 1). *Braithwaitea* differs in having a strongly reduced peristome (Fig. 42).

All species have almost spherical, minutely papillose spores (Plate I), which can be divided into three size classes:

1. spores *c.* 10—20 μ: *Hypnodendron* sect. *Mniodendropsis*, *Comosa*, *Pseudomniodendron*, *Hypnodendron*, *Lindbergiodendron*, *Tristichophyllum*.
2. Spores *c.* 15—25 μ: *Braithwaitea*, *Hypnodendron* sect. *Sciadocladus*.
3. Spores *c.* 20—35 μ: *Hypnodendron* sect. *Phoenicobryum*, *Leiocarpos*.

Erdtman (1965) described the spores of *H. dendroides* and *H. cf. menziesii*.

The number of spores per capsule was counted by Kreulen (in print) for a collection of

H. auriconum ssp. *auriconum* (*van Zanten 683582*). Each capsule contained the very large number of *c.* 1,500,000 spores, which had been formed by two concentric layers of sporocytes.

CHROMOSOMES

Ramsay (in Löve, 1967) published chromosome counts for *Hypnodendron vitiense* ssp. *australe*. She reported the numbers n=9 and 2n=18. These numbers appear to be rare among mosses. However, very few counts have been made for tropical pleurocarps, and for several families of *Eubryales Pleurocarpi* no counts at all are available.

CHEMICAL CHARACTERS

Hypnodendron colensoi is characterized by the presence of crystals, very probably consisting of calcium oxalate, in the epidermal cells of the basal part of the costa of the leaves. Such crystals have been found in all specimens of that species, and have never been found in any other species belonging to the *Hypnodendraceae*.

CULTIVATION OF HYPNODENDRON

From 1968 and early 1969 onwards thirteen species of *Hypnodendron* have been cultivated in a greenhouse in the Botanic Garden of the University of Leiden in order to obtain data with regard to their development and rejuvenation under controlled conditions, and for chromosome analysis of young sporophytes. Cultivation was started from field-samples of full-grown plants. Unfortunately, all plants appeared to be female, and no sporophytes could be obtained. Moreover, the rather crude cultivation methods used up to the time of writing proved defective, as they resulted in the development of atypical plants. On the other hand, successful cultivation of these plants seems quite possible if more sophisticated methods are used, as nearly all the *Hypnodendraceae* survived, whereas a number of other bryophytes from the same collecting localities have died.

SUBDIVISION AND INTERRELATIONS

a. History

The group under consideration here was raised to family level by Brotherus (1905, 1909C), who accomodated the genera *Hypnodendron*, *Mniodendron* and *Sciadocladus* in it. At first these genera had been placed in the *Hypnaceae*, and later Kindberg (1898) transferred them to the *Climaciaceae*. *Braithwaitea*, a genus of doubtful affinity was transferred to the *Hypnodendraceae* by Fleischer (1906), who later (1920) raised the group to the monotypic suborder *Hypnodendrineae* which he considered to belong to the *Eubryales*.

The name *Hypnodendron* was first used by Mueller (1851A) for a section of *Hypnum* comprising all dendroid species. He divided this section into two subsections, *Comatulina* and *Flabellaria*. The former only comprised species that are now included in the genus *Hypnodendron*. Subsect. *Flabellaria* contains species now considered to belong to other families.

Lindberg (1861) accomodated the species of subsect. *Comatulina* in four new genera: *Hypnodendron*, *Mniodendron*, *Phoenicobryum*, and *Sciadocladus*. As he gave no descriptions but only listed the species belonging to them, none of these genera was validly published at that time. In his second and last publication on this group Lindberg (1866) again gave no descriptions of the genera, and reduced *Phoenicobryum* to an unspecified infrageneric taxon belonging to *Hypnodendron*. *Hypnodendron*, *Mniodendron*, and *Sciadocladus* were

adopted from the beginning by most bryologists. These names were validated by Mitten (1873A, *Hypnodendron*) and Kindberg (1899, *Mniodendron, Sciadocladus*). Mitten gave a much wider circumscription to *Hypnodendron* than Lindberg did, as he included all the species that he treated of *Mniodendron* and *Pterobryella* (*Pterobryaceae*). As *H. junghuhnii* is the only species figuring under *Hypnodendron* in Mueller's publication as well as in those of Lindberg and Mitten, that species has been chosen as a lectotype of the genus. The absence of a delineation of Lindberg's genera will have been the main source of many errors made by later authors who tried to place new species in them. Short diagnoses were given by Kindberg (1899), but following these, the species belonging to sect. *Mniodendropsis* and *Tristichophyllum* cannot be placed in any of the genera. Brotherus (1909C, 1924B, 1925) classified all species known at the time mainly according to the indications given by Lindberg, Kindberg, and Dixon (1922). His unsatisfactory arrangement has met serious criticism. Nevertheless, it has been maintained unaltered up to the present.

In the Index Muscorum (van der Wijk et al., 1962) *Dendro-Hypnum* Hampe has been accepted as the validly published name of a genus which is considered a synonym of *Hypnodendron*, because its type species (*D. beccarii*) belongs there. This has serious implications as *Dendro-Hypnum* Hampe (1872) antedates *Hypnodendron* Lindberg *ex* Mitten (1873A). However, from Hampe's publication it appears that he did not intend to create a new genus. From 1852 onwards he used the name *Dendro-Hypnum* (sometimes spelt *Dendro Hypnum* or *Dendrohypnum*) for an initially unspecified group of dendroid *Hypnum* species largely corresponding with Mueller's section *Hypnodendron*; in 1880 he termed it a section. In his publications he often cited the name of the section in connection with the name of the genus and the specific epithet, but he equally often omitted either the name of the section or the generic name. Many examples illustrate this loose and inconsistent manner of citation. In my opinion, this also applies to *Dendro-Hypnum beccarii*. To that combination he added only the indication '*nova species*', whereas two monotypic genera described in the same publication have been clearly indicated as new genera. Therefore, *Dendro-Hypnum* has been considered not validly published.

b. Hypnodendron, Mniodendron, Sciadocladus

The species placed up to the present in *Hypnodendron*, *Mniodendron*, and *Sciadocladus* have been rearranged here into nine sections. Five of these are monotypic (*Leiocarpos, Mniodendropsis, Pseudomniodendron, Lindbergiodendron, Tristichophyllum*), one consists of two species (*Sciadocladus*), and the remaining three (*Phoenicobryum, Hypnodendron, Comosa*) have five, six, and seven species respectively. The phenetic relationships between these sections are expressed in the diagram of Fig. 2. The sections show reticulate relationships, and for the sake of simplicity connecting lines have been drawn only between the most closely related sections. Many-dimensional relationships are shown here in two dimensions, and, consequently, the length of the lines in the diagram has little significance. Palmate and umbellate fronds are thought to have been derived from pinnate ones. If the lines in the diagram reflect the course of evolution the umbellate sections are of polyphyletic origin. Sect. *Phoenicobryum* occupies a central position as it shows close morphological affinity to the remaining three groups of sections. It shows more assumedly primitive characters than any of the other sections: pinnate fronds, absence of distal innovations, spreading stipe leaves that are often little different from the almost isomorphous branch leaves and capsules varying from being smooth to deeply sulcate. Most of these characters also occur in the monotypic sect. *Lindbergiodendron*.

Smooth capsules, large spores, and strongly coloured, very incrassate basal cells forming

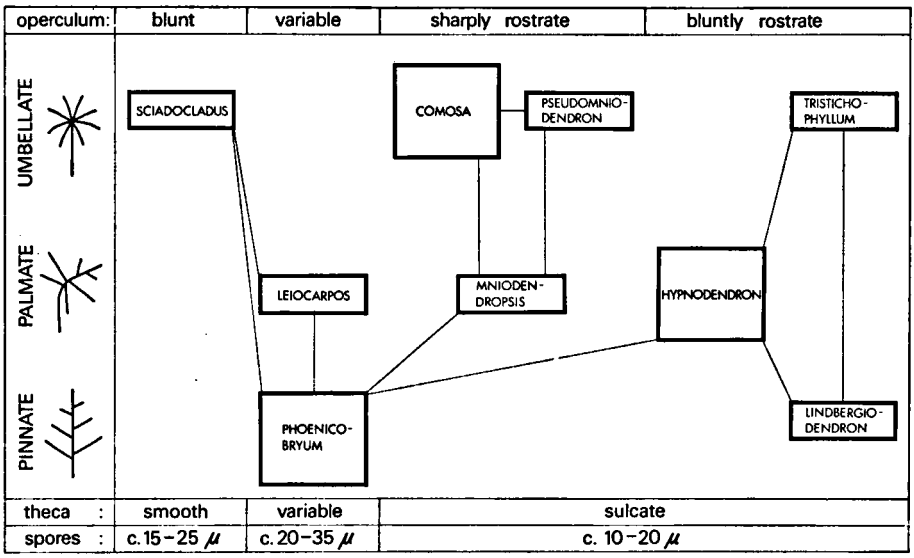

Fig. 2. Intersectional relationships in *Hypnodendron*.

a large alar group are found only in the sections *Phoenicobryum*, *Leiocarpos*, and *Sciadocladus*. *Sciadocladus* differs from the other two by the spore size, sometimes pendulous capsules, short and often blunt operculi, and by the shape of the branch leaves.

The group formed by the sections *Lindbergiodendron*, *Hypnodendron* and *Tristichophyllum* has weakly plicate perichaetial leaves, inclined to horizontal capsules, bluntly rostrate operculi, strongly anisomorphous branch leaves, thin-walled cells, and hardly or not at all differentiated alar cells.

The sections *Mniodendropsis*, *Comosa*, and *Pseudomniodendron* differ from all other sections by having inclined to cernuous capsules, yellowish brown calyptrae, strongly differentiated alar cells, and short marginal cells.

The species Lindberg (1866) cited under the three genera he recognized belong to the following sections as understood here:

Hypnodendron: sect. *Hypnodendron*, *Lindbergiodendron*, *Phoenicobryum*.
Mniodendron: sect. *Comosa*, *Mniodendropsis*.
Sciadocladus: sect. *Sciadocladus*.

The sections to which the species cited by Brotherus (1909C, 1924B, 1925) belong are indicated below:

Brotherus:	sections as understood here:
Hypnodendron	
subg. *Phoenicobryum*	*Phoenicobryum*, *Leiocarpos*, *Hypnodendron*
subg. *Euhypnodendron*	*Hypnodendron*, *Pseudomniodendron*, *Tristichophyllum*, *Leiocarpos*
subg. *Leiocarpos*	*Leiocarpos*
subg. *Limbella*	*Hypnodendron*, *Mniodendropsis*

Mniodendron	
sect. *Eu-Mniodendron*	*Comosa, Pseudomniodendron, Mniodendropsis*
sect. *Comatulina*	*Comosa, Mniodendropsis*
Sciadocladus	
sect. *Pseudo-Hypnodendron*	*Sciadocladus*
sect. *Eu-Sciadocladus*	*Sciadocladus*

Brotherus had also included a number of species which are transferred to other genera here. *H. arcuatum* (the sole species belonging to sect. *Lindbergiodendron*) is not listed by Brotherus, who presumedly followed Jaeger (1880) in considering this a variety of *H. spininervium* (sect. *Hypnodendron*). The weakness of his subdivision appears from the repeated distribution of forms belonging to the same species over different sections, subgenera, and even genera (note the distribution of the monotypic sections *Leiocarpos*, *Pseudomniodendron*, and *Mniodendropsis*!). Tomentose stipes and bistratose leaf margins are the characters by which Brotherus separated *Mniodendron* from *Hypnodendron*. However, the sect. *Tristichophyllum* (having tomentose stipes) is found under *Hypnodendron*, and bistratose leaf margins are also found in that genus (in sect. *Phoenicobryum* and *Hypnodendron*). As has been stated before smooth capsules, by which *Sciadocladus* is characterized by Brotherus, also occur in *Phoenicobryum* and *Leiocarpos*, which he placed in *Hypnodendron*. The latter genus appears to have been used as a depository of species which he did not want to place either in *Mniodendron* or in *Sciadocladus*. His unsatisfactory classification, which was also adopted by Fleischer (1923), met the serious criticism of Dixon (1929, 1935A) and Bartram (1939). Both felt inclined to reduce *Mniodendron*, but did not want to make that decision on the base of their knowledge, and maintained the genus 'in deference to the distinctions maintained by Fleischer and Brotherus' (Bartram, 1939).

In my opinion the reduction of *Mniodendron* and *Scaidocladus* results in a classification giving a good reflection of the interrelationships between the sections. Raising sections or groups of sections to generic level would mean an underestimation of similarities and a gross exaggeration of differences.

c. The circumscription of the Hypnodendraceae and the systematic position of Braithwaitea

For the time being no well-founded revision can be given of the circumscription of the family, as the families with which it should be compared are rather vaguely circumscribed and have not yet been the subject of a critical revision. Therefore, some provisional remarks only can be made.

Hypnodendron forms a highly derived and isolated genus of dendroid pleurocarpous mosses which is characterized by predominantly basal innovations usually lacking a creeping part, a strong differentiation into a stipe and an often umbellate frond of which the basal part is more strongly developed than the distal part, leaves that are differentiated into stipe leaves and branch leaves and often have coarse, sometimes partly geminate teeth, a long, dorsally toothed costa and prosenchymatous cells that are papillate at their ends, and often sulcate capsules elevated on a long seta and having a perfect bryoid peristome. In these characters *Hypnodendron* shows similarity to the *Rhizogoniaceae* and — to a less extent — to the *Pterobryelloideae* (*Pterobryaceae*) as had been remarked already by Fleischer (1914, 1923), but the genus does not fit into the circumscription of either group and should be placed in a separate family.

The retention of *Braithwaitea* in the *Hypnodendraceae* is very questionable. The growth

form, the differentiation into stipe leaves and branch leaves, the long, dorsally toothed costa, the prosenchymatous papillate cells, and the sulcate capsules are common to both *Hypnodendron* and *Braithwaitea*. However, these characters also occur in other genera (notably among the *Leucodontineae*), and it is the particular combination of these only which makes *Braithwaitea* more similar to *Hypnodendron* than to any other genus. I doubt very much whether this phenetic similarity should be interpreted as phyletic affinity, as *Braithwaitea* differs from *Hypnodendron* in many respects: the stipe anatomy and costa anatomy, the predominantly distal development of the frond, the shape of the branch leaves (only showing some resemblance to those of sect. *Sciadocladus*), the arrangement and shape of the alar cells, the very small teeth, the shape and situation of the perichaetia, the short seta, the structure of the exostome, the reduced endostome, and the presence of rhizoidal gemmae. Several of these characters suggest affinity to the *Pterobryaceae*, in which family *Braithwaitea* had been accommodated before by Brotherus in 1906. In the same year Fleischer transferred the genus to the *Hypnodendraceae* on account of '*die Sporogone und gewisse Blattmerkmale*', without any further argumentation. *Braithwaitea* does not seem closely related to *Hypnodendron*, but has reluctantly been retained here in the *Hypnodendraceae*, because at present a more satisfactory solution cannot be given. This question has to be reconsidered in the course of a critical re-examination of the classification of the *Leucodontineae*.

DISTRIBUTION

Before discussing the distribution of the *Hypnodendraceae* I want to emphasize that the number of collections per area, island, or island group varies considerably and is often low, as appears from Table 1. In many islands or island groups collections were made from a few localities only: at least 308 out of 511 collections from Java are from Mt. Gedeh-Pangrango, 29 out of 41 from the Solomons are from Mt. Popomanasiu, 26 out of 48 from the New Hebrides are from the islet of Aneityum, etc. Moreover, a large majority of collections have been made by collectors with very little knowledge of bryophytes. They are likely to have collected especially showy and easily recognizable species. Much more collecting has to be done by bryologists in the mountains of Central and South-East Borneo, the Philippines, Celebes, the Moluccas, the Lesser Sunda Islands, West New Guinea, and nearly all island groups in the Pacific. Important additions (as far

Table 1. Number of examined collections per area, island, or island group.

Ryukyus	6	Solomon Is.	41
Taiwan	3	New Hebrides	48
Ceylon	10	New Caledonia	58
Annam	5	Fiji Is.	35
Malay Peninsula	95	Samoa group	45
Sumatra	189	Society group	43
Java	511	Marquesas	2
Lesser Sunda Is.	2	Queensland	58
Borneo	251	New South Wales + Victoria	225
Luzon	118	Tasmania	138
Philippines excl. Luzon	107	New Zealand	948
Celebes	26	Subantarctic islands	18
Moluccas	19	Juan Fernandez group	3
New Guinea	461	South America	36
Bismarck Arch.	5	other areas	7

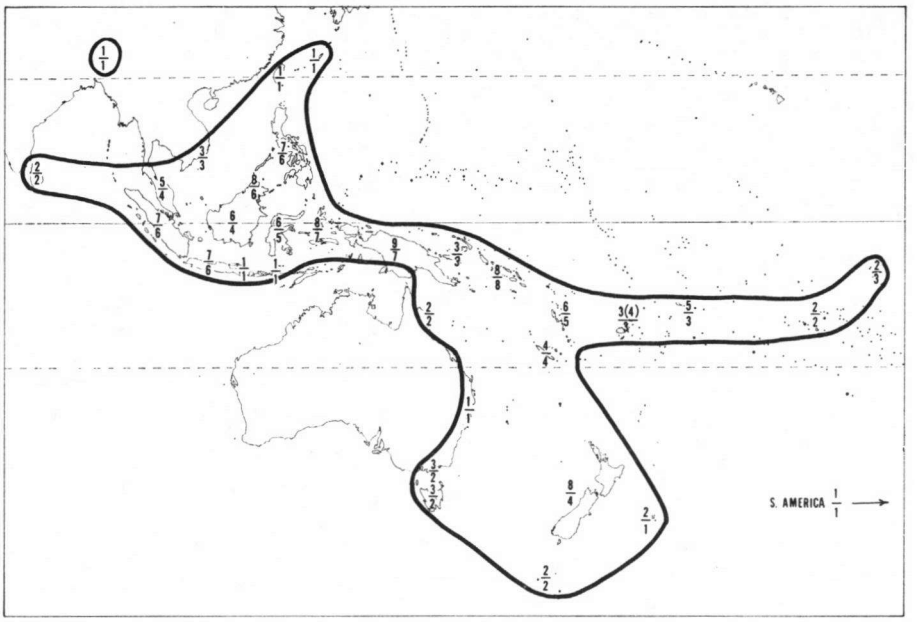

Fig. 3. Generalized distribution of *Hypnodendron*. The figure above the hyphen indicates the total number of species, the figure below the hyphen the number of sections.

as the *Hypnodendraceae* are concerned) are to be expected from the Solomons and the New Hebrides, which are poorly explored and appear to be rich in species. This is illustrated by the results of van Zanten's short visit to Mt. Popomanasiu (Guadalcanal, Solomon Is.) in 1968. To the four species already known from the Solomons another four could be added from his collections. These included *H. menziesii* which had been found previously only in New Zealand and New Caledonia.

The distribution area of *Braithwaitea* (Fig. 43) includes tropical and subtropical East Australia and Northern New Zealand. Single collections are known from New Caledonia and Lord Howe I.

The greatest species density of *Hypnodendron* (Fig. 3) is found in North Borneo, New Guinea, Melanesia, and New Zealand. The greatest density of its sections is found in New Guinea and West Melanesia. The areas of the sections are of three kinds:

a. occupying almost the entire area of the genus: *Hypnodendron, Comosa.*
b. Indo-Pacific: *Phoenicobryum, Leiocarpos, Mniodendropsis, Pseudomniodendron, Tristichophyllum.*
c. mainly New Zealand: *Sciadocladus, Lindbergiodendron.*

The only area common to categories b and c are the Solomons and New Caledonia.

Eight out of sixteen Indo-Pacific, Malesian, or tropical Australian species are widely distributed and show a more or less marked geographic variation, which induced me to recognize a number of subspecies. These have sometimes been adopted reluctantly because only a few collections were available from island groups connecting the partial areas of the subspecies. Five of these species occur in West Malesia (Java, Sumatra, and the Malay Peninsula), and the tallest specimens of four of them (*H. diversifolium, H. dendroides,*

H. milnei, *H. reinwardtii*) are found there. In West Malesia *H. vitiense* is replaced by the much taller *H. junghuhnii*. In *H. subspininervium* the tallest specimens occur in the Pacific islands, and in *H. auricomum* they are found in the Moluccas and New Guinea. As a rule, the eastern subspecies are more closely related to other species than are the western.

The remaining eight Indo-Pacific species occur in only a rather small area. Five species (*H. brevipes*, *H. beccarii*, *H. junghuhnii*, *H. samoanum*, *H. tahiticum*) are closely related to more widespread species and may represent regional segregates of these. The remaining species are *H. comatulum* (Queensland), *H. camptotheca* (New Caledonia), and *H. flagelliferum* (New Hebrides). All things considered, these data suggest that Melanesia is a distribution centre of *Hypnodendron*.

The Australasian species are centred in New Zealand. Eight out of nine species have been found there, and five are endemic or subendemic. The only Australian and Tasmanian species (with the exception of *H. comatulum* mentioned above) not occurring in New Zealand is the very widespread *H. vitiense*.

ECOLOGY

The *Hypnodendraceae* are largely restricted to areas having an everwet climate. Almost all Malesian species are montane, but several descend into the tropical lowland rainforest or occur up to the tree-line. The Pacific, Australian, and South American species show a wide range of vertical distribution from the lowland upwards. *Braithwaitea* and the species of *Hypnodendron* sect. *Phoenicobryum* are epiphytes; the remaining species are mostly found on humid rocks, decaying tree trunks, tree roots, and terrestrial.

The water requirements of the pinnate plants will be met by water flowing down the tree trunks and rock faces on which they grow, to the stipes and so to the fronds. The palmate and umbellate plants often grow on level substrata. They will be largely dependent on water falling directly on the frond or conducted from below. They are often found near water, and always in areas with an evenly distributed heavy precipitation and a constantly high atmospheric humidity (as far as can be judged from the available data). It is worth noticing that structures which are assumed to improve external water conduction or storage (appressed, concave, plicate, or striate leaves, decurrent bands, large pseudoparaphyllia, tomentum) are more strongly represented in umbellate and palmate species than in pinnate ones.

SOME NOTES ON COLLECTIONS OF DOUBTFUL ORIGIN

a. von Siebold

Van der Sande Lacoste (1867) and Mitten (1891) reported *Mniodendron korthalsii* from Japan, where it is supposed to have been collected by Ph. von Siebold. The species has never been found in Japan since. Von Siebold's collection also contains a specimen of *H. subspininervium* ssp. *arborescens* labelled 'Japonia'. The occurrence of these *Hypnodendraceae* in Japan seems very unlikely. His specimens belong to the forms occurring in Java. Moreover, mixed with his specimen of *H. milnei* ssp. *korthalsii* was a small branch of *Aerobryopsis longissima* (Dz. et Molk.) Fleisch., a widespread Malesian species which has never been reported from Japan. Dr. N. Kitagawa informed me (verbal communication) that von Siebold's collection also contains specimens of the Malesian hepatics *Plagiochila blepharophora* (Nees) Nees and *Lopholejeunea eulopha* (Tayl.) Spruce labelled 'Japonia', and which likewise have never been reported from Japan by others. These facts strongly suggest that these collections (and maybe others) have been mislabelled, and presumably

originated from Java. Von Siebold is not known to have collected there during his stay in 1823, but he might have received plants from other collectors. Further, they could have got mixed up with his Japanese collections when these were send to Europe via Batavia, or at a later occasion.

b. Gunn

In the nineteenth century R. C. Gunn made a herbarium of Tasmanian mosses. I have not seen any *Hypnodendraceae* of his bearing labels indicating other localities. Among his plants are *H. colensoi* and *H. menziesii*, which have not been reported from Tasmania either before or afterwards. I very much doubt whether they have actually been collected there, and suppose they came from New Zealand.

c. Cunningham

The only collection of *H. colensoi* from New South Wales was collected by Alan or Richard Cunningham. I have never seen any other *Hypnodendron* they collected there, but have examined many Cunningham specimens from New Zealand. Here too, mislabelling cannot be ruled out, and is suggested by the great similarity between the above mentioned gathering and one labelled 'New Zealand'. Likewise, their Norfolk Island collections of *H. arcuatum*, *H. comatum*, and *H. menziesii* very much resemble collections of the same species labelled 'New Zealand'.

d. Milne and McGillavray

I have seen several Melanesian collections which are said to have been collected by Milne or McGillavray during the voyage of the 'Herald' in 1853 and 1854, but I doubt whether the collector or the collecting locality of these have been given correctly (see note 1 under *H. subspininervium* ssp. *subspininervium*, note 2 under *H. flagelliferum*, and the notes under *H. dendroides*, entity 5).

SPECIAL PART

HYPNODENDRACEAE

Brotherus (1909c) 1166; (1905) 11, *nom. nud.*; Fleischer (1906) 670, *nom. nud.*; (1914) 110, 114; (1917) 33; (1920) 395; (1923) 1598; Brotherus (1924B) 433; Dixon (1932B) 411. — *Climaciaceae* Abt. *Hypnodendreae* Kindb. (1899) 393.

Type genus: *Hypnodendron* Lindb. *ex* Mitt.

Plants mostly medium-sized to very tall and more or less glossy, mostly erect, less often projecting horizontally from the substrate. *Innovations* predominantly basal; distal innovations often present, mostly weak, sprouting from the fronds. *Stipe* circular, elliptic, or angular in cross section. Dormant buds often surrounded by lacerate leaflike pseudoparaphyllia. *Frond* complanate. *Stipe leaves* appressed to widely spreading or squarrose-recurved; costa ending in apex to long-excurrent; lamina cells elongate to mostly narrowly linear, mostly bearing single papillae at their basal and distal ends. *Branch leaves* isomorphous to strongly anisomorphous; margin, costa and cells as in the stipe leaves, but costa bearing dorsal teeth in its distal part, cells shorter and often more strongly papillate, alar and basal cells less strongly differentiated.

Dioecious. Male gametoecia bud-shaped; antheridia mixed with filiform hyaline paraphyses. *Female gametoecia* mostly tomentose at base, tubular; archegonia mixed with filiform hyaline paraphyses. Outer leaves of perichaetia bearing mature sporophytes small, ovate, the inner ones long, erect, sheathing, imbricate; apex caudate, often formed mainly by the ill-defined costa; margin entire to crenulate, often bearing stronger teeth near apex; cells linear, smooth or nearly so. *Vaginula* immersed to emergent, covered by paraphyses and decrepit archegonia. *Seta* long, smooth, sulcate or angular, twisted. *Theca* mostly asymmetrical, more or less curved, ovate to cylindrical, mostly sulcate, costate, or angular, less often smooth; apophysis distinct, pustulose, bearing phaneroporous stomata. *Annulus* present. *Peristome* double; exostome teeth 16, endostome slightly shorter than the exostome, hyaline, papillose, processes 16. *Spores* subglobose, 10—35 μ across, finely papillose. *Operculum* conical, mostly obliquely rostrate, occasionally blunt or bluntly apiculate. *Calyptra* glabrous, cucullate.

Distribution: Ceylon, Khasi Hills (?), Annam, Taiwan, Ryukyus, Malesia, Melanesia, Samoa group, Society group, Marquesas, E. Australia, Tasmania, Lord Howe I. (?), Norfolk I. (?), New Zealand, Auckland Is., Campbell I., Chatham Is., Juan Fernandez group, S. Chile, and the adjacent part of Argentina.

Ecology: Terrestrial, on rocks, on decaying wood, and epiphytic; in rain forests and scrubs from sea-level up to the tree-line.

KEY TO THE GENERA

1. Exostome teeth horizontally striate near base, papillose near apex, ventral lamellae high; basal membrane of endostome high, cilia 2—5. Cortical cells of the stipe moderately incrassate; central strand wide. Branch leaves flat to weakly concave, acute to acuminate. Rhizoidal gemmae absent **Hypnodendron**

1. Exostome teeth papillose throughout, ventral lamellae very low; basal membrane of endostome low, cilia absent. Cortical cells of the stipe extremely incrassate; central strand very narrow. Apex of branch leaves cymbiform, obtuse to truncate or emarginate. Branches often bearing filiform rhizoidal gemmae **Braithwaitea**

1. HYPNODENDRON

(C. Muell.) Lindberg *ex* Mitten in Seemann (1873A) 401; Lindberg (1861) 374, *nom. inval.*; Lindberg in Dozy et Molkenboer (1866) 132; Mitten (1869) 566; Jaeger in Jaeger et Sauerbeck (1880) 357; Paris (1895) 603; Kindberg (1899) 393; Paris (1904) 1168; Brotherus (1909C) 1168; Fleischer (1923) 1600; Brotherus (1924B) 436; Dixon (1929) 341; Bartram (1939) 152; Sainsbury (1955B) 318. — *Hypnum* Hedw. sect. *Hypnodendron* C. Mueller (1851A) 496, *excl. subsect. Flabellaria.* — *Isothecium* Brid. § *Hypnodendron* Wilson in J. D. Hooker (1854) 105, (1859) 206; J. D. Hooker (1867) 463; Bastow (1887) 84. — *Hypnum* Hedw. subsect. *Comatulina* C. Mueller (1851A) 503, *nom. illeg.*

Lectotype species: *Hypnum junghuhnii* C. Muell.

For further synonyms see under the sections.

Stipe red to black, straight, without or occasionally with short creeping basal part, either tomentose at base only or completely covered by tomentum, rarely bearing scattered tufts of tomentum; two or three outermost layers of cells narrow, dark coloured, often nearly filled by layers of secondary thickening, cortical cells parenchymatous, incrassate, central strand distinct, consisting of narrow thin-walled cells, mostly measuring more than 10 cells across. *Frond* mostly palmate or umbellate, less often pinnate or bipinnate; branches rarely flagelliferous. *Stipe leaves* often longitudinally plicate or striate; base mostly shortly decurrent; insertion line mostly concave, occasionally straight; apex mostly somewhat twisted when dry, mostly gradually acuminate, occasionally acute or abruptly acuminate; margin near base mostly recurved and entire or nearly so, upwards flat and serrulate to coarsely serrate by simple teeth or geminate teeth mixed with simple ones, occasionally entire or nearly so; costa dorsally smooth or nearly so, costa cells differentiated into four to five types; marginal, alar and basal cells indistinct to distinctly differentiated, marginal cells occasionally bistratose, alar and basal cells often orange. *Branch leaves* often longitudinally plicate or striate, often complanate or secund, in weak plants sometimes caducous; apex acute to gradually and often long-acuminate, rarely abruptly acuminate.

Male plants often slightly smaller than the female ones. *Male gametoecia* numerous, situated along the rhachis and the stronger branches, sometimes grouped together in a conspicuous disk. *Female gametoecia* situated near the base of the rhachis and the main branches; *inner perichaetial leaves* smooth to deeply plicate longitudinally, apex more or less spreading, flexuose. *Exothecial cells* strongly incrassate. *Exostome teeth* yellowish with narrow hyaline border, horizontally striate, becoming coarsely papillose near apex; ventral lamellae very high. Basal membrane of *endostome* high; processes widely cleft; *cilia* 2—5, nodose. *Calyptra* yellowish or brownish, darker coloured and often mamillate at apex.

Distribution and ecology: As the family.

KEY TO SECTIONS AND SPECIES

1. Stipe leaves very widely spreading to squarrose-recurved when moist 2
1. Stipe leaves appressed or obliquely spreading 18
2. Operculum conical or shortly and bluntly apiculate. Stipe leaves faintly serrulate to crenulate, occasionally bearing a few stronger teeth, broadly ovate, abruptly narrowed to a long, narrow, and ± entire acumen. Spores 15—25 μ, theca smooth. Frond umbellate to subumbellate: sect. *Sciadocladus* . 3
2. Operculum rostrate. Stipe leaves coarsely serrate to spinose-serrate 4
3. Theca *c.* 1.5—3 mm long, horizontal when deoperculate; operculum apiculate to very shortly rostrate; seta *c.* 1.5—4 cm long; up to *c.* 8(—25) sporophytes on each frond. Base of stipe leaves broadly cordate, neither reflexed nor distinctly decurrent . . . . . **8. H. kerrii**

3. Theca *c.* 4.5—7.5 mm long, pendulous when deoperculate; operculum conical; seta *c.* 5—7.5 cm long; up to *c.* 3 sporophytes on each frond. Base of stipe leaves reflexed and decurrent **7. H. menziesii**
4. Branch leaves of unequal size (dorsal leaves smaller), asymmetrical, ovate to ovate-oblong, bearing long, simple, often spinose teeth. Base of stipe leaves often orange coloured. Operculum bluntly rostrate. Spores 10—19 μ 5
4. Branch leaves isomorphous or nearly so, symmetrical to weakly asymmetrical. Operculum sharply rostrate 6
5. Branch leaves tristichous, those of the dorsal row much smaller than the laterally spreading ones. Stipe leaves broadly ovate-triangular, base cordate, apex narrowed to a long and narrow acumen, strongly reflexed, concave, often long-decurrent. Stipe erect, naked to tomentose; frond umbellate. Pseudoparaphyllia conspicuous: sect. *Tristichophyllum* . . . . . **16. H. diversifolium**
5. Branches complanate, leaves arranged in more than three rows. Stipe leaves ovate-oblong, gradually rounded and not or very shortly decurrent at base; apex acute, shortly aristate. Stipe oblique to horizontal, tomentose at base only; frond pinnate. Pseudoparaphyllia indistinct, appressed, sparse: sect. *Lindbergiodendron* . . . . . **9. H. arcuatum**
6. Plants growing ± horizontally; frond pinnate to bipinnate. Theca smooth to sulcate; spores 22—34 μ. Basal and alar cells of stipe leaves strongly incrassate, orange: sect. *Phoenicobryum* 7
6. Plants erect; frond palmate to umbellate. Theca sulcate; spores 12—20 μ. Basal cells of stipe leaves usually greenish 11
7. Frond bearing up to 5 cm long, caducous and microphyllous flagellae . . **5. H. flagelliferum**
7. Microphyllous flagellae absent (but branchlets often attenuate or caudate) 8
8. Leaves of main branches less than three times as long as wide. Frond bipinnate (rarely pinnate) with attenuate branchlets. Theca usually inclined to horizontal . . . . . **1. H. subspininervium**
8. Leaves of main branches more than three times as long as wide. Frond pinnate (rarely bipinnate); branchlets occasionally caudate 9
9. Theca inclined, smooth to weakly angular below the orifice. Marginal teeth of branch leaves *c.* 40—75 μ long, geminate teeth absent . . . . . **4. H. beccarii**
9. Theca erect or nearly so when deoperculate, usually shallowly to deeply sulcate, rarely almost smooth. Marginal teeth of branch leaves mostly shorter than 45 μ; geminate teeth rarely absent . . . 10
10. Seta up to 3 cm long; theca shallowly sulcate, *c.* 4—5 mm long . . . . . **3. H. brevipes**
10. Seta 3—9 cm long; theca shallowly to deeply sulcate, *c.* 6—9 mm long . . . **2. H. reinwardtii**
11. Stipe tomentose at base only; geminate teeth present; stipe leaves gradually contracted at base; pseudoparaphyllia indistinct, appressed, sparse: sect. *Mniodendropsis* . . . . . **17. H. milnei**
11. Stipe entirely tomentose; geminate teeth absent; base of stipe leaves usually cordate or auriculate, occasionally rounded; pseudoparaphyllia distinct, small: sect. *Comosa* 12
12. Epidermal cells of the basal part of the costa containing colourless crystals. Seta *c.* 3.5—4.5 cm long, up to *c.* 3 per frond . . . . . **20. H. colensoi**
12. Crystals absent 13
13. Stipe leaves triangular-ovate, costa thin, ending in apex . . . . . **18. H. comatulum**
13. Stipe leaves triangular to triangular-ovate, costa strong and percurrent to excurrent 14
14. Stipe leaves triangular to broadly triangular; margin near base serrulate to serrate. Theca usually inclined to horizontal, cylindrical, occasionally obconical 15
14. Stipe leaves narrowly triangular; margin near base entire, rarely serrulate. Theca mostly horizontal to cernuous, mostly obconical 16
15. Stipe leaves at least 2.5 times as long as wide; base rounded to strongly cordate; apex slightly acuminate **24. H. tahiticum**
15. Stipe leaves less than 2.5 times as long as wide, or long-subulate to aristate from a broadly triangular auriculate base; apex mostly distinctly acuminate. A very variable species . **23. H. dendroides**
16. Branch leaves rather abruptly narrowed to either a coarsely serrate subula or a strong brownish arista. Leaves provided with a dark coloured and often partly bistratose border . . **22. H. comosum**
16. Branch leaves acute to gradually acuminate. Border absent or indistinct, neither strongly coloured nor bistratose 17
17. Costa of branch leaves upwards narrowed and ending in the rather wide leaf apex to percurrent. Stipe leaves very narrowly triangular; base rounded to cordate and little narrowed; marginal teeth up to 12 μ long . . . . . **19. H. camptotheca**
17. Costa not narrowed upwards, percurrent to excurrent; leaf apex narrow. Stipe leaves narrowly triangular; base cordate to auriculate; marginal teeth stronger . . . . . **21. H. comatum**
18. Stipe tomentose at base only, completely covered by the usually coarsely serrate leaves, which often have strongly coloured basal cells. Theca smooth, inclined to horizontal, mostly longer than 8 mm; operculum long-conical to bluntly or sharply rostrate. Spores 20—35 μ: sect. *Leiocarpos* **6. H. auricomum**

18. Stipe not completely covered by the leaves, which have green to pale orange basal cells. Theca sulcate, inclined to cernuous, up to 7 mm long. Spores 10—19 μ 19
19. Stipe tomentose. Basal and alar cells of branch leaves strongly enlarged; lamina cells *c.* 3—6.5 μ wide, smooth or nearly so; geminate teeth absent. Operculum sharply rostrate. Mostly dull, erect plants; frond umbellate: sect. *Pseudomniodendron* . . . . . **25. H. fusco-mucronatum**
19. Stipe glabrous, exceptionally with a few scattered tufts of tomentum. Basal and alar cells of branch leaves not or slightly enlarged; lamina cells mostly wider. Operculum bluntly rostrate. Frond in most species palmate or subumbellate: sect. *Hypnodendron* 20
20. Branch leaves bordered by several rows of bistratose narrowly linear cells, clearly distinct from the irregularly elongate, up to 40 μ long and smooth inner lamina cells; geminate teeth absent. Stipe leaves entire or nearly so. Dull to slightly glossy plants . . . . . **15. H. marginatum**
20. Border absent or indistinct; lamina cells much longer, mostly distinctly papillate; geminate teeth often present. Mostly glossy to very glossy plants; branches often strongly complanate 21
21. Base of stipe leaves not or little narrowed, mostly closely appressed to the stipe; alar cells absent or very indistinct. Capsules not strumose 22
21. Base of stipe leaves rounded to cordate, mostly recurved at the angles; alar cells rectangular to hexagonal, wider than the lamina cells. Stipe leaves distinctly spreading. Open capsules often weakly strumose 24
22. Stipe leaves rather widely spreading, narrowly triangular, their margin coarsely serrulate to shortly serrate . . . . . **14. H. samoanum**
22. Stipe leaves closely appressed to weakly spreading at apex 23
23. Stipe leaves coarsely serrate to spinose-serrate . . . . . **13. H. junghuhnii**
23. Stipe leaves usually entire or nearly so, occasionally bearing a few teeth near apex **12. H. vitiense**
24. Base of stipe leaves cordate; papillae in branch leaves short, very distinct. Plants usually yellowish green, very glossy; fronds usually pinnate, strongly complanate . . . . **11. H. microstictum**
24. Base of stipe leaves rounded; papillae long, sometimes indistinct. Plants usually sordid green and dull to somewhat glossy; fronds palmate to pinnate, usually less strongly complanate **10. H. spininervium**

Sect. Phoenicobryum

(Lindb. *ex* Broth.) Touw, *stat. nov.* — *Phoenicobryum* Lindberg (1861) 374, *nom. nud.* — *Hypnodendron* subg. *Phoenicobryum* Lindberg *ex* Brotherus (1909C) 1169; Lindberg in Dozy et Molkenboer (1866) 133, *comb. inval.*; Fleischer (1923) 1623; Brotherus (1924B) 437. — Type species: *Hypnum reinwardtii* Schwaegr.

Plants medium-sized to tall, horizontally to obliquely projecting from the substrate. *Distal innovations* absent or simple and weak. *Stipe* mostly tomentose at base only, occasionally bearing scattered tufts of tomentum. *Pseudoparaphyllia* inconspicuous, appressed, sparse or absent. *Frond* ± ovate, pinnate to bipinnate; branches mostly complanate. *Stipe leaves* patent to squarrose-recurved, ovate to ovate-oblong; insertion line concave; base rounded, rarely cordate, mostly shortly decurrent; apex mostly gradually long-acuminate; margin near base recurved, upwards flat, coarsely serrate to spinose-serrate; costa strong, often bearing dorsal teeth, percurrent to excurrent in a mostly brown colored and often serrate, cuspidate point; lamina cells smooth to mostly weakly papillate, papillae long; walls of basal and alar cells often extremely incrassate, porate, orange; alar cells enlarged to inflated, forming a mostly large group. *Branch leaves* isomorphous or nearly so, erecto-patent to widely spreading, ovate-oblong to triangular-ovate-lanceolate; apex acute to shortly or long-acuminate; margin, costa, and areolation as in the stipe leaves, but costa ending in apex to shortly excurrent, cells smooth to strongly papillate, basal and alar cells less distinct.

Male gametoecia scattered. *Perichaetial leaves* deeply plicate. *Theca* smooth to sulcate, erect to horizontal. Spores 22—34 μ. *Operculum* sharply rostrate.

Distribution: Ceylon, Khasi Hills (?), Malesia, Melanesia, Samoa group.

Ecology: In rain forests, mostly growing on trunks and branches of trees and

shrubs, occasionally epiphyllous, on rocks, or terrestrial. From sea level up to 2600 (— 3000) m. No data are available with regard to the ecology of *H. flagelliferum*.

1. Hypnodendron subspininervium (C. Muell.) Jaeg. — **Fig. 4, 5.**

For synonyms, literature, and type specimens see under the subspecies.

Plants medium-sized to tall, up to 12 cm long, pale greenish to pale yellowish green or straw-coloured, often becoming tinged with brown with age, weakly to distinctly glossy. *Stipe* up to 8 cm long. *Frond* ovate, 1—6 cm long, densely to rather loosely pinnate to mostly bipinnate, occasionally tripinnate; main branches up to *c.* 2.5 cm long; ultimate branchlets often finely tapering and flexuose. *Stipe leaves* patent to squarrose-recurved, ovate-oblong, (1.0—) 1.5—3.8 by 0.9—1.6 mm, L/W ratio (1.7—) 1.8—2.7; base broadly rounded, gradually narrowed; apex mostly gradually acuminate; margin bearing a mixture of geminate teeth and simple ones, which are up to *c.* 30 μ long and often brown-tipped; costa bearing 0—4 (—5) dorsal teeth, in the lower stipe leaves often long-excurrent cells 35—90 (—100) by 2.5—5 μ, L/W ratio *c.* 8—18 (—27), smooth to indistinctly papillate. *Branch leaves* spreading, gradually becoming almost appressed towards the tips of the ultimate branchlets, ovate-oblong, 1.2—2.5 by (0.4—) 0.5—1.2 mm, L/W ratio 2.0—3.0; apex acute to slightly acuminate; margin bearing a mixture of geminate teeth and simple ones which are up to *c.* 25 μ long; costa ending in apex to excurrent in a short cuspidate point, bearing up to 6 dorsal teeth; lamina cells 35—80 by 2.5—4 (—5) μ, L/W ratio *c.* 10—20, walls distinctly papillate to almost smooth.

Up to *c.* 8 *sporophytes* on each frond. *Ochrea* mostly tomentose. *Seta* 3—5 cm long, arcuate to flexuose or nearly straight, yellowish to pale brown, orange or reddish when young, mostly becoming reddish brown to dark brown with age. *Theca* erect to horizontal, very weakly curved to almost straight, cylindrical, 5—8 (—10.5) mm long, smooth to angular or shallowly sulcate in the distal half, often weakly constricted below the orifice, yellowish brown to orange brown, pale brown, or greyish brown, becoming darker with age. *Cilia* 2—4. *Operculum c.* 2—5 mm long. *Calyptra c.* 3.5—6 mm long.

Distribution: As the section.

Ecology: See under the section; 0—1300 (—1700) m.

Note: Typical plants of *H. subspininervium* are larger than typical plants of *H. arborescens*. However, in Borneo and the Philippines some plants of the latter have been collected that approach the size of the former. On the other hand juvenile or poor specimens of that species may be the size of *H. arborescens*. In such cases one has to rely on the differential characters of the stipe leaves: size and number of geminate teeth, and length of the excurrent part of the costa. In West Malesian plants of *H. arborescens* geminate teeth are often sparse or absent, but they are somewhat more numerous in plants from Borneo, the Philippines, and New Guinea. In *H. subspininervium* the geminate teeth usually are very numerous, but plants with few geminate teeth have been found as well. Occasionally, the costa of the stipe leaves is distinctly excurrent in plants of *H. arborescens*, or hardly excurrent in *subspininervium*. Anyhow, one must be very careful in applying this character, as the lower stipe leaves may have rather long-excurrent nerves in both. In my opinion these taxa should not be maintained as species. Here they have been given the rank of subspecies, and even that might be too high a valuation. The area of ssp. *arborescens* comprises Ceylon, Khasia, and Malesia, whereas ssp. *subspininervium* has been collected in a number of Pacific island groups ranging from the Solomons to Samoa. Unfortunately, very few collections are available from the region connecting both areas (the Bismarck Archipelago, the Solomons, the Santa Cruz Islands, the northern New Hebrides, and New Caledonia), and those that do exist are almost invariably poor.

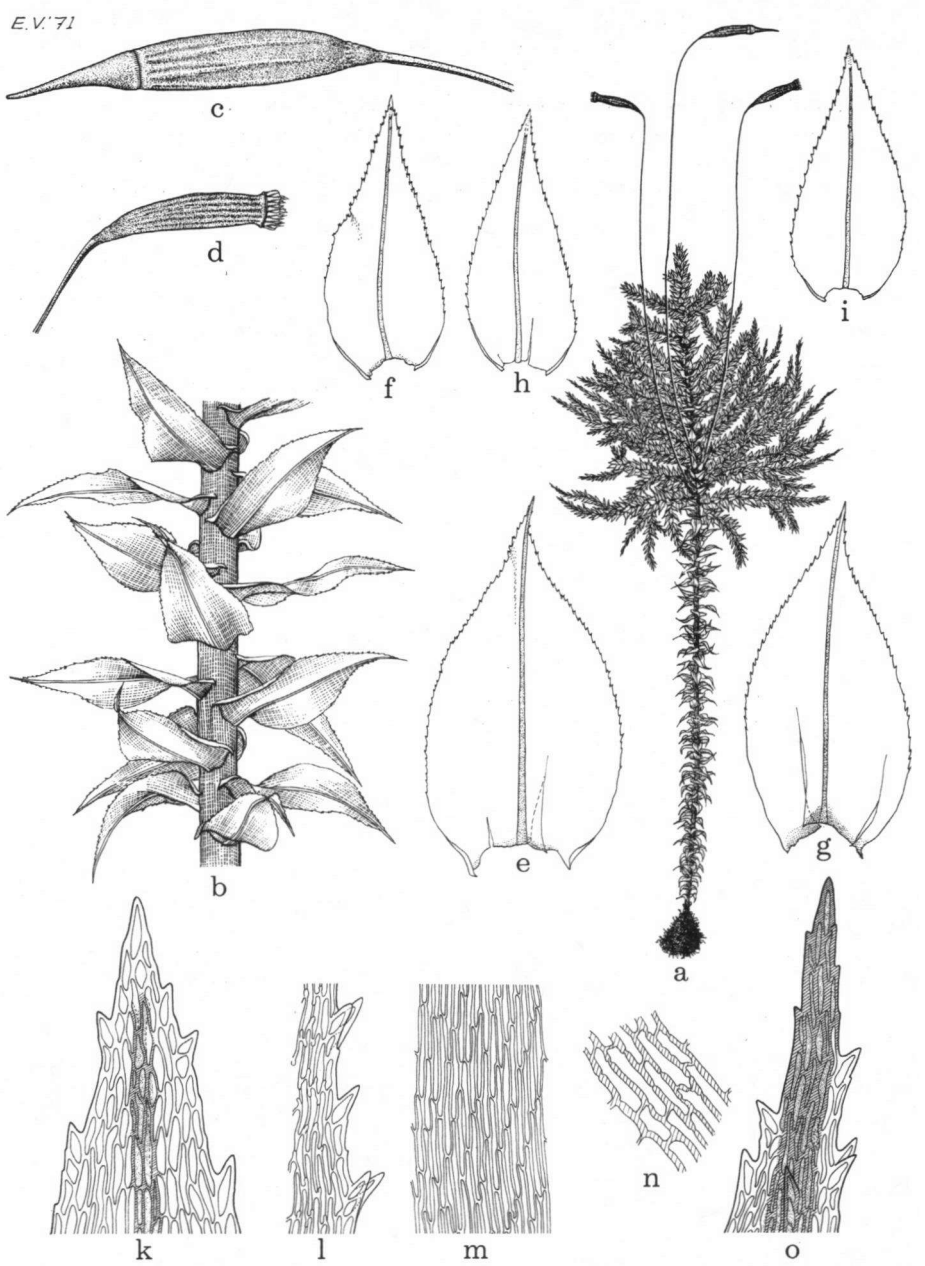

Fig. 4. *Hypnodendron subspininervium*. a—f, l—o: ssp. *subspininervium*; g—k: ssp. *arborescens*. — a: Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e, g: stipe leaves, × 17; f, h, i: branch leaves, × 17; k, o: apices of branch leaves, × 260; l: margin of branch leaf, × 260; m: areolation of branch leaf, × 260; n: basal cells of stipe leaf, × 260. (a, b: *Graeffe s.n.*; c, d, o: *Smith 642*; e, f, l—n: *Smith 294*; g, i, k: *Gardner 1016*; h: *Robbins 1993*).

Much more material is needed from these islands, and should it become available one will have to reconsider whether these subspecies can be maintained or whether they should be merged.

KEY TO THE SUBSPECIES

1. Median stipe leaves 2.6—3.8 mm long; costa excurrent in a strong, serrate, cuspidate point; geminate teeth numerous. Medium-sized to tall plants, up to 12 cm long . . . . ssp. **subspininervium**
1. Median stipe leaves up to 2.6 mm long; costa percurrent to very shortly excurrent; geminate teeth often few or absent. Medium-sized plants, up to 6(—8) cm long . . . . . ssp. **arborescens**

a. ssp. **subspininervium.** — *Hypnum subspininervium* C. Mueller (1857) 782, (1874A) 90. — *Hypnodendron subspininervium* Jaeger in Jaeger et Sauerbeck (1880) 359; Paris (1895) 605; C. Mueller (1896B) 332; Paris (1904) 375; Brotherus (1908A) 400, (1909C) 1169; Cardot (1912) 177; Brotherus et Watts (1915) 157; Fleischer (1923) 1601; Brotherus (1924B) 438; Thériot (1937) 129; Bartram (1956) 394, (1957B) 22; van der Wijk et al. (1962) 534. — Type: *Thwaites s.n.* in coll. Cuming (B holo, †), Fiji Is., mountains of Ovalau; see note 1; neotype: *W. G. Milne 351* (H holo, K, NY, S-PA), Fiji Is., Ovalau.

Trachyloma arborescens Mitt. *sensu* Mitten (1861) 366, *pro parte*. — *Hypnodendron arborescens* Mitt. *sensu* Mitten (1868) 193, *pro parte*; Mitten in Seemann (1873A) 401, *pro parte*; Dixon et Greenwood (1930) 300; Bartram (1936A) 10.

? *Braithwaitea arborescens* Mitten (1882B) 101, *nom. nud.*

Plants medium-sized to tall, up to 12 cm long. *Stipe* up to 8 cm long. *Frond* up to 6 cm long; main branches up to *c.* 2.5 cm long. *Stipe leaves* 2.6—3.8 by 1.1—1.6 mm, L/W ratio (1.7—) 2.1—2.7; geminate teeth numerous, often outnumbering the simple ones; costa bearing 1—4 dorsal teeth, excurrent in a cuspidate point of variable length. *Branch leaves* (1.7—) 2.0—2.5 mm long; costa mostly percurrent to excurrent in a short cuspidate point. Up to 8 *sporophytes* on each frond. *Female gametoecia c.* 4.5—6 (—7) mm long; inner leaves up to *c.* 6 mm long. *Vaginula c.* 4 mm long. *Seta* 4—5 cm long. *Theca* erect to horizontal, straight or nearly so, 5—8 (—10.5) mm long.

Distribution: Solomon Islands, New Caledonia (?), New Hebrides, Fiji Islands, Samoa group. Apparently common in the New Hebrides, Fiji, and Samoa.

Solomon Islands. Guadalcanal. Mt. Popomanasiu: *van Zanten 682464* (GRO, L), *682465* (GRO, L), *682510* (GRO, L). — San Cristobal: *Braithwaite 4218* (L).

New Hebrides. Tongoa: *Bowie 66 p.p.* (H), *519* (H), *863* (BM). — Futuna: *Aubert de la Rue*, 7 collections. — Aneityum: *Gunn 374a* (H), *378* (H, L), *763* (H).

New Caledonia. Tao: *Franc, Musci Nov.-Caled. Exsicc. 135*, doubtful (BM, FH, H, JE, L, PC, S-PA, W), *id. 136* (BM, FH, GRO, JE, L, PC, W).

Fiji Islands: *Milne 3* and *s.n.* (FH, NY); *Seemann 845* (FH, K, NY); *unknown coll. s.n.* (H, NY). — Vomo: *Seemann 843* (K). — Viti Levu. Suva: *Armstrong 1006* (H). — Ovalau: *Graeffe 602* (JE); *Milne 351* (H, K, NY, S-PA); *Wilkes s.n.* (BM, K, US). Mt. Ndelaiovalau: *Smith 7612* (FH, K, NICH, US). Mt. Tana Lailai: *Smith 7722* (B, BO, FH, US, W). — Kandavu. Mt. Mbuke Levu: *Smith 294* (FH, K, L, NY, S-PA, US). — Vanua Levu. Mt. Mbatini: *Smith 642* (B, FH, K, L, NY, S-PA, US). — Taveuni: *Weber s.n.* (S-PA). Somosomo: *Smith 882* (B, FH, K, L, NY, S-PA, US), *8382* (B, FH).

Samoa group: *Hills 3* (BM); *Veitch s.n.* (K). — Savaii: *Graeffe 639* (H, JE). Sili: *Chistophersen 3228* (FH, L). Mt. Maugaloa: *Reinecke 28 p.p.* (FH). — Upolu: *Boswell s.n.* (BM, L); *Graeffe s.n.* (FH, H, NY, S-PA, W); *Reinecke 27* (FH, US). Mt. Lanutoo: 15 collections. Mafa Pass: *Irwin 7* (FH), *338* (FH). Tofua: *Graeffe s.n.* (BM, JE, NY). Malua: *Hills 34* (BM). Afiamalu: *Irwin 139* (FH). Tiavi: *Rechinger 2660* (W). Lepua: *Reinecke 28A* (FH). Falealili: *Weber s.n.* (H). — Tutuila: *Powell 52* (K, NY, S-PA); *Reinecke 114* (FH, S-PA, US); *Wilkes s.n.* (K, US).

Notes: 1. According to Mueller (1857) the type specimen of *Hypnum subspininervium* was collected on Ovalau I., in October, 1854. He further added the indication 'Thwaites

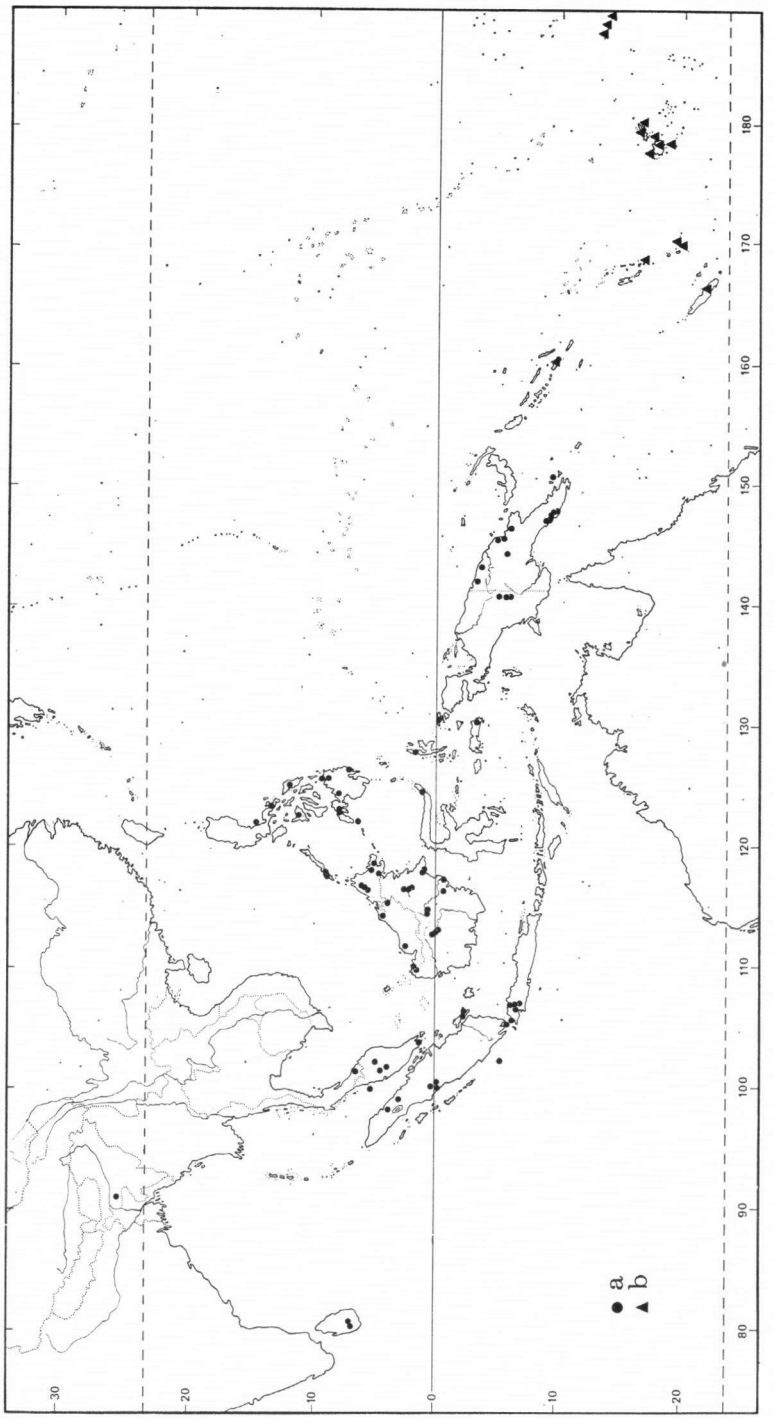

Fig. 5. Distribution of *Hypnodendron subspininervium* ssp. *arborescens* (a) and ssp. *subspininervium* (b).

in coll. Cuming'. Neither of these can have been the actual collector of the specimen as Thwaites did not collect outside Ceylon (according to Nelmes & Cuthberton, 1931), and Cuming did not visit Fiji. Moreover, the latter's Pacific voyage took place in the years 1827 and 1828 (according to St.John, 1940). Milne and McGillavray collected in Ovalau between Sept. 29 and Nov. 24, 1854 during their voyage in the 'Herald', and as no other collectors of botanical specimens are known to have visited Ovalau during the same period I assume one of them collected the type of the present species. Most species which Mueller described in the above mentioned publication are based on specimens from Cuming's collection, but originate from places Cuming never visited himself. The collecting date has only been given for *Neckera* (=*Papillaria*) *kermadecensis*, which was collected in the Kermadecs in July, 1854. As Milne and McGillavray visited Sunday Island (one of the Kermadecs) from July 2—24, 1854, this appears to support the above assumption. Mitten (1873A) also examined Milne's collections and described new species from these, apparently ignorant of Mueller's publication. It must be feared that he created several nomenclatural synonyms. As a matter of fact, Mitten's herbarium does contain a Milne specimen of *H. subspininervium* ssp. *subspininervium* from Ovalau.

2. Plants of the same collection may vary from densely pinnate and bearing many caudate branchlets to remotely pinnate and almost devoid of caudate branchlets. The last mentioned plants can be recognized by the shape of their stipe leaves and branch leaves and by the length and L/W ratio of the branch leaves which mostly reach lower values than in *H. reinwardtii*. Moreover, the Pacific form of *H. reinwardtii* has the stipe leaves erecto-patent instead of squarrose-recurved and is strongly fulvous.

3. Plants bearing sporophytes have been found much more often in the present subspecies than in ssp. *arborescens*.

4. From New Caledonia only two or three collections are available. One sample (in BM) consists of branch fragments, to which a drawing of a complete plant has been added. This sample undoubtedly represents *H. subspininervium* ssp. *subspininervium*. According to the label it was collected in New Zealand by Mossman, but Dixon added a note to it stating that 'from the associate plants this was certainly from New Caledonia'. Unfortunately, these associate plants have been removed. I have preferred to leave this specimen out of consideration. Two other samples consist of very small juvenile plants, and many have not even formed a frond. One sample may belong to ssp. *subspininervium*, the other one could belong to either subspecies.

5. What Mitten (1882B) understood by *Braithwaitea arborescens* is not exactly clear. According to the publication, in which no description was given, that species was collected by Milne in Aneityum, but the specimen could not be traced in Mitten's herbarium, nor did I find any other specimen bearing that name. Presumably, this record concerns *H. subspininervium* ssp. *subspininervium*.

b. ssp. **arborescens** (Mitt.) Touw, *stat. nov.* — *Trachyloma arborescens* Mitten (1859A) 91. — *Hypnodendron arborescens* Lindberg *ex* Mitten in Seemann (1873A) 401, *pro parte*; Lindberg in Dozy et Molkenboer (1866) 133, t. 232, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 358; Paris (1895) 603, (1904) 372; Brotherus (1909C) 1169; Giesenhagen (1910) 789; Fleischer (1923) 1605; Brotherus (1924B) 438; Dixon (1926) 45; Herzog (1926A) 339; Holttum (1927) 92; Brotherus (1928) 123; Dixon (1932A) 32, (1935A) 95; Bartram (1939) 154, *pro parte*, f. 189; Froehlich (1953) 84; Bartram (1961) 371; van der Wijk et al. (1962) 532; Schultze-Motel (1963) 441; van Zanten (1964) 291, *pro parte*. — Type: *Gardner 1016* (NY holo, BM, H), Ceylon.

Hypnodendron pseudo-arborescens Fleischer (1923) 1607; (1917) 34, *nom. nud.*; Brotherus

(1925) 531; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443. — Type: *Amdjah s.n.*, exped. Nieuwenhuis (FH holo), Borneo, Bukit (Batu) Milie.

Hypnodendron reinwardtii non (Schwaegr.) Jaeg.: Meijer (1954A) 263, 271; Bartram (1939) 154, *pro parte*, (1960A) 145, *pro parte*.

Plants medium-sized, up to 6 (—8) cm long. *Stipe* up to 3.5(—5.5) cm long. *Frond* up to 3(—4) cm long; main branches up to *c.* 1 cm long. *Stipe leaves* (1.0—)1.5—2.6 by 0.9—1.4 mm, L/W ratio 1.8—2.4; geminate teeth often absent or sparse; costa bearing 0—3 (—5) dorsal teeth, percurrent to shortly excurrent. *Branch leaves* 1.2—2.1(—2.3) mm long; costa ending in apex to percurrent. Up to 2 (—6) *sporophytes* on each frond. *Female gametoecia c.* 3.5—5.5 (—6) mm long; inner leaves up to *c.* 4.7 mm long. *Vaginula c.* 2.5—3 mm long. *Seta c.* 3—5 cm long. *Theca* inclined to horizontal, slightly curved to almost straight, *c.* 5—7 (—8) mm long.

Distribution: Ceylon, Khasi Hills (?), Thailand, Malay Peninsula, Sumatra, Java, Borneo, Palawan, Luzon, Polillo, Samar, Panay, Mindanao, Basilan, Celebes, Halmaheira, Ceram, New Guinea (and adjacent islands).

CEYLON: *Gardner 115* (NY), *1016* (BM, H, NY); *Wallace s.n.* (BM). — Central Province: *Thwaites CM 168 p.p.* (BM, CANTY, FH, H, K, NY, PC, W). Adam's Peak: *unknown coll. s.n.* (MEL). Maskeliya and Dikoya: *Thwaites CM 168 p.p.* (CANTY). Kabot's Gap: *Alston 1584* (BM).

INDIA. Khasi Hills: *unknown coll. s.n.* (BM, FH).

PENINSULAR THAILAND. Pattani. Khao Khalakhiri: *Kerr 282* (BM, K).

MALAY PENINSULA. P. Penang. Penang Hill: 12 collections. — Perak. G. Batu Puteh: *Wray 928* (BM, BO, H, K, L, SING, US, W). — Pahang. G. Tahan: *Holttum SFN 20834* (BM, SING); *Ridley 214* (BM, H, SING); *Seimund s.n.* (SING). Fraser's Hill: *Allen 631* (GRO), *1179* (GRO); *Holttum SFN 11373* (BM, SING, US). — Singapore: *Ridley 438* (BM, NY, SING), *704* (SING), *706* (NY).

SUMATRA: *Korthals s.n.* (BO, FH, GRO, H, K, L, S-PA). — East Coast. Patani R.: *van der Wijk 1585* (GRO, L). Asahan R.: *Bartlett 6637a* (BM, US); *Rahmat si Boeea 7584* (FH, L). — West Coast. Bt. Gadang: *van Borssum Waalkes 2039* (BO). Mt. Tandikat: *Meijer B 7038* (L), *B 8090b* (L), *B 8090g* (L). Taram: *Meijer B 8326* (L), *B 8575* (L), *B 8580* (L). Melalag: *Micholitz 74a* (H). — P. Enggano: *Modigliani 1674* (BM, FH, S-PA, W). — P. Bangka. Lobok Besar: *Anta s.n.* (BO, GRO). G. Pading: *Kostermans s.n.* (BO, GRO). — P. Sebesie: *Docters van Leeuwer 5311* (BO, GRO, L). — Krakatau group. P. Rakata: *van Borssum Waalkes 896* (BO), *949* (BO).

JAVA. West Java. G. Salak: *Blume s.n.* (BO, GRO, L); *Fleischer s.n.* (FH, L); *Giesenhagen 104* (H); *Kurz s.n.* (BM, K); *Schiffner 12461* (L, S-PA, W), *12462* (L). Depok: *Holle s.n.* (GRO, H, L, W). G. Megamendong: *Schiffner 12463* (W); *Zippelius s.n.* (BO, FH, GRO, L). G. Gedeh: *Wichura s.n.* (FH); *Zippelius s.n.* (BO, FH, GRO, L).

BORNEO. Sabah. Bahandoi Spur N. of Mt. Kinabalu: *Kanis B 002* (L). Mt. Kinabalu, Ranau: *Meijer B 11599* (L). Mt. Trus Madi: *Nooteboom 1471* (L). Lamag: *Wood 1438* (BM, GRO). Mt. Silam: *Iwatsuki 5374A* (L, NICH). Tawau R. Forest Reserve: *Meijer*, 7 collections (L). — Sarawak: *Everett s.n.* (NY). Mt. Murud: *Moulton 163* (BM, SING); *native coll. of Sarawak 2907* (H). Baram R.: *Everett 77* (H, L). Sibu: *Everett s.n.* (BM). Mt. Poi: *Everett 55* (H). Lundu: *Micholitz 230* (BO, GRO, H, JE, L), *244* (CANTY, FH, H, K, L, NY, PC), *317 p.p.* (JE, NY). — Indonesian Borneo. Long Kiau: *Endert 4648* (BM, BO, GRO). Long Petak: *Endert 3386* (BM, BO, GRO, L). Long Hut: *Endert 2578A* (BM, BO). Bt. Mehipit: *Winkler 3105* (H), *3218* (H). Bt. Bidang Menabai: *Winkler 3140* (H). Bt. Tilung: *Winkler 3312* (H). Sg. Dengeg: *Jaheri 799* (FH, GRO, K, L). Batu Mili: *Amdjah s.n* (FH). Berouw, Mt. Ilas Bungaan: *Kostermans 13797A* (L). P. Sangkulirang: *Kostermans 6143* (BO). Peak of Balikpapan: *Meijer*, 10 collections (BO, L). S. Mukum near Sangasanga: *Meijer B 3087* (BO, L), *B 3161* (BO, L).

PALAWAN. Mt. Gantung: *Edaño BS 80890* (BM). Penigisan: *Sandermann Olsen 2155* (L).

LUZON. Camarines Sur. Botol R.: *Edaño BS 84263* (FH).

POLILLO: *McGregor BS 10515* (H, K, NY).

SAMAR. Mt. Sarawag: *Edaño PNH 15911* (PNH).

PANAY. Capiz. Mt. Bulilao: *Martelino & Edaño BS 38505 p.p.* (H).

MINDANAO. Zamboanga. Mt. Hiapan: *Ebalo 694* (FH). Mt. Mate: *Ebalo 810* (FH, L). — Lanao. Dansalan, Sacred Mt.: *Zwickey 645* (FH). — Agusan: *Weber 1311* (BO, H, L, NY, US). — Surigao: *Bolster s.n.* (BM, BO). — Davao. Mt. Mayo: *Edaño PNH 12895* (GRO, PNH).

BASILAN: *Reillo BS 16272* (BO, GRO, H, L, NY, US).

CELEBES: *unknown coll. s.n.* (FH, H, L, S-PA). — North Peninsula. Bojong: *Warburg s.n. p.p.* (FH).

Halmaheira. G. Sembilan: *Pleyte 333d* (BO, L).
Ceram. Rumoga: *Buwalda 5920* (FH, L).
New Guinea. Waigeo Island. Mt. Nok: *Cheesman 103* (BM), *111* (BM). — West New Guinea. Star Mts., Ariemkop: *van Zanten 298A* (L), *300C* (L). Ujambib: *van Zanten 278D* (GRO, L). Umkubun: *van Zanten 268* (BM, GRO, L). — Territory of New Guinea. Torricelli Ra., Miwaute: *Darbyshire 216* (CANB, L). Prince Alexander Ra., Maprik—But track: *Robbins 1982* (CANB, FH, L), *1993* (CANB, FH, L). Mt. Hagen Village: *van Zanten 68853B* (GRO, L). Nobonob near Madang: *Schulz s.n.* (JE). Bogadjim: *unknown missionary s.n.* (JE, S-PA). Finisterre Ra.: *Eiffert 47* (BM, JE). — Territory of Papua. Aroa R.: *Weiss s.n.* (H, JE). Brown R. Valley: *Musgrave s.n.* (BM, H). Musgrave R.: *van Zanten 68095* (GRO, L). Astrolabe Ra.: *Clark 110* (BM). Moroko ('Mo-roka'): *Loria 730 p.p.* (FH, H, NY, W), *730B p.p.* (BM, S-PA), *748 p.p.* (H), *768 p.p.* (K), *1599* (W), *1600 p.p.* (CANTY, FH, S-PA). — Fergusson Island. Mts. between Agamoia and Ailuluai: *Brass 27142* (FH, L).

Notes: 1. The foliage of the New Guinea plants is usually very pale coloured which makes the red branches very conspicuous. The setae and capsules are somewhat shorter than those of plants from elsewhere.

2. In the present subspecies sporophytes have been collected less frequently than in ssp. *subspininervium*. They have not yet been found in Ceylon and on the Asian mainland, and appear to be rare in Sumatra.

3. According to Fleischer (1923) *H. pseudo-arborescens* should differ from *H. subspininervium* ssp. *arborescens* by its cylindrical and emergent vaginula and completely smooth theca. However, the vaginula is usually cylindrical and immersed to emergent in *H. subspininervium* ssp. *arborescens*. As the structure of the capsule wall is very variable too, I fail to see how *H. pseudo-arborescens* could be interpreted other than as a robust form of the present subspecies. Fleischer mentioned only one collection, gathered by Nieuwenhuis on Bukit Milie (= Batu Mili), Central Borneo. That specimen (collected by Amdjah, an Indonesian employed by Nieuwenhuis) is sterile; Fleischer's description of the sporophyte was based on another Amdjah specimen of which the exact collecting locality is not known.

4. I have examined 10 out of 13 collections mentioned by Bartram (1939); 4 of these had been identified correctly, the remaining 6 belong to *H. reinwardtii* ssp. *caducifolium*.

2. Hypnodendron reinwardtii (Schwaegr.) Jaeg. — **Fig. 6—8.**

For synonyms, literature, and type specimens see under the subspecies.

Plants medium-sized to tall, rarely very small, up to 11(—17) cm long; young parts yellowish green to pale green or sordid green, mostly becoming golden brown to rusty red with age, glossy. *Stipe* up to 6.5(—12) cm long. *Frond* mostly irregularly broadly ovate to ovate, loosely to densely pinnate to subpalmate, exceptionally bipinnate, 1.5—5 (—8.5) cm long; main branches up to *c.* 3 (—3.5) cm long, flexuose to stiff; side branches mostly few or absent; branch tips rounded to somewhat attenuate, occasionally caudate. *Stipe leaves* squarrose to squarrose-recurved, ovate-oblong, (1.9—)2.2—3.8(—4.1) by 0.8—1.4 mm, L/W ratio *c.* 2.0—3.0; base weakly to strongly narrowed; apex acute to gradually or abruptly shortly or long-acuminate; marginal teeth simple or mixed, *c.* 25—50 (—100) μ long, often brown-tipped; costa bearing 0—3 (—6) dorsal teeth; lamina cells 40—115 by 4.5—7.5 μ, L/W ratio *c.* 10—20, smooth to rather indistinctly papillate; marginal cells occasionally more strongly incrassate and darker coloured than the inner lamina cells and bistratose below the teeth, thus forming an indistinct to distinct border. *Branch leaves* spreading to patent, the ultimate ones occasionally caducous, ovate-lanceolate, (1.9—) 2.2—4.2 by 0.6—1.3 mm, L/W ratio 2.7—5.5; apex acute to gradually long-acuminate; margin bearing a mixture of geminate and simple teeth which are up to 35 (—65) μ long, geminate teeth occasionally very sparse or absent; costa bearing up to 8 (—13) dorsal

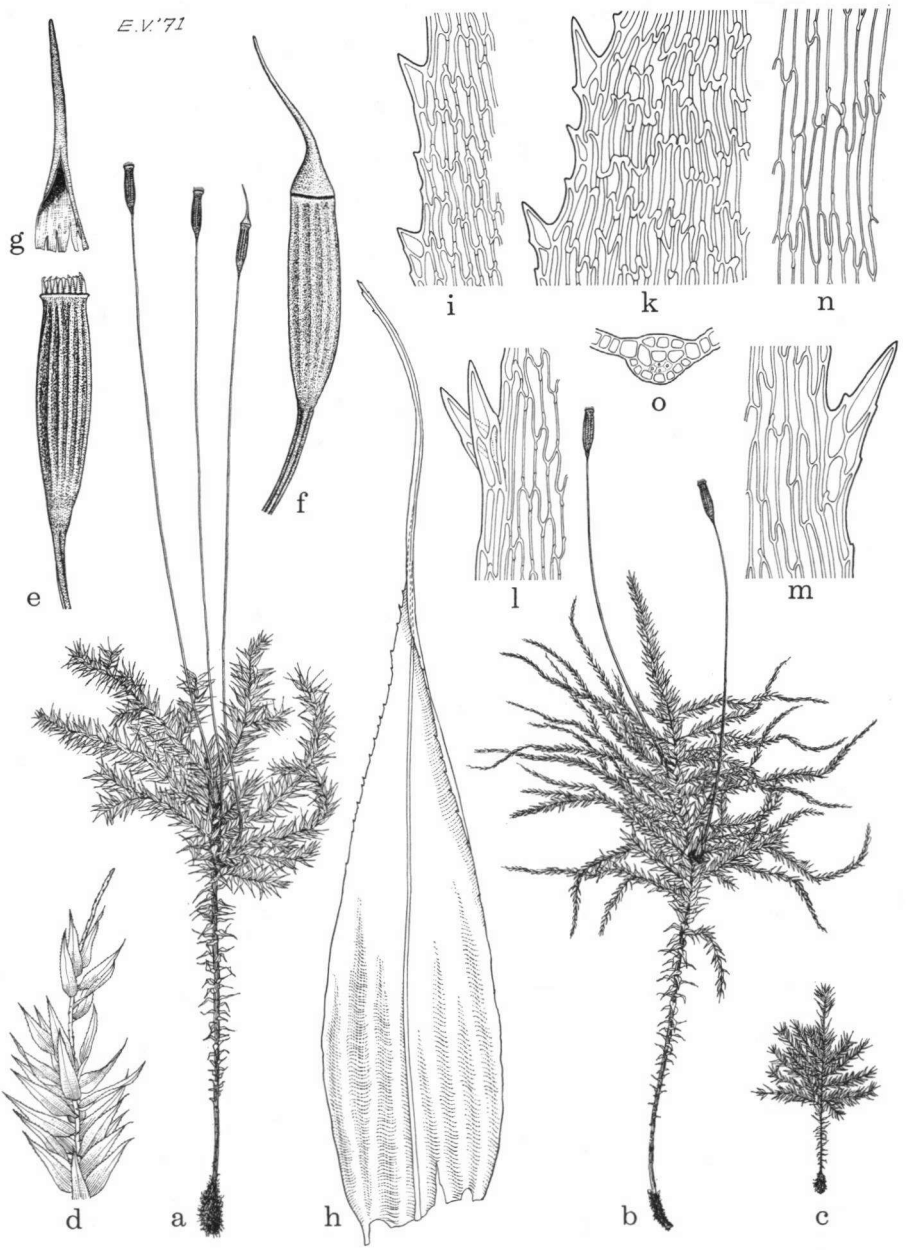

Fig. 6. *Hypnodendron reinwardtii*. a, d—h, m—o: ssp. *reinwardtii*; b, l: ssp. *caducifolium*; d: '*gedehense*'; c, i, k: '*microvagum*'. — a—c: Habits, × 1; d: apex of branch, × 4; e, f: capsules, × 4; g: calyptra, × 4; h: perichaetial leaf, × 17; i—m: margins of stipe leaves, × 260; n: areolation of stipe leaf, × 260; o: cross section of costa of branch leaf, × 260. (a: *Möller 188*; b: *Fenix BS 3849*; c, k: *Fleischer s.n.*; d: *Treub s.n.*; e, f, o: *Möller 197*; g: *Junghuhn s.n.*; h: *Schiffner, Cr. Exsicc. 3962*; i: *Meijer B 11765*; l: *Elmer 7835*; m, n: *Meijer B 9160*).

teeth, ending in apex to percurrent or excurrent in a short serrate and often brownish cuspidate point; lamina cells 45—90 by 3.5—6 μ, L/W ratio *c.* 8—20, walls smooth to papillate; border absent to distinct.

Up to 4 (—6) *sporophytes* on each frond. *Seta* 3—9 cm long, straight to flexuose, brownish, orange, or reddish. *Theca* erect to suberect, straight or nearly so, narrowly cylindrical, (4.7—) 6—9 (—10) mm long, shallowly to deeply sulcate, exceptionally angular or nearly smooth, not or weakly constricted below the orifice, greyish brown to pale brown or dark brown. *Cilia* 2—4. *Operculum c.* 3—6 cm long. *Calyptra c.* 5—8 mm long.

Distribution: Malesia, Samoa group?

Ecology: See under the section; (600—) 1300—2600 (—3000) m.

Notes: 1. Two collections from the mountains of Savaii have been placed here provisionally:

SAMOA GROUP. Savaii: *Graeffe 180* (JE, L). Mt. Maugaloa: *Reinecke 28b p.p.* (FH, K, US, W).

Though this locality falls far outside the area of *H. reinwardtii* these plants agree rather closely with ssp. *caducifolium* in general appearance. They differ in having very narrow leaves (L/W ratio in stipe leaves 3.2—3.9, in branch leaves 3.5—5.0) bearing up to only 25 μ long teeth, and stipe leaves which are straight and widely patent instead of being squarrose-recurved. The only available seta measures 3 cm and bears a heavily damaged theca. These plants apparently either belong to an undescribed species or represent a local form of *H. reinwardtii*. I prefer to leave this taxon unnamed until more is known about the *Hypnodendron* flora of the insufficiently explored mountains of the islands in the West Pacific Ocean.

2. Plants having weakly developed fronds often have proportionally narrow stipe leaves which are longer than usual (L/W ratio up to 3.2, length up to *c.* 4.1 mm). Such leaves also bear more dorsal teeth than usual.

3. *H. reinwardtii* consists of many forms, most of which cannot be separated satisfactorily from the others. However, the specimens from West Malesia are much more homogeneous than those from other parts of the area of the species and constitute a regional segregate (ssp. *reinwardtii*) which is characterized by having a very long seta. In that subspecies a seta shorter than 6 cm has been found only three times, always in small and sometimes distinctly poorly developed plants. Outside the area of ssp. *reinwardtii* only three samples have been collected of which at least some setae measure over 6 cm. These collections all consist of exceptionally tall and often flaccid plants. Ssp. *reinwardtii* is rather uniform in its vegetative characters, but, unfortunately, the very wide range of variation of ssp. *caducifolium* makes the idendification of sterile specimens often impossible.

Unfortunately, few collections are available from the islands adjacent to West Malesia (Borneo, Celebes, the Lesser Sunda Islands) and New Guinea, and many of these are very scanty and sterile. They closely resemble ssp. *reinwardtii* in their vegetative parts, but often have narrower branch leaves with an excurrent costa. Those bearing sporophytes all have short setae, except *Stresemann 229*, an exceptionally tall specimen from Ceram.

Philippine plants mostly have attenuate to caudate branches, a feature already observed by Bartram (1939) and Noguchi (1963). Moreover, they often have clearly acuminate leaves provided with a marginal border, predominantly geminate teeth, and a distinctly excurrent costa. However, there are many specimens in which the characters of the Philippine form and ssp. *reinwardtii* have been found in various combinations. The sporophytes of ssp. *caducifolium* also show a wider range of variation than those of ssp. *reinwardtii*. The ochrea, which usually is tomentose in ssp. *reinwardtii*, is often glabrous or only sparingly tomentose is ssp. *caducifolium*. The theca is always sulcate in the former,

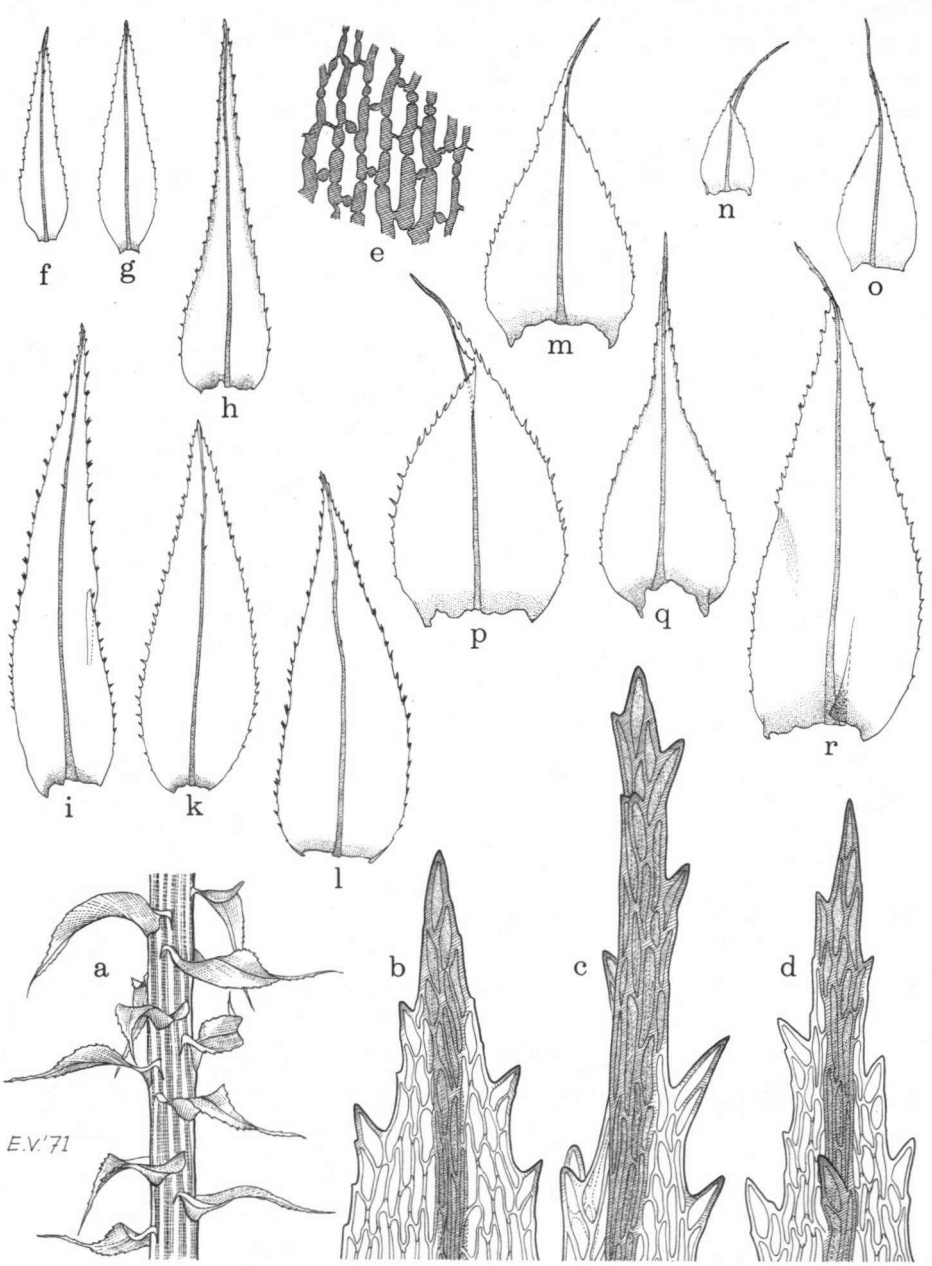

Fig. 7. *Hypnodendron reinwardtii*. a, b, e, k—m, p: ssp. *reinwardtii*; c, h, i, q, r: ssp. *caducifolium*; d, f, g, n, o: '*microvagum*'. — a. Stipe, × 8; b—d: apices of branch leaves, × 260; e. basal cells of stipe leaf, × 260; f—l: branch leaves, × 17; m—r: stipe leaves, × 17. (a: *Alston 12855*; b, k, p: *Schiffner 12486*; c, i, r: *Elmer 7835*; d, g, n: *Fleischer s.n.*; e: *Schiffner, Cr. Exsicc. 3962*; f, o: *Meijer B 11765*; h, q: *Magdamo 41*; l, m: *Fleischer MAI 48*).

whereas it is sometimes angular to almost smooth in the latter. Lax, pale green plants often deviate in lacking a distinct border to the leaves and having predominantly simple teeth. As a weak differentiation of the border and the teeth in lax, pale coloured plants from very dark and humid places has been observed in other species as well, this might be just a phenotypic modification. However, in some islands only such plants have been found.

The plants from the northernmost island of Batan are long and flaccid and have many very long and caudate branches, which gives the plants a very peculiar appearance (Fig. 6b). Batan appears to be the only island where the species has been collected at altitudes below 1000 m. Plants from Batan also have proportionally wide branch leaves and predominantly simple teeth; the sporophytes are often very small.

All specimens from Catanduanes, Mindoro, Panay, and Biliran have leaves bearing mainly simple teeth and lacking a distinct border. Those from Catanduanes are small and have short branch leaves and branches that are not or only slightly attenuate. The Mindoro specimens agree with the latter but occasionally are bipinnate (as some plants from South Luzon are) which makes them resemble *H. subspininervium*. In one large gathering (*Merrill BS 5737*) such plants were found together with plants approaching the Philippine form described before and intermediate forms. The specimens from Panay and Biliran have distinctly attenuate branches, the leaves of which are over four times as long as wide.

Most plants from Luzon, Negros, and Palawan, and the only specimen from Mindanao belong to the 'Philippine form', but plants having rather short leaves and simple teeth and lacking attenuate branches have also been found in Luzon and Negros, sometimes even in the same localities.

Unfortunately, our knowledge of the variability of *H. reinwardtii* in the areas outside West Malesia is based on rather few and unevenly distributed collections. Forms like those from Batan or Catanduanes might deserve a formal name, but it seems unwise to name them as long as the extent of the variability is unknown.

4. In some plants the tips of the ultimate branchlets are defoliate, and the remaining branch leaves can be removed easily. Most of these plants are smaller than usual and have simple marginal teeth only. Sporophytes have rarely been found among them, and the setae are shorter than usual in the local form of the species. Such plants have usually been found growing on small twigs or leaves of trees and shrubs. Their stipe leaves may approach the branch leaves in size and shape, and sometimes they are caducous too. *H. gedehense* Fleisch. was based on such plants from West Java, and the type of *H. caducifolium* Herz. from Buru represents a similar form. They are nothing but depauperate forms of *H. reinwardtii*. Several times *'gedehense'* plants were found mixed with normal plants and apparently sprouting from each other.

Another species characterized by caducous leaves is *H. microvagum* Fleisch. That species comprises very small plants (often not exceeding 3 cm) having simply pinnate fronds bearing very narrow leaves that are less widely spreading than they mostly are in *H. reinwardtii*.The stipe leaves and branch leaves are both very small and have short simple teeth. The stipe leaves measure about 1.1—2.0 by 0.4—0.65 mm (L/W ratio *c.* 2.8—3.3) and are rather abruptly narrowed to a more or less toothed arista; the lamina cells are distinctly papillate. The branch leaves measure *c.* 1.3—1.8 by 0.25—0.45 mm (L/W ratio *c.* 3.6—5.0); the costa is percurrent to shortly excurrent and the cells are strongly papillate. Fleischer (1923) mentioned rhizoids sprouting from the basal cells, but this appears to be an exceptional condition as such rhizoids have only been found by me in a few leaves of the type specimen. Some plants bear female gametoecia, but male gametoecia and sporophytes have never been found. These plants are also mostly growing on small branchlets or

epiphyllous. At first sight plants of *H. microvagum* do not resemble *H. reinwardtii* at all, but small '*gedehense*' plants show the same leaf shape and branches. Thus I presume *H. microvagum* represents an extreme dwarfed form of *H. reinwardtii*, but culture experiments are needed to prove this point. Very small and aberrant dwarfed plants have been found in many other species of *Hypnodendron*, and these occasionally have caducous leaves too. As a rule, such dwarfs can be identified rather easily, but '*microvagum*' plants are difficult to identify because they do not show the characters by which the species of sect. *Phoenicobryum* can be distinguished. Plants of '*microvagum*' type have been found all over the area of *H. reinwardtii*. This distribution and the absence of plants clearly connecting '*microvagum*' with *H. beccarii* or *H. brevipes* have led me to include all '*microvagum*' plants in *H. reinwardtii*. No differences have been found between '*microvagum*' plants from West Malesia and those from other regions.

KEY TO THE SUBSPECIES

1. Seta (5—) 6—9 cm . . . . . ssp. **reinwardtii**
1. Seta 3—6 (—7.5) cm . . . . . ssp. **caducifolium**

a. ssp. **reinwardtii.** — *Hypnum reinwardtii* Schwaegrichen (1828) t. 223 f. 1, 3—6, 10—16, '*reinwardti*'; Hornschuch in Reinwardt et Hornschuch (1829) 722, *pro parte*, f. a (*except.* Ib); Moritzi (1846) 130; C. Mueller (1851A) 505; Zollinger (1854) 27. — *Trachyloma reinwardtii* Mitten (1859A) 91, *comb. inval in syn.* — *Phoenicobryum reinwardtii* Lindberg (1861) 374, *comb. inval.* — *Hypnodendron reinwardtii* Lindberg *ex* Jaeger in Jaeger et Sauerbeck (1880) 358; Lindberg in Dozy et Molkenboer (1866) 135, t. 233, *comb. inval.*; Geheeb (1894) 85; Paris (1895) 604; Renauld et Cardot (1896) 107; Cardot (1897) 28, (1891) 118; Paris (1904) 374; Usteri (1906) 392, 473; Brotherus (1909C) 1169; Cardot (1912) 176; Möller (1919) 329; Fleischer (1923) 1607, f. 253; Seifriz (1924) 311, 312; Brotherus (1924A) 438; Herzog (1926B) 347, f. 129; Dixon (1935B) 11; Froehlich (1953) 84; Meijer (1954B) 16; van der Wijk et al. (1962) 534. — Type: *C. G. C. Reinwardt s.n.* (B holo †, L lecto, GRO), Java.

Hypnodendron gedehense Fleischer (1923) 1604; Brotherus (1925) 531; Froehlich (1953) 84; van der Wijk et al. (1962) 533. — Type: *M. Fleischer s.n.* (FH holo, L), West Java, Mt. Gedeh, above Tjibodas, 1550 m.

? *Hypnodendron microvagum* Fleischer (1923) 1603; Brotherus (1925) 531; van der Wijk et al. (1962) 533. — Type: *M. Fleischer s.n.* (FH holo, BM), West Java, Mt. Gedeh, Tjiburrum—Tjipanas, 1800 m.

Hypnum orthocarpon Nees *ex* Schwaegrichen (1828) t. 233, *nom. nud. in syn.*

Hypnodendron arborescens non (Mitt.) Mitt.: Möller (1919) 330; Seifriz (1924) 311.

Frond pinnate to subpalmate; branch tips mostly rounded, not caudate. *Stipe leaves* mostly squarrose-recurved, 1.0—1.4 mm wide, L/W ratio *c.* 2.1—2.5; base mostly distinctly narrowed; apex acute to weakly acuminate; border absent. *Branch* leaves mostly less than four times as long as wide; apex acute to weakly acuminate; costa mostly ending in apex to percurrent, occasionally excurrent; border absent. *Female gametoecia* (4.5—) 6—8.5(—9) mm long. *Ochrea* mostly densely tomentose, rarely glabrous. *Seta* (5—)6—9 cm long. *Theca* 6—9(—10) mm long, sulcate. *Operculum* 3—6 mm long. *Calyptra c.* 5—8 mm long.

Distribution: Malay Peninsula, Sumatra, Java. Common in West Java.

MALAY PENINSULA. Pahang. G. Tahan: *Holttum SFN 20894* (BM, SING). — Selangor. G. Nuang: *Meijer B 12270* (L), *B 12278* (L).

SUMATRA. Mt. Simpai: *Korthals s.n.* (BO, GRO, L). — Atjeh. G. Kemiri: *van Steenis 9523A p.p.*

(GRO, L). — East Coast. Dg. Salit = Tongkeh: *Staal 307* (GRO), *326* (GRO). Lake Toba: *Maibach s.n.* (JE, *'microvagum'*). Asahan R.: *Bartlett & La Rue 251* (BM, BO, GRO, H, K, L, NY, US). — Tapanuli. Lae Pondon: *Alston 14906B* (BM, *'microvagum'*), *15072C* (BM). — West Coast. G. Singgalang: *Beccari 3* (GRO); *Schiffner 12486* (L, S-PA). G. Kerintji: *Meijer, 6* collections (L, *p.p. 'microvagum'*).

Java. West Java. G. Salak: 9 collections. Depok: *Holle s.n.* (H). G. Megamendong: *Schiffner 12478* (L); *Zippelius s.n.* (GRO, L). G. Gedeh and G. Pangrango: 90 collections *(p.p. 'microvagum')*. G. Patuha: *Hildebrand 297* (FH); *Korthals s.n.* (L); *van Oye 236* (BM). G. Masigit: 9 collections. G. Burangrang: *Blume s.n.* (L, *p.p. 'microvagum'*). G. Tangkuban Prahu: *White 63* (FH). Tjibitu (= Tjikitu ?) above Bandung: *Veldhuis*, 7 collections (BM). G. Malabar: *Pulle 8* (BM); *Wichura 2417a* (H); *Wichura & Kurz s.n.* (BM, FH). G. Wajang: *Junghuhn s.n.* (L). G. Kendang: *Scheffer s.n.* (FH, L). G. Tjikurai: *Hasskarl s.n.* (BO, GRO, L); *Korthals s.n.* (FH, GRO, L). G. Telaga Bodas: *Korthals s.n.* (L); *Schiffner 12479* (BM, L, S-PA). — Central Java. G. Slamet: *Junghuhn s.n.* (BO, FH, GRO, H, K, L, S-PA). G. Telemojo: *Fleischer 86* (FH, L).

Notes: 1. As a rule Reinwardt & Hornschuch are cited as the first authors who validly published the combination *Hypnum reinwardtii*. Their paper was read on May 23, 1826, but Margadant (1968) stated: '...there is little doubt that the periodical containing the printed article indeed appeared in 1829, though I have not investigated this as I would have liked to do. No indication of the separate as an earlier publication has been found, though its existence is likely.' As Schwaegrichen published a description of the species in 1828 already, the combination has been ascribed here to that author.

2. As Lindberg (1866) already mentioned, Schwaegrichen's (1828) description of the vegetative parts, the female plant, and the sporophyte refer to *H. reinwardtii*, whereas his description of the male plant and fig. 2 and 7—9 refer to *H. junghuhnii*. The description and illustration given by Hornschuch (1829) are also based on a mixture of these two species. Fig. 1b clearly refers to *H. junghuhnii*, the remaining figures represent *H. reinwardtii*. The description is composed of a mixture of characters of both species.

3. Hornschuch (1829) cited *'Malabaria et Iava insulae'* as regions where Reinwardt collected *Hypnum reinwardtii*. Malabaria was obviously taken for a region in India by Hornschuch, Mueller (1851), Jaeger (1880), Paris (1895, 1904), and Schultze-Motel (1963). As far as I know Reinwardt never visited India, and 'Malabaria' more likely stands for G. Malabar, a mountain situated in West Java, which Reinwardt climbed in 1819. The species has been collected on the same mountain by Kurz, Pulle, and Wichura. Unfortunately all the Reinwardt specimens I was able to examine only bore the indication 'Java'. Hornschuch's herbarium is no longer available as it was destroyed in Berlin.

b. ssp. **caducifolium** (Herz.) Touw, *stat. nov.* — *Hypnodendron caducifolium* Herzog (1919) 292; Brotherus (1924B) 438; van der Wijk et al. (1962) 532. — Type: *K. Deninger 101* (JE holo, GRO, H), Central Buru, 1700 m.

Hypnodendron reinwardtii (Schwaegr.) Jaeg. f. *breviseta* Brotherus (1907) 343, *nom. nud.*, (1910) 161.

Hypnodendron reinwardtii (Schwaegr.) Jaeg. *sensu* Brotherus (1910) 161; Robinson (1914) 212; Herzog (1919) 292; Bartram (1939) 152, *pro parte* f. 188; Merrill (1947) 9; Noguchi (1963) 146; Schultze-Motel (1963) 444; Shin (1965) 266.

Hypnodendron beccarii non Jaeg.: Dixon (1935A) 95.

Mniodendron korthalsii non Par.: Pilous (1959) 248.

Hypnodendron arborescens non (Mitt.) Mitt.: Bartram (1939) 154, *pro parte*.

Frond variable; branch tips rounded to caudate. *Stipe leaves* squarrose to squarrose-recurved, usually 0.8—1.2 mm wide, L/W ratio 2.4—3.0; base weakly to strongly narrowed; apex acute to long-acuminate; border often present. *Branch leaves* usually more than four times as long as wide; apex acute to long-acuminate; costa usually excurrent; border often present. *Female gametoecia* up to 7 mm long. *Ochrea* tomentose to almost

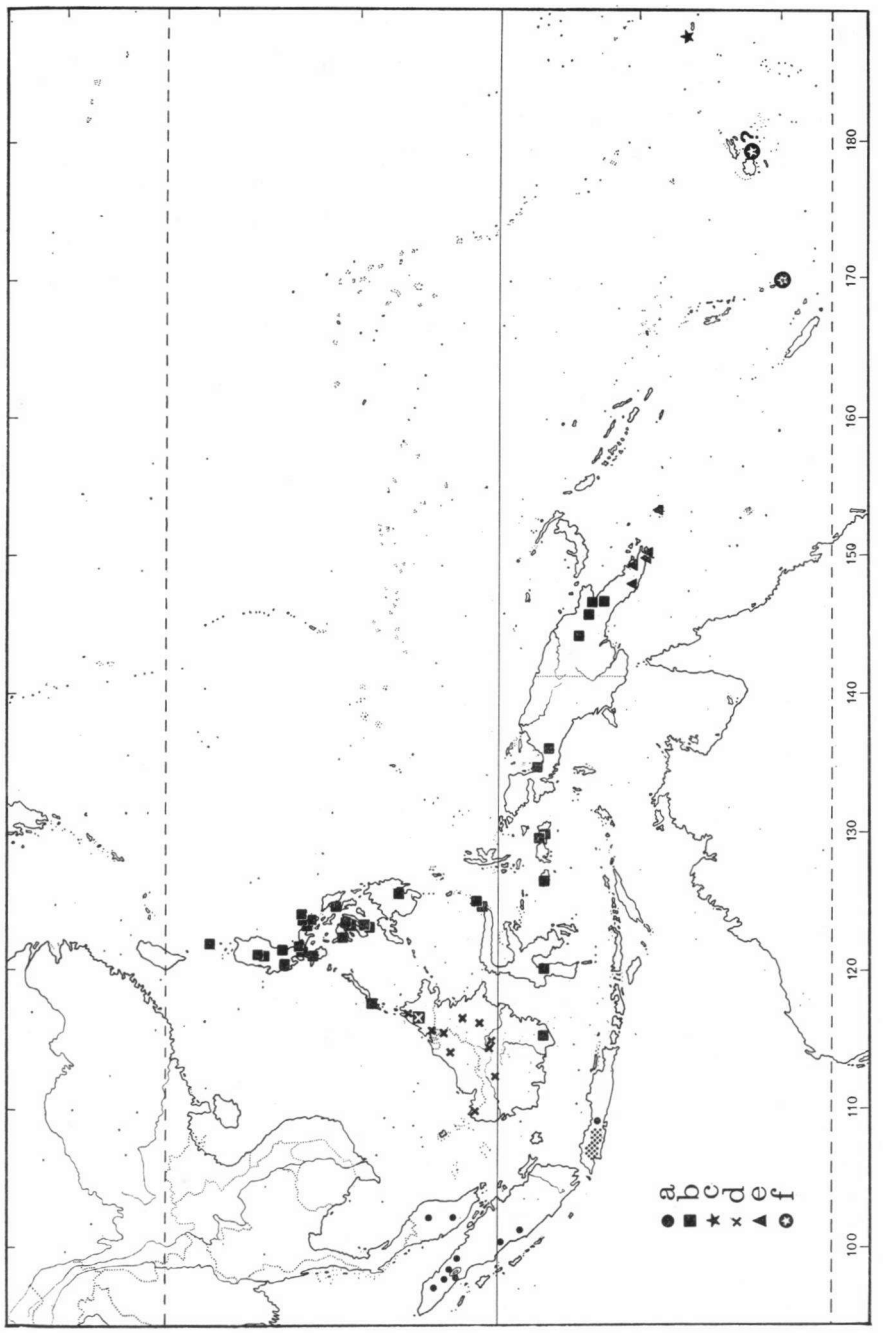

Fig. 8. Distribution of *Hypnodendron reinwardtii* ssp. *reinwardtii* (a and shaded area), *H. reinwardtii* ssp. *caducifolium* (b), Samoan form of *H. reinwardtii* (c). *H, beccarii* (d), *H. brevipes* (e), and *H. flagellíferum* (f).

glabrous. *Seta* 3—6 (—7.5) cm long. *Theca* (4.7—) 6—8 (—9) mm long, shallowly to deeply sulcate, occasionally angular or nearly smooth. *Operculum c.* 3—5 mm long. *Calyptra c.* 5.5—6.5 mm long.

Distribution: Borneo, Palawan, Batan, Luzon, Catanduanes, Mindoro, Panay, Negros, Biliran, Mindanao, Celebes, Buru, Ceram, New Guinea. Widespread but uncommon.

Borneo. Sabah. Mt. Kinabalu: 7 collections *(p.p. 'microvagum')*. Crocker Ra. between G. Alab and Bundu Tuhan: *Meijer B 10194* (L, *'microvagum'*). — Indonesian Borneo. G. Sakumbang: *Korthals s.n.* (GRO, H, K, L, MEL, S-PA).

Palawan. Mt. Mantalingajan: *Edaño PNH 607* (GRO, L, PNH), *PNH 608* (GRO, L, PNH), *PNH 613* (GRO, L, PNH), *PNH 621* (GRO, L, PNH).

Batan. Mt. Iraya: 14 collections.

Luzon. Ifugao. Mt. Polis: *Celestino PNH 13000* (GRO, PNH); *van Zanten 684035* (GRO, L). Mt. Tabayoc: *Jacobs B 10* (L), *B 11* (L), *B 12* (L). — Zambales: *Curran & Merritt FB 8186* (BO, H, MO, NY). Laguna: *Mabesa 23* (GRO). Mt. Banahao (= Mahahai): *Copeland s.n.* (NY); *Iwatsuki et al. 16375* (L, NICH, *'microvagum'*); *Robinson BS 6599* (H, K, NY); *Wallis s.n.* (BM, JE, NY, S-PA). — Quezon. Infanta: *Robinson BS 9373* (FH, H, NY). Lucban: *Elmer 7835* (BO, GRO, H, K, L, NY, US, W). — Camarines Sur. Mt. Isarog: *Edaño BS 84228* (FH). Mt. Madooy: *Edaño BS 84244* (FH, L). Kinaclan: *Edaño BS 84254* (FH, L). Mt. Potianay: *Edaño BS 84267* (FH), *BS 84274* (FH). Mt. Bagacay: *Ramos & Edaño BS 33930* (BO, H, JE, K, L, MO, NY, PC, US).

Catanduanes: *Ramos BS 30611* (BO, GRO, H, JE, K, MO, NY, US). Mt. Abucay: *Ramos & Edaño BS 84400* (FH), *BS 84405* (FH, L).

Mindoro. Mt. Halcon: *Merrill BS 5737* (BO, H, K, L, NY, S-PA, US, W); *Ramos & Edaño BS 40666* (BM, FH).

Panay. Antique: *McGregor BS 32628* (GRO, H), *BS 32639* (H, K, NY).

Negros. Occidental. Mt. Canlaon: *Edaño PNH 20160* (PNH). Mt. Silay: *Whitford BF 1550* (H, NY, W). — Oriental. Cuernos de Negros: *Elmer 9872* (BM, BO, FH, H, K, L, MO, NY, US, W); *Magdamo 9* (FH), *41* (FH), *70* (FH), *76* (FH). Dumaguete: *Patterson 1342* (FH).

Biliran. Mt. Suiro: *Sulit PNH 20237* (PNH).

Mindanao. Davao. Mt. Apo: *Elmer 11661* (BM, BO, FH, GRO, H, K, L, MO, NY, US, W).

Celebes: *de Vriese s.n.* (L). — North Peninsula. Bojong: *Warburg s.n. p.p.* (FH, H). G. Klabat: *Forsten s.n.* (L). — Southwest Peninsula. Bt. Rante Mario: *Eyma 809* (BO, GRO).

Buru. G. Fogha: *Deninger 101* (GRO, H, JE).

Ceram: *de Vriese s.n.* (L). G. Binaija: *Stresemann 229* (GRO, JE, L).

New Guinea. West New Guinea. Wandammen Peninsula, Wondiwoi Mts.: *Schram BW 13407* (L). Weijland Mts., Mt. Jabi: *Janowski s.n.* (L). — Territory of New Guinea. Mt. Hagen Village: *van Zanten 68845A* (GRO, L). Okapa: *Henty s.n.* (L, *'microvagum'*). Mt. Kaindi: *Hewson 480* (L, *'microvagum'*). Mt. Herzog, Wagau: *Eddy 1869* (BM), *1991* (BM, L), *1999* (BM).

Notes: 1. The type specimen represents a rather poor form: though the plants are normal in size and branching, and geminate teeth are present, the distal branch leaves are very narrow and caducous, except in the sole plant bearing a sporophyte.

2. Brotherus did not refer all Philippine plants of *H. reinwardtii* to f. *breviseta*, as both the species and the forma have been recorded in his paper of 1910.

3. Many specimens Bartram (1939) listed under *H. arborescens* belong to *H. reinwardtii* ssp. *caducifolium*. The remarkable lowland plants of *H. reinwardtii* mentioned by Meijer (1954A) belong to *H. subspininervium* ssp. *arborescens*.

3. Hypnodendron brevipes Brotherus (1898) 189; Paris (1900) 191, (1904) 372; Brotherus (1909C) 1169, f. 823 F—H; Fleischer (1917) 34; Brotherus (1924B) 438, f. 384 F—H; van der Wijk et al. (1962) 532; Schultze-Motel (1963) 442. — Syntypes: *W. Micholitz 130* (H lecto, BM, FH, K, L, S-PA, W), New Guinea, mountains near Mila ('Mita'), 2000 ft; *ibid. 130bis* (GRO, H), New Guinea, Cloudy Mountains, 1000—4000 ft. — **Fig. 8, 9.**

? *Hypnodendron laxum* Bartram (1957A) 41; van der Wijk et al. (1962) 533; Schultze-

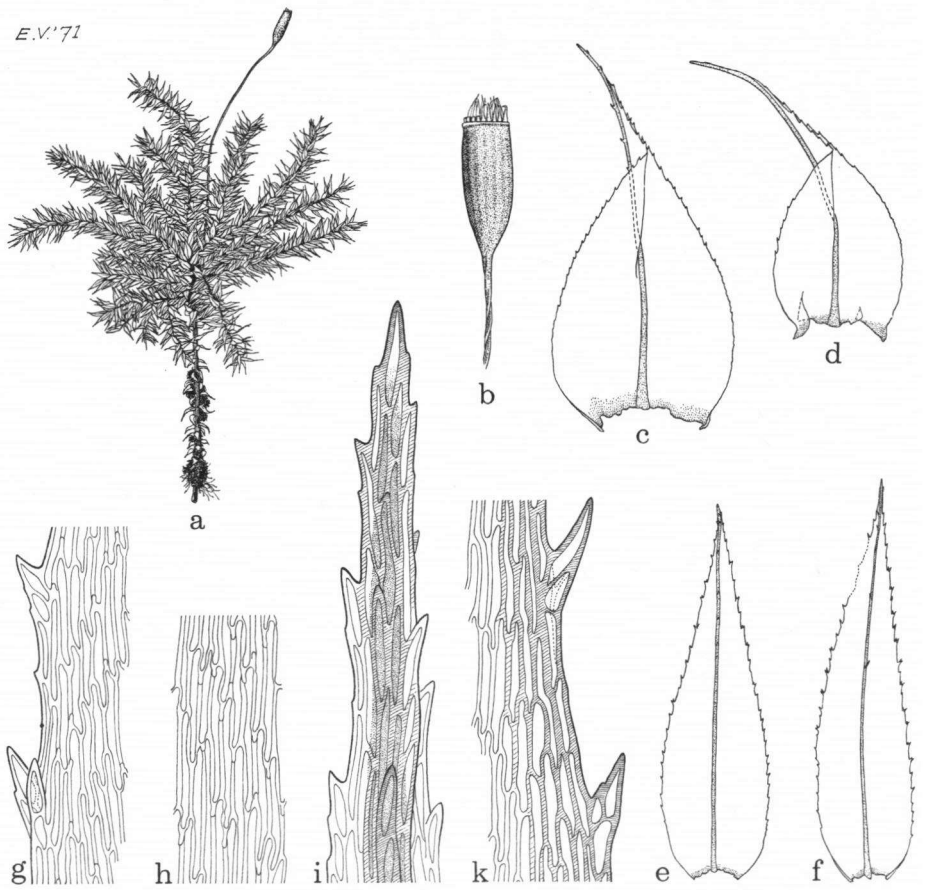

Fig. 9. *Hypnodendron brevipes.* — a: Habit, × 1; b: capsule, × 4; c, d: stipe leaves, × 17; e, f: branch leaves, × 17; g: margin of branch leaf, × 260; h: areolation of branch leaf, × 260; i: apex of branch leaf, × 260; k: margin of stipe leaf, × 260. (a, c, e, g—k: *Brass 28415;* b: *Micholitz 130bis;* d, f: *Micholitz 130*).

Motel (1963) 443. — Type: *L. J. Brass 23078* (FH holo), New Guinea, Maneau Range, Mt. Dayman, north slopes; on living twigs in oak forest, 1550 m.

Hypnodendron reinwardtii non (Schwaegr.) Jaeg.: Bartram (1960A) 145, *pro parte.*

Plants medium-sized, up to *c.* 7.5 cm long, straw-coloured, becoming rusty red with age, glossy. *Stipe* up to *c.* 4.5 cm long. *Frond* triangular to irregularly broadly ovate, compactly to loosely pinnate to irregularly fasciculate, *c.* 2—3.5 cm long; main branches up to *c.* 3 cm long, flexuose; side branches few or absent, branch tips not or hardly narrowed, rounded. *Stipe leaves* squarrose-recurved, ovate-oblong, *c.* 2.4—3.4 by 0.8—1.5 mm, L/W ratio 1.9—3.0; base broadly rounded, distinctly constricted; apex gradually long-acuminate; margin bearing up to *c.* 60 μ long and often brown-tipped simple teeth which are often mixed with a few geminate ones; costa bearing 0—4 dorsal teeth, cuspidate point smooth to strongly serrate; lamina cells *c.* 50—105 by 5—6 μ, L/W ratio *c.* 10—20, walls smooth or nearly so. *Branch leaves* spreading, ovate-lanceolate, *c.* 2.8—3.4 by

0.7—1.0 mm, L/W ratio *c.* 2.9—4.6; apex weakly shortly acuminate; marginal teeth mixed, up to 45 μ long, often brown-tipped, geminate teeth often predominating in the distal half of the leaf; costa bearing up to 8 dorsal teeth, excurrent in a brown, serrate, cuspidate point; lamina cells *c.* 55—90 by 4.5—5.5 μ, L/W ratio *c.* 11—19, walls smooth to indistinctly papillate.

Up to *c.* 4 *sporophytes* on each frond. *Female gametoecia c.* 3.5—6.5 mm long. *Ochrea* glabrous or sparingly hairy. *Seta c.* 2.5—3 cm long, usually straight, sometimes flexuose, pale brown to brown. *Theca* erect, straight or nearly so, shortly cylindrical, *c.* 4—5 mm long, shallowly sulcate to almost smooth, not or hardly constricted below the orifice, greyish brown, pale brown, or brown. *Cilia* 2—4. *Operculum c.* 2.5 mm long. *Calyptra* not seen, according to Brotherus (1898) normal.

Distribution: SE. New Guinea, Louisiade Archipelago.

New Guinea. Territory of Papua. Moroko ('Mo-roka'): *Loria 730 p.p.* (GRO, H). Mt. Dayman: *Brass 23078* (FH). Mts. near Mila ('Mita'): *Micholitz 130* (BM, FH, H, K, L, S-PA, W). Cloudy Mts.: *Micholitz 130bis* (GRO, H).

Louisiade Archipelago. Rossel Island. Mt. Rossel: *Brass 28415* (FH, GRO, L, S-PA, US).

Ecology: See under the section; 600—1550 m.

Notes: 1. As a rule, *H. brevipes* forms compact tufts consisting of small often fastigiately branched plants. The stipe leaves are usually wide and broadly rounded at the base and may resemble those of *H. subspininervium*.

2. *H. brevipes* is closely related to *H. reinwardtii*. The vegetative characters of the former have all been found in the latter but never in that specific combination. However, the available collections of *H. reinwardtii* from Eastern New Guinea and those of *H. brevipes* are few in number and partly scanty; they probably do not reflect the total local range of variation. The possibility that intermediate forms will be found in the future is in my opinion unlikely but it may not be excluded and would necessitate the reduction of *H. brevipes* to a local form of *H. reinwardtii*.

3. *Hypnodendron laxum* comprises deciduous plants comparable to the '*gedehense*' plants of *H. reinwardtii* (see note 4 below that species). It has been collected only once, and like '*gedehense*' it was found growing on branchlets. Its stipe leaves hardly differ from the branch leaves. They are widely spreading instead of being recurved, which is normal in sect. *Phoenicobryum*. Only the lowermost stipe leaves of *H. laxum* have the normal *Phoenicobryum* stipe-leaf shape. Very remarkably, the stipe leaves are caducous like the branch leaves, and most stipes of the type specimen are completely defoliate. The branch leaves resemble those of '*gedehense*', but they bear a lower number of dorsal teeth and usually have the costa ending below the leaf apex or percurrent. Deciduous stipe leaves occur in several stipes of *H. brevipes*, but distinct intermediate forms between *H. laxum* and *H. brevipes* have not yet been found. Therefore, the reduction of *H. laxum* remains questionable, as it is based to a large extent on analogy with *H. reinwardtii* and the coinciding distribution of *H. brevipes* and *H. laxum*.

4. As stated under *H. reinwardtii* (note 4) all '*microvagum*' plants from New Guinea completely agree with '*microvagum*' plants collected elsewhere and have been included in that species.

4. Hypnodendron beccarii [Hampe] Jaeger in Jaeger et Sauerbeck (1880) 358; Paris (1895) 603, (1904) 372; Brotherus (1909C) 1169, (1924B) 438; Dixon (1935A) 95, *pro parte*; Bartram (1936B) 240; Dixon (1941) 61; van der Wijk et al. (1962) 532. — *Dendro-*

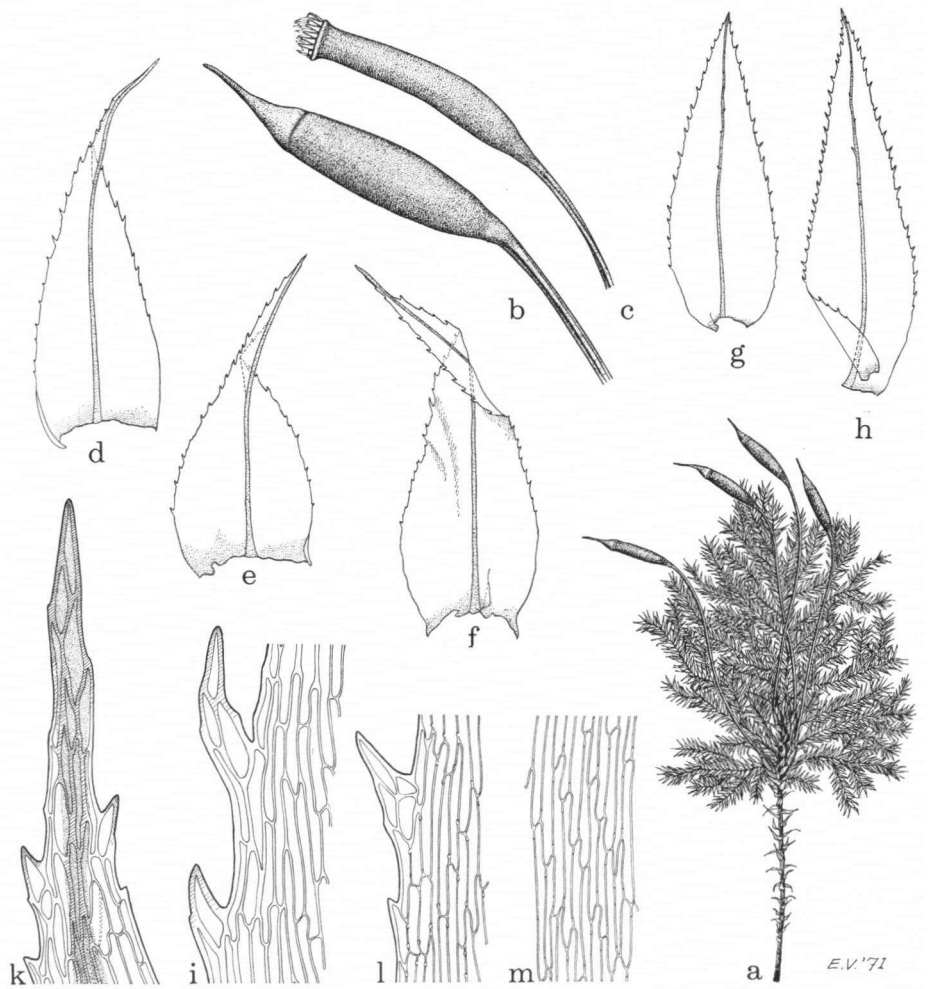

Fig. 10. *Hypnodendron beccarii.* — a: Habit, × 1; b, c: capsules, × 4; d—f: stipe leaves, × 17; g, h: branch leaves, × 17; i: margin of stipe leaf, × 260; k: apex of branch leaf, × 260; l: margin of branch leaf, × 260; m: areolation of branch leaf, × 260. (a, b: *Clemens s.n.*; c: *Clemens 50075*; d, i—m: *Holttum SFN 25347*; e, g: *Beccari 24*; f: *Clemens 40557A*; h: *Kostermans 12863A*).

Hypnum beccarii Hampe (1872) 289, *comb. inval.* — Type: *O. Beccari 24* (BM holo, GRO, L), Borneo, Sarawak, Mt. Poe, 3000—5000 ft. — **Fig. 8, 10.**

Hypnodendron arborescens non (Mitt.) Mitt.: Geheeb (1886) 353.

Hypnodendron reinwardtii non (Schwaegr.) Jaeg.: Mitten et Wright in Stapf (1894) 259; Brotherus (1928) 123.

Plants medium-sized to tall, up to 9(—10) cm long, mostly straw-coloured or golden brown, less frequently pale sordid green or tinged with red, glossy. *Stipe* up to 4.5(—6) cm long. *Frond* broadly ovate to ovate, rather loosely to densely pinnate to bipinnate, 1.5—4.5(—6) cm long; main branches up to 3 cm long, branch tips rounded to weakly

attenuate. *Stipe leaves* squarrose to squarrose-recurved, ovate-oblong, 2.3—3.6 by 1.0—1.2 mm, L/W ratio 2.3—3.2; base mostly hardly narrowed; apex acute to gradually acuminate; margin bearing spinose, brownish, simple teeth which are *c.* 40—60 μ long; costa bearing 0—2 dorsal teeth, cuspidate point smooth to weakly serrate; lamina cells 60—115 by (3.5—)5—7 μ, L/W ratio *c.* 12—22(—30), walls smooth to mamillate or distinctly papillate. *Branch leaves* spreading, ovate-lanceolate, 2.2—3.5 by 0.6—1.0 mm, L/W ratio 3.0—4.5; apex acute; margin bearing spinose simple teeth which are *c.* 40—75 μ long; geminate teeth rarely present and very few in number; costa bearing 4—8 dorsal teeth, mostly excurrent in a smooth cuspidate point, less frequently percurrent only; lamina cells 50—105 (—120) by 3.5—5.5 μ, L/W ratio *c.* 10—18 (—30), walls strongly papillate to mamillate or smooth.

Up to *c.* 4 *sporophytes* on each frond. *Female gametoecia c.* 5—6.5 mm long. *Ochrea* glabrous to very sparingly tomentose. *Seta* 3—4.5 cm long, arcuate to straight, orange to red or dark brown. *Theca* mostly inclined, occasionally suberect, straight to weakly curved, cylindrical, 5—8 (—9.5) mm long, smooth to faintly angular, exceptionally shallowly sulcate in its distal part, mostly distinctly constricted below the orifice, pale brown to orange or dark brown. *Cilia* 2—4. *Operculum c.* 3—4.5 mm long. *Calyptra c.* 4.5—5.5 mm long.

Distribution: Borneo.

Borneo. Sabah: *Burbidge s.n.* (BM, FH, K, NY); *Meijer B 12268* (L). Mt. Tambuyokon: *Meijer B 11185* (L), *B 11334* (L). Mt. Kinabalu: 30 collections. G. Lumaku: *Wood 1694* (GRO). — Sarawak: *Brooks 43* (BM); *Everett s.n.* (SING). G. Murud: *Paie S 26436 p.p.* (L). G. Dulit: *Richards M 1785* (BM, FH, GRO, L). Mt. Poi: *Beccari 24* (BM, GRO, L); *Everett 47* (H). — Indonesian Borneo. G. Kemul: *Endert 4296* (BM, NICH). G. Palimasan near Tabang: *Kostermans 12863A* (L). Bt. Mulu: *Winkler 3057* (H), *3061* (H). Bt. Antara: *Amdjah s.n.* (FH, L). Bt. Batu Lesung: *Amdjah 476* (FH, GRO, H, L, NY).

Ecology: See under the section; (600—) 1100—2500 m.

Notes: 1. The most striking features of *H. beccarii* are its simple marginal teeth which are longer than in the other species of sect. *Phoenicobryum*, and its usually smooth, inclined, and often vividly coloured capsules borne on short setae. Specimens with geminate teeth are very scarce, and the geminate teeth are few in number. Capsules as described for *H. beccarii* also occur in *H. subspininervium*, and small bipinnate specimens of *H. beccarii* may resemble *H. subspininervium* ssp. *arborescens*. They can be recognized, however, by the shape and size of the leaves and the very long simple teeth. *H. brevipes* occasionally has nearly smooth capsules but the capsules are shorter and erect and the seta is even shorter than in *H. beccarii*. Though *H. brevipes* resembles *H. beccarii* vegetatively, it differs greatly in usually having very narrowed stipe leaves and short marginal teeth, many of which are geminate.

2. The stipe leaves are usually hardly narrowed at the base. Such leaves occur in *H. reinwardtii* as well, though less frequently. Shallowly sulcate capsules have been found in specimens collected before the capsules had become fully mature. The type collection contains one such open capsule together with a number of very young ones.

3. In Borneo several small deciduous plants have been collected corresponding with *H. microvagum* (see note 4 below *H. reinwardtii*). Whether these belong to *H. beccarii* or *H. reinwardtii* is not certain. One sample (*Holttum SFN 25682*) contained '*microvagum*' plants together with normal plants of both species. As stated before, the Bornese '*microvagum*' plants closely agree with those from other islands. Forms intermediate between *H. microvagum* and *H. beccarii* are unknown.

4. Dixon (1935A) mentioned sterile Philippine plants that might belong to *H. beccarii*.

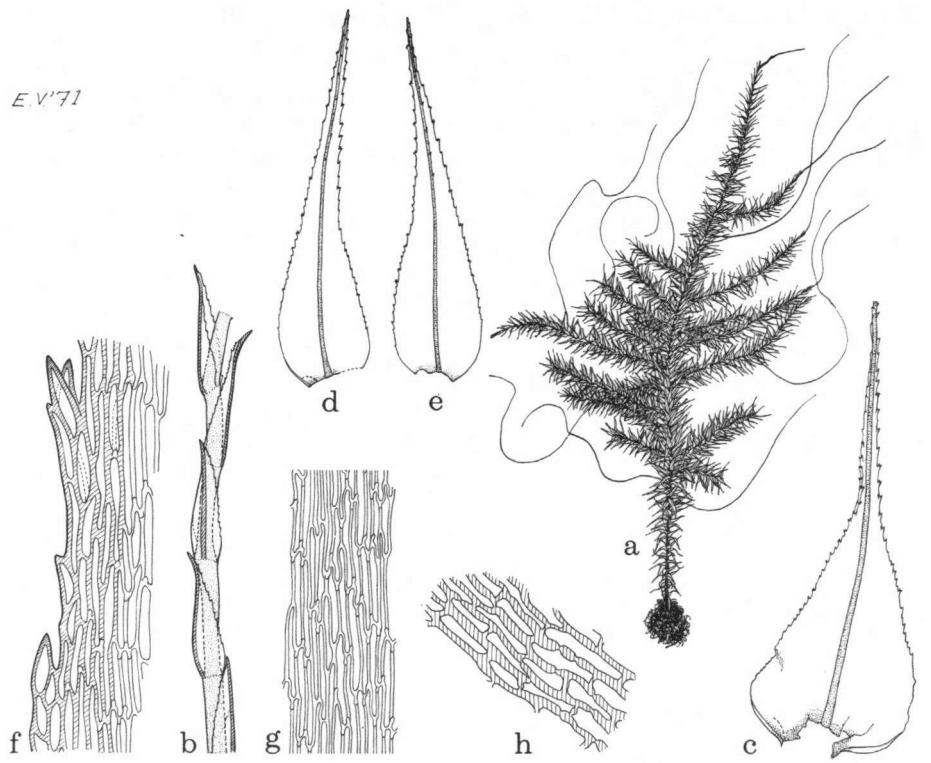

Fig. 11. *Hypnodendron flagelliferum.* — a: Habit, × 1; b: detail of flagellum, × 40; c: stipe leaf, × 17; d, e: branch leaves, × 17; f: margin of stipe leaf, × 260; g: areolation of branch leaf, × 260; h: basal cells of stipe leaf, × 260. (a: *Gunn 689;* b—h: *Gunn 746*).

As these collections have not been specified it is impossible to give any further comments on them. I suppose they belong to *H. reinwardtii* ssp. *caducifolium*, as forms of *H. beccarii* with attenuate branches resemble that subspecies in general aspect.

5. Hypnodendron flagelliferum Brotherus et Watts (1915) 165; Brotherus (1925) 531; van der Wijk et al. (1962) 533. — Syntypes: *W. Gunn 746* (H lecto, BM, L), New Hebrides, Aneityum; *W. Gunn 144=689* (H), *402* (H), *417* (H), all from the same locality. **— Fig. 8, 11.**

Plants medium-sized to tall, up to *c.* 9 cm long, pale yellowish green, turning dark rusty brown with age, somewhat glossy. *Stipe* up to *c.* 3.5 cm long. *Frond* weakly differentiated, rather loosely pinnate, *c.* 2—6 cm long; branches up to *c.* 3.5 cm long, widely spreading, flexuose, often tapering finely to an up to *c.* 5 cm long microphyllous flagellum; side branches mostly flagelliform. *Stipe leaves* squarrose to squarrose-recurved, triangular-ovate-oblong, *c.* 3.3—3.5 by 1.1—1.3 mm, L/W ratio *c.* 2.7—2.9; base broadly rounded to cordate; apex gradually to abruptly narrowed to a long subula; margin bearing a mixture of simple and geminate teeth which are up to *c.* 25 μ long; costa bearing *c.* 4 dorsal teeth; lamina cells *c.* 30—70 by 2—3.5 (—5) μ, L/W ratio *c.* 13—20, walls papillate, strongly to extremely incrassate, often wider than the ± vermicular lumen, porate at their ends.

Branch leaves spreading, gradually becoming appressed along the flagella, ovate-lanceolate, *c.* 2.8—3.2 by 0.6—0.8 mm, L/W ratio *c.* 3.9—4.3; base rounded; apex narrow, often twisted when dry, gradually acuminate; margin bearing geminate teeth mixed with a smaller number of simple ones which are up to *c.* 27 μ long; costa bearing *c.* 7—10 dorsal teeth which occasionally are geminate and are often mixed with a few additional small teeth, excurrent in a strong, serrate, brownish, cuspidate point; lamina cells *c.* 45—85 by 2.5—4 (—5) μ, L/W ratio *c.* 15—25; walls strongly papillate, moderately to extremely incrassate. *Flagella* very brittle, bearing appressed, minute, crenulate to serrulate, ovate-lanceolate leaves measuring *c.* 0.5—0.6 by 0.1 mm.

Sporophytes unknown.

Distribution: New Hebrides (Aneityum), Fiji (?).

New Hebrides. Aneityum: *Gunn 144* = *689* (H), *402* (H), *417* (H), *689* (H), *746* (BM, H, L). Fiji. *Unknown coll. s.n.* (NY).

Ecology: No data available.

Notes: 1. Widely different from all other *Hypnodendraceae* by the presence of long microphyllous flagella, which in all probability serve as means of vegetative propagation. Furthermore deviating from the other species of sect. *Phoenicobryum* in having cordate stipe leaves and very narrow cells. Narrowly acuminate leaves have also been found in specimens belonging to *H. reinwardtii* ssp. *caducifolium*.

2. Of the present species only the cited syntypes from Aneityum and one additional collection in Mitten's herbarium which is said to have been collected in Fiji are known. The name of the collector of these Fijian plants is unknown. They were found in a wrapper containing *H. samoanum* Mitt., and are not given in Mitten's (1873A) contribution to Seemann's 'Flora Vitiensis'. The occurrence of *H. flagelliferum* in Fiji seems rather unlikely, as such a peculiar and conspicuous plant could hardly have been overlooked by other collectors. The specimen might have been collected in Aneityum by Milne, who visited both Fiji and Aneityum in 1854 during his voyage in the 'Herald'.

Sect. Leiocarpos

(Dix.) Touw, *stat. nov.* — *Hypnodendron* Lindb. *ex* Mitt. subg. *Leiocarpos* Dixon (1922) 495; Brotherus (1925) 531. — Type species: *Hypnodendron auricomum* Broth. et Geh.

Plants medium-sized to tall, obliquely projecting from the substrate or erect. *Distal innovations* absent or simple and weak. *Stipe* tomentose at base only, exceptionally upwards bearing a few scattered tufts of tomentum. *Pseudoparaphyllia* inconspicuous, sparse or absent, appressed. *Frond* mostly palmate; branches often more or less complanate. *Stipe leaves* appressed, imbricate, completely covering the stipe, broadly ovate to ovate-oblong; insertion line straight or nearly so; base ± not to weakly narrowed, not decurrent; apex acute to shortly acuminate; margin plane, mostly coarsely serrate; costa rather ill defined, narrow to wide, percurrent to shortly excurrent; lamina cells papillate; walls of basal cells strongly incrassate, porate, often orange; alar cells not differentiated. *Branch leaves* isomorphous or nearly so, ovate to ovate-oblong; base broadly rounded; apex acute; margin flat, coarsely serrate; costa strong, ending in apex to percurrent; areolation as in the stipe leaves.

Male gametoecia scattered. Inner *perichaetial leaves* more or less plicate. *Theca* smooth or nearly so, inclined to horizontal. *Spores* 20—35 μ. *Operculum* usually weakly rostrate, apex acute or bluntish.

Distribution: See under the species.

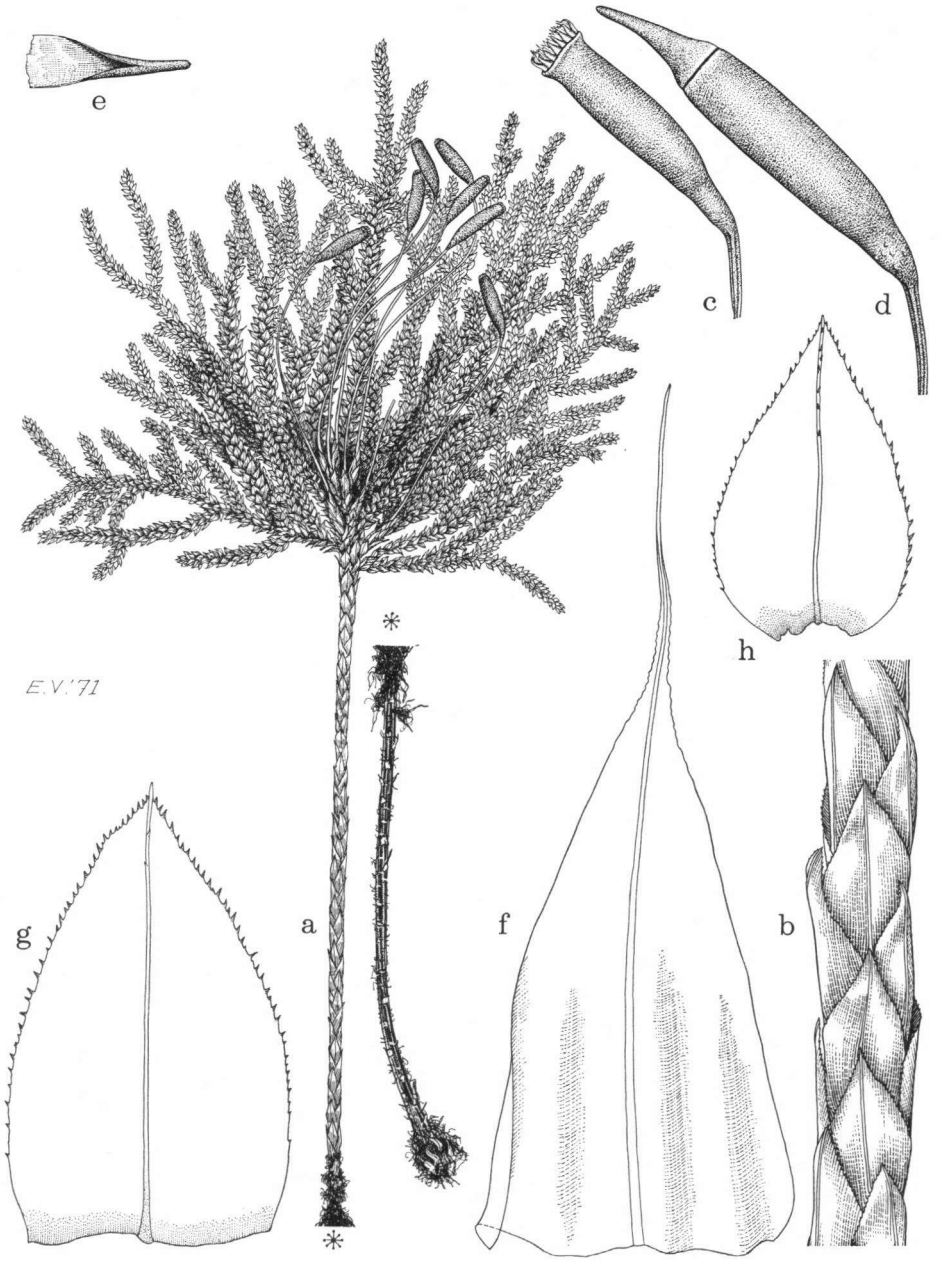

Fig. 12. *Hypnodendron auricomum* ssp. *auricomum*, subalpine form. — a: Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e: calyptra, × 4; f: perichaetial leaf, × 17; g: stipe leaf, × 17; h: branch leaf, × 17. (a, b: *Schodde 1809;* c—e: *van Balgooy 760;* f—h: *van Balgooy 757*).

6. Hypnodendron auricomum Broth. et Geh.—**Fig. 12—14.**

For synonyms, literature, and type specimens see under the subspecies.

Plants up to 16 (—24) cm long, golden green to yellowish green or sordid green, somewhat glossy. *Stipe* up to 11 (—19) cm long. *Frond* up to 9 cm across, mostly palmate, less often pinnate, occasionally subumbellate or umbellate, ovate to broadly ovate, occasionally circular; branches mostly remotely branched. *Stipe leaves* 3.0—4.7 by 1.1—2.5 mm, L/W ratio (1.3—) 1.6—2.9; marginal teeth simple, mostly orange- or brown-tipped, up to 50 (—80) μ long (occasionally much smaller); costa bearing 0—2 (—4) dorsal teeth; lamina cells (40—) 50—120 (—145) by (3.5—) 5—7.5 (—10) μ, L/W ratio *c.* 10—20, walls incrassate, distinctly or indistinctly papillate. *Branch leaves* mostly weakly complanate, 2.0—3.0 (—3.9) by 0.8—1.8 mm, L/W ratio 1.4—3.1; margin coarsely serrate as in the stipe leaves, teeth simple, up to 45 (—60) μ long, occasionally mixed with geminate ones; costa bearing up to 6 (—8) dorsal teeth; lamina cells (20—) 25—55 (—70) by 4—7.5 μ, L/W ratio *c.* 4—11, walls more or less papillate.

Up to 11 (—18) *sporophytes* on each frond. *Seta* 2.5—3.5 (—4.5) cm long, occasionally shorter, arcuate to straight, brownish red, becoming pale brown to blackish with age. *Theca* straight or weakly curved, cylindrical, (6—) 8—10 (—12) mm long, brownish red, becoming pale brown to blackish with age, smooth or when empty very weakly striate, constricted below the orifice. *Cilia* 3 (—5). *Operculum* *c.* 3.5—4 mm long. *Calyptra* *c.* 4.5—6 mm long.

Distribution: Sumatra, Java, Celebes, Ceram, New Guinea, Solomon Islands.

Ecology: See under the subspecies.

Notes: 1. *Hypnodendron auricomum* is a very variable species as may be inferred from its synonymy. Best known is the variability of the New Guinea plants, of which many often very rich collections are available. Unfortunately, the collections from other islands invariably are few in number and usually consist of only a few plants. The available data seem to indicate that in Sumatra and Celebes a variation can be expected which is similar to that described from New Guinea under ssp. *auricomum*.

2. Occasionally, dwarfed plants which deviate rather strongly from the normal ones have been found. They appear to grow almost exclusively epiphytically in montane forests (1300—2500 m) and have once been gathered together with a comparable form of *H. diversifolium*. These plants are extremely small and often have very fragile branch leaves which are narrower than is usual. The lamina cells in the apical part of the stipe leaves are very coarsely mamillate-papillate. These papillae are often confluent and give the leaf a strongly verrucose or rugose appearance. Sporophytes are rare and very small. Such dwarfed plants have been found in Sumatra, Java, New Guinea, and Guadalcanal. In New Guinea and Guadalcanal they have been found mixed with somewhat taller plants belonging to the montane form of *H. auricomum* ssp. *auricomum*, and in such samples transitional forms have been found as well. *H. opacum* Fleisch. from Sumatra and Java is almost identical with these dwarfed forms from New Guinea but its stipe leaves have longer dark coloured teeth. From this analogy I presume *H. opacum* represents a dwarfed form of the West Malesian subspecies of *H. auricomum*. Unfortunately, the available specimens do not show the differential characters, as the marginal teeth are all simple, and sporophytes have not yet been found.

KEY TO THE SUBSPECIES

1. Marginal teeth mixed; spores rather coarsely papillate . . . . . ssp. **opacum**
1. Marginal teeth always simple; spores minutely papillate 2

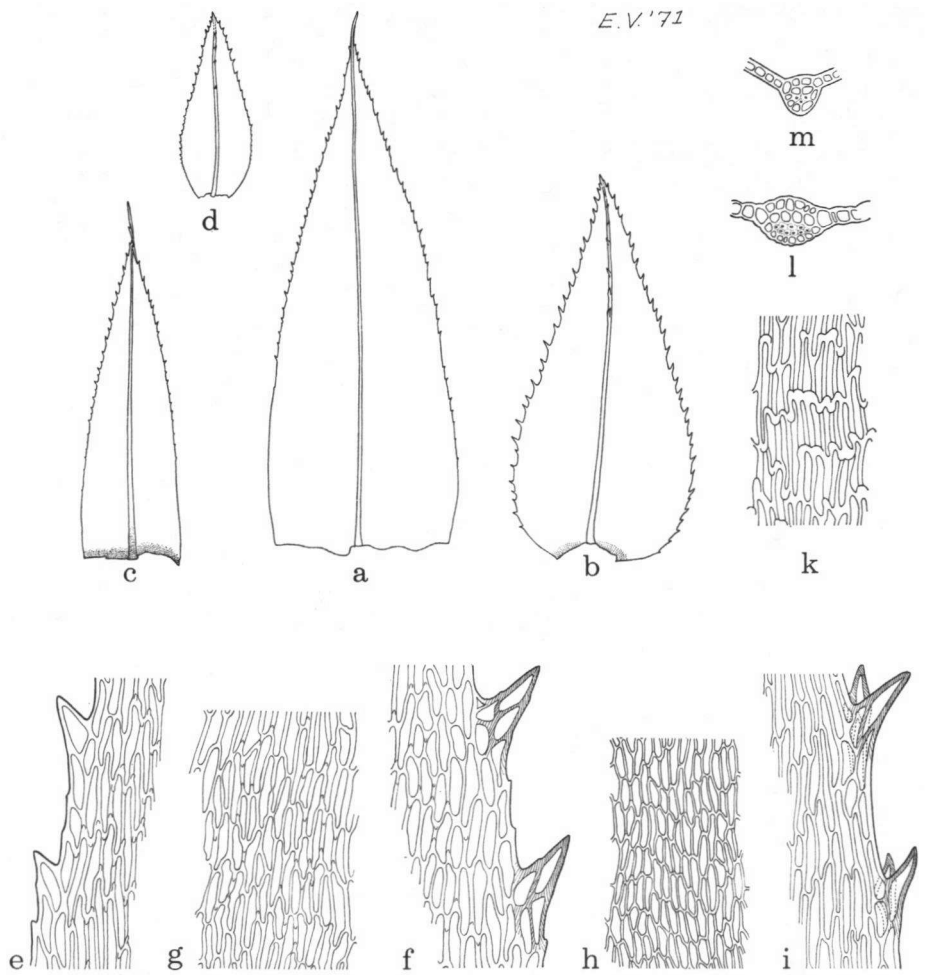

Fig. 13. *Hypnodendron auricomum*. a, b, e: ssp. *auricomum*, montane form; f, g, l, m: id., subalpine form; c, d, h, i, k: ssp. *opacum* (all: dwarfed form, except i). — a, c: Stipe leaves, × 17; b, d: branch leaves, × 17; e, f, i: margins of branch leaves, × 260; g, h: areolation of branch leaves, × 260; k: areolation of stipe leaf, × 260; l, m: cross sections of costae of branch leaves, × 260. (a, e: *Carr 14184;* b: *Robbins 531;* c, d, h, k: *Fleischer s.n.;* f: *van Balgooy 757;* g: *Vink & Schram BW 8982;* i: *Schiffner 12487;* l, m: *van Balgooy 760*).

2. Frond in well developed specimens ± radial, subumbellate to umbellate; female gametoecia clustered in the centre of the frond . . . . . ssp. **celebensis**
2. Frond unilateral, palmate or pinnate; female gametoecia scattered . . . . . ssp. **auricomum**

a. ssp. **auricomum.** — *Hypnodendron auricomum* Brotherus et Geheeb (1898) 190; Paris (1900) 191, (1904) 372; Brotherus (1909C) 1169; Fleischer (1917) 34; Dixon (1922) 495; Brotherus (1924B) 438, (1925) 531; Herzog (1926A) 339; Bartram (1942) 264, (1957A) 40, (1959) 90, (1962) 192; van der Wijk et al. (1962) 532; Schultze-Motel (1963) 442; Bartram

(1965) 52. — Type: *W.E.M. Armit 622* (H holo, *pro parte*; JE, K, L, S-PA), New Guinea, Mt. Dayman.

Hypnodendron macrocarpum Herzog (1916) 241, (1919) 293; Dixon (1922) 510; Brotherus (1924B) 438; Herzog (1926B) 353; van der Wijk et al. (1962) 533. — Syntypes: *E. Stresemann 240* (JE lecto, GRO, L), Central Ceram, G. Binaija, *c.* 2530 m; *id. 296* (BO, L), same locality, *c.* 2530—2750 m.

Sciadocladus novae-guineae Dixon *ex* Dixon (1943A) 34, (1939) 53, *nom. nud., excl. spec.*, (1942A) 9, *nom. nud.*; Bartram (1945) 115, (1953) 399. — *Hypnodendron novae-guineae* Bartram (1957A) 41, (1962) 193; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443; van Zanten (1964) 291; van der Wijk et al. (1969) 699. — Type: *C.E. Carr 14184*= *Musci Sel. Crit. 243* (BM holo, BO, FH, GRO, JE, K, L, MO, NY, S-PA, US, W), New Guinea, Alola above Port Moresby, corticolous in mountain forest, 6000 ft.

Sciadocladus wisselii Dixon (1943A) 34; Schultze-Motel (1963) 441; van der Wijk et al. (1967) 371, (1969) 893. — Type: *F.J. Wissel 138* (BM holo, BO, GRO, L), New Guinea, Mt. Carstensz, Grasbergen and rintis near Dajakweide, 3800—4300 m.

Hypnodendron climacioides Noguchi (1953) 12, f. 6; Bartram (1957A) 40; van der Wijk et al. (1962) 532; Schultze-Motel (1963) 442; van der Wijk et al. (1969) 699. — Type: *M.S. Clemens s.n.* (TNS holo, not seen), New Guinea, Mt. Sarawaket, in mossy bush, 11000—12000 ft.

Hypnodendron chalmersii non Mitt.: Herzog (1926A) 339.

Hypnodendron reinwardtii non (Schwaegr.) Jaeg.: van Zanten (1964) 292, *pro parte.*

Plants medium-sized to very tall. *Frond* palmate to pinnate. *Stipe leaves* 3.0—4.7 by 1.5—2.5 mm, L/W ratio (1.3—) 1.6—2.9. *Branch leaves* 2.0—3.0 by 1.0—1.8 mm, L/W ratio 1.4—2.2. *Marginal teeth* of stipe leaves and branch leaves simple. *Spores* minutely papillate.

Distribution: Ceram, New Guinea, Solomon Islands (Guadalcanal).

Ceram. G. Binaija: *Stresemann 240* (GRO, JE, L), *296* (BO, L).

New Guinea. West New Guinea. Wissel Lakes, Pèkèglbaro: *Vink & Schram BW 8982* (L). Mt. Carstensz: *Kloss 38* (BM), *41* (BM); *Wissel 138* (BM, BO, GRO, L). Mt. Hellwig: *Pulle 717* (BO, GRO, K, L). Lake Habbema: *Brass 9382* (BO, FH, GRO), *9493* (BO, FH, L), *10696* (BO, FH). Bele R.: *Brass 11281* (BO, FH). Orion Mts., Tenmasigin: *van Zanten 311* (GRO, L). Star Mts., Mt. Antares: *van Zanten 452a* (GRO, L), *503c p.p.* (L). — Territory of New Guinea. Wabag Subdistrict: *Hoogland & Schodde 6882* (CANB, FH). Yaki R.: *Hoogland & Schodde 6912* (CANB, FH). Laiagam: *Robbins 3359* (CANB, FH). Sirunki: *Robbins 3137* (CANB, FH). Wapenamanda: *Robbins 2804* (CANB, FH). Mt. Sugarloaf: *Robbins 2777* (CANB, FH). Mt. Hagen: 9 collections. Tomba: *Robbins 12* (CANB, FH, L); *van Zanten 683249* (GRO, L). Mt. Hagen Village: *van Zanten 68851* (GRO, L), *68853A* (GRO), *68872* (GRO, L). Nondugl: *Gyldenstolpe 22* (FH, S-PA). Kubor R.a.: *Robbins 531* (CANB, FH, L), *5038* (CANB, L), *5262* (CANB, L). Mt. Wilhelm: 24 collections. Pengagl Creek: *Millar NGF 23207* (L). Mt. Otto: *Brass 31112* (FH, L, S-PA), *Robbins 852* (CANB, FH, L). Kotuni: *McKee 1538* (FH). Marafunga: *Sleumer 4613* (L). Daulo Pass: *van Zanten*, 5 collections (GRO, L). Kainantu, Waisa: *Eddy*, 7 collections (BM). Finisterre Ra.: *Eiffert 46* (JE). Ibid., Moro: *Eddy 1102 p.p.* (BM), *1119* (BM). Ibid. Abilala: *Eddy 1238* (BM), *1239* (BM, L), *1261 p.p.* (BM, L). Ibid., Freybourg Pass: *Eddy 1309* (BM). Mt. Elandora: *Eddy 2077 p.p.* (BM). Saruwaged Ra., Bolan: *Keysser s.n.* (BM). Edie Creek: *Eddy 26* (BM), *172* (BM, L). Boana: *Clemens s.n.* (FH). Sarawaket Ra., Gimdoh: *Hoogland 9963* (CANB, L). — Territory of Papua. Ibiwara: 6 collections. Mt. Ne: *Kalkman 4864* (L), *4865* (L), *4935* (L). Mt. Ambua: *Kalkman 5101* (L). Mt. Giluwe: *McVean 267299* (L); *Schodde 1809* (BO, CANB, FH, L, MEL); *van Zanten 683292* (GRO, L), *683438* (GRO, L), *683510* (GRO, L). Alola: *Carr 14184* (BM, BO, FH, GRO, JE, K, L, MO, NY, S-PA, US, W). Moroko ('Mo-roka'): *Loria 730B p.p.* (BM, S-PA). Mt. Dayman: *Armit 622 p.p.* (H, JE, K, L, S-PA); *Brass 22335 p.p.* (FH), *22479* (FH). — Goodenough Island: *Brass 24733* (FH, L).

Solomon Islands. Guadalcanal. Mt. Popomanasiu: *van Zanten 682558* (GRO, L).

Ecology: On decaying logs, terrestrial on soil rich in humus, on humus covered rocks, and low on trees; in forests and shrubberies. (800—) 1500—4000 m; most gatherings have been collected at 2000 m at least.

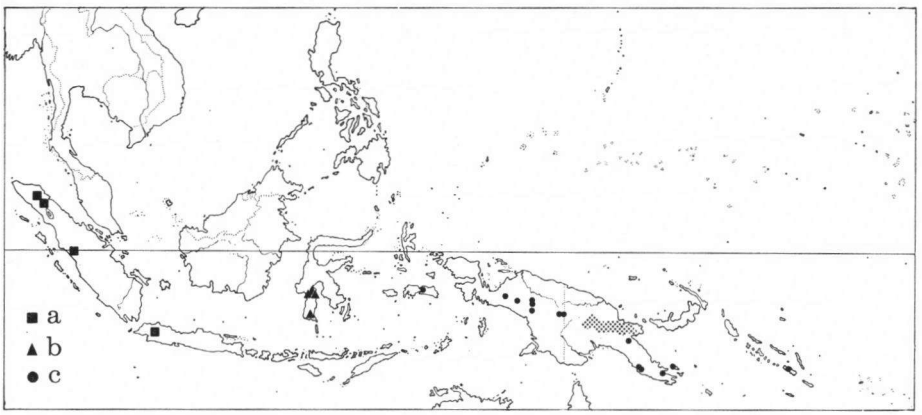

Fig. 14. Distribution of *Hypnodendron auricomum* ssp. *opacum* (a), ssp. *celebensis* (b), and ssp. *auricomum* (c and shaded area).

N o t e s: 1. The present subspecies shows altitudinal variation in many characters and can be divided arbitrarily into three forms which gradually pass into one another and show some overlap in altitudinal distribution. As these forms are by no means sharply defined and presumably are only phenotypic modifications they have not been given nomenclatural status.

a. *high subalpine form: c.* 3200—4000 m. Plants tall to very tall; frond compact, mostly wider than long. Stipe leaves yellowish green to orange green, broadly ovate, up to *c.* 4.0 by 2.0—2.5 mm; apex abruptly narrowed; teeth very strong; lamina cells *c.* 50—100 μ long. Branch leaves often somewhat homotropous. Seta 2.5 cm long at least. To this form belong the types of *H. climacioides*, excellently described and illustrated by Noguchi (1953), and *Sciadocladus wisselii*.

b. *low subalpine form: c.* 2400—3200 (—3600) m. Plants medium-sized to tall; frond loose to compact. Stipe leaves yellowish green, ovate, up to *c.* 4.0 by 2.0 mm; apex gradually narrowed; teeth and areolation as in the preceding form. Branches distinctly complanate, leaves hardly or not at all homotropous. Seta 2.5 cm long at least. Here belongs the type of *H. auricomum*.

c. *montane form: c.* (800—) 1500—2400 m. Plants small to medium-sized; frond loosely pinnate, mostly distinctly longer than wide. Stipe leaves pale green to colourless, ovate-oblong, mostly over 4 mm long and 1.5—2.0 mm wide; apex gradually narrowed; teeth varying from very short to very long (*c.* 15—80 μ); lamina cells *c.* 70—120 μ. Branches distinctly complanate, leaves never homotropous. Sporophytes sometimes poorly developed; seta often shorter than 2.5 cm. Nearly always epiphytic or growing on decaying logs. The type specimen of *Sciadocladus novae-guineae* belongs to the present form. The deciduous dwarfed plants described under the species (note 2) appear to represent a very poor extreme of it.

The montane form itself appears to represent a more or less depauperate form of the subspecies, which is optimally developed in the subalpine zone. As *H. auricomum* ssp. *auricomum* has been found only in mountain complexes which are 2500 m high at least, one might even wonder whether the montane zone belongs to the area of permanent establishment of the subspecies.

2. The degree of papillosity of the leaf cells is very variable. As a rule the papillae

are well developed at the dorsal side of the distal part of the leaf. However, in some plants the leaves appeared completely smooth, whereas dwarfed plants may have strong papillae borne on mamillate cell apices. The pustules on the apophysis are most prominent in empty capsules. In young ones the apophysis may appear smooth, as has been noted by Bartram (1957A). Empty capsules sometimes are superficially ribbed when dry, but upon moistening appear completely smooth.

3. The holotype of *H. auricomum* consists of specimens of *H. auricomum* and *H. junghuhnii* glued to a single sheet. The isotypes investigated all belong to the former, and the diagnosis of the species was also based on plants belonging to *H. auricomum* alone.

4. Bartram (1957A) had already noted the close affinity between *Hypnodendron auricomum* and *Sciadocladus novae-guineae* but has maintained both as species because of a difference in the shape of the leaf apex and the denticulation of the stipe leaves. However, these characters are unfit for use as they have been found in both 'species'.

5. Noguchi (1953) compared his new species *H. climacioides* with a collection Brotherus had named *H. auricomum*. Judging from Noguchi's notes this unspecified reference collection belongs to either *H. junghuhnii* or *H. vitiense*. This view is supported by the presence of specimens of *H. vitiense* in Brotherus's herbarium, which he had identified as *H. auricomum*. Reduction of *H. climacioides* has already been suggested by Bartram (1957A).

6. According to Kreulen (in print) some capsules of plants belonging to the present subspecies contained *c.* 1,500,000 spores each.

b. ssp. **celebensis** (Dix.) Touw, *stat. nov.* — *Sciadocladus celebensis* Dixon (1934A) 28, (1934B) 161; van der Wijk et al. (1967) 371. — Type: *G.K. Kjellberg 104M* (BM holo, BO, FH, S-PA), Celebes, Bt. Poka Pindjang, 2000 m.

Hypnodendron junghuhnii non (C. Muell.) Jaeg.: Dixon (1934A) 28.

Plants medium-sized. *Frond* (in well developed plants) subumbellate to umbellate. *Stipe leaves c.* 3.0—4.3 by 1.1—2.3 mm, L/W ratio *c.* 1.8—2.7; apex distinctly shortly acuminate; marginal teeth *c.* 25—50 (—80) μ long. *Branch leaves c.* 2.1—2.4 by 0.8—1.4 mm, L/W ratio *c.* 1.7—2.8. Marginal teeth of stipe leaves and branch leaves simple. *Spores* not seen.

Distribution: Celebes.

Celebes. Southwest Peninsula. Rante Lemo: *Kjellberg 95M* (BM, BO, FH, GRO, S-PA). Bt. Poka Pindjang: *Kjellberg 104M* (BM, BO, FH, S-PA). Bt. Rante Mario: *Eyma 808* (BO, GRO, L). G. Lompobattang (= Peak of Bonthain): *Binnemeyer 11879* (BM, BO, L); *Prince Leopold 6* (BM); *Warburg s.n.* (BM, FH, GRO, L, NY).

Ecology: Almost unknown; 1500—3000 m? (four reports).

Note: Very close to ssp. *auricomum* but differing in having ± umbellate fronds, which make the plants resemble very tall *H. fusco-mucronatum*. Juvenile and small (poor?) specimens have pinnate fronds and are indistinguishable from comparable plants belonging to ssp. *auricomum*.

c. ssp. **opacum** (Fleisch.) Touw, *stat. nov.* — *Hypnodendron opacum* Fleischer (1923) 1610; Brotherus (1925) 531; van der Wijk et al. (1962) 533. — Type: *M. Fleischer s.n.* (FH holo, BM, L), West Java, G. Gedeh, mountain forest near Tjibodas, 1500 m.

? *Hypnodendron sumatranum* Baumgartner in Froehlich (1953) 84; van der Wijk et al. (1962) 534. — Type: *V. F. Schiffner 12487* (W holo, not seen, GRO), Sumatra, G. Singgalang, *c.* 2360 m.

? *Sciadocladus novae-guineae non* Dix. *ex* Dix.: Dixon (1939) 53, (1943A) 34, *excl. type.*

Description based on specimens of *H. sumatranum*:

Plants medium-sized. *Frond* palmate to pinnate. *Stipe leaves c.* 3.1—4.0 by 1.4—2.0 mm, L/W ratio *c.* 2.2—2.4. *Branch leaves c.* 2.8—3.9 by 0.9—1.6 mm, L/W ratio *c.* 2.4 —3.1. *Marginal teeth* of stipe leaves and branch leaves predominantly simple, mixed with a number of geminate teeth, often blackish. *Spores* rather coarsely papillate.

Distribution: Sumatra, Java.

SUMATRA. Atjeh. G. Lembu: *van Steenis 10201* (BM, BO, GRO, L). — East Coast. Dg. Salit = Tongkeh: *Staal 340* (GRO, *'opacum'*). — West Coast. G. Singgalang: *Schiffner 12487* (GRO).
JAVA: *unknown coll. s.n.* (K, *'opacum'*). — West Java. G. Gedeh: *Fleischer s.n.* (BM, FH, L, *'opacum'*).

Ecology: Almost unknown; 1300—3000 m (four reports).

Notes: 1. *Hypnodendron sumatranum* and the Sumatran plants Dixon identified as *Sciadocladus novae-guineae* are undoubtedly identical, but *Hypnodendron opacum* differs widely from them. The reasons why it has been united here with the first mentioned species have been given in note 2 under the species.

2. Well developed specimens of ssp. *opacum* are very distinct in having dark coloured and partly geminate teeth. The spores appear to be more coarsely papillate than in ssp. *auricomum* but they have been observed only once. The often very long branch leaves form an additional character on which, however, not too much value can be set at present as the leaf size and shape are very variable in *H. auricomum*, and only a very few specimens of ssp. *opacum* could be investigated.

Sect. Sciadocladus

(Kindb.) Touw, *stat. nov.* — *Sciadocladus* Lindb. *ex* Kindberg (1899) 393; Lindberg (1861) 374, *nom. nud.*; Jaeger in Jaeger et Sauerbeck (1880) 360; Brotherus (1909C) 1167; Fleischer (1923) 1600; Brotherus (1924B) 435; Dixon (1929) 340; Sainsbury (1955B) 315. — *Sciadocladus* sect. *Eu-Sciadocladus* Brotherus (1909C) 1168, *nom. illeg.*, (1924B) 436. — Type species: *Hypnum menziesii* Hook.

Sciadocladus Kindb. sect. *Pseudo-Hypnodendron* Brotherus (1909C) 1168, (1924B) 436. — Type species: *Trachyloma kerrii* Mitt.

Plants erect, medium-sized to tall, glossy. *Distal innovations* absent to strongly developed. *Stipe* tomentose at base only, soon becoming defoliate below. *Pseudoparaphyllia* inconspicuous, appressed, sparse or absent. *Frond* mostly umbellate; branches mostly weakly or not at all complanate. *Stipe leaves* patent to squarrose-recurved, often concave, broadly ovate, pale sordid green to brownish or colourless, very fragile and soon decaying; insertion line concave to almost straight; base broadly rounded to broadly cordate, often shortly decurrent; apex usually abruptly narrowly acuminate; margin at the leaf base flat or recurved, entire or nearly so, near apex faintly crenulate to serrulate, occasionally bearing a few large simple teeth; costa thin and narrow, ending in apex to long-aristate, dorsal teeth absent; lamina cells almost smooth to rather coarsely papillate; basal cells extremely incrassate, porate, orange, in decurrent leaves forming a large alar group. *Branch leaves* isomorphous or nearly so, erecto-patent, sometimes complanate, concave, ovate to ovate-oblong, very fragile; apex acute to apiculate, acumen recurved; margin near base entire to faintly crenulate, upwards coarsely serrate with simple teeth; costa thin and narrow, excurrent, more or less carinate-serrate dorsally; areolation as in the stipe leaves, but basal cells less strongly differentiated.

Male gametoecia scattered. *Inner perichaetial leaves* deeply plicate. *Theca* smooth, horizontal or pendulous, not or very weakly constricted below the orifice. *Spores* 15—25 μ. *Operculum* conical to very shortly and bluntly rostrate.

Distribution: Solomon Islands, New Caledonia, Norfolk Island (?), New Zealand, Tasmania (?).

Ecology: Terrestrial and on decaying logs, less often on soil covered rocks and tree bases; in rain forests.

Note: Small plants sometimes have pinnate fronds, and have occasionally been confused with *H. arcuatum*.

7. Hypnodendron menziesii (Hook.) Par. — **Fig. 15, 16.**

For synonyms, literature, and type specimens see under the subspecies.

Plants up to 17 cm long ,yellowish green to sordid green. *Stipe* up to 6 (—11) cm long. *Frond* up to 4.5 (—8) cm across, dense, umbellate, occasionally palmate or subumbellate, often bearing 1—3 (—8) tiers of strong *distal innovations*; main branches pinnate to partly bipinnate, apex rounded. *Stipe leaves* 2.1—3.7 by 1.0—1.9 mm, L/W ratio 1.6—2.5; base decurrent; margin near base recurved, upwards flat, crenulate to serrulate, occasionally bearing a few large teeth near the base of the acumen; cells 35—85 by 5 μ, L/W ratio *c.* 7—18, almost smooth to papillate, basal cells forming a large alar group at the decurrent leaf angles. *Branch leaves* along the ultimate branches often distinctly arranged in five rows, (1.8—) 2.0—2.9 by 0.7—1.3 mm, L/W ratio 1.9—2.6; base broadly rounded; apex often truncate, shortly apiculate or aristate, acumen *c.* 0.15—0.5 mm long; costa mostly excurrent, occasionally ending in apex, bearing *c.* 4—13 strong dorsal teeth mixed with some much smaller ones; lamina cells 30—85 by 3—4.5 (—5) μ, L/W ratio *c.* 8—20, bearing short papillae to almost smooth.

Up to 3 (—11) *sporophytes* on each frond. *Seta* (3.5—) 5—7.5 (—9.5) cm long, straight to somewhat flexuose, red, distally yellowish red. *Theca* erect to inclined when young, becoming pendulous when deoperculate, straight or nearly so, cylindrical, (3.3—) 4.5—7.5 mm long, pale brown to greyish brown, orange brown, or chestnut brown. *Cilia* 2—4. *Spores c.* 17—25 μ. *Operculum c.* 1—1.5 mm long, conical, often very shortly apiculate. *Calyptra c.* 5.5—7 mm long.

Distribution: As the section.

Ecology: As the section; often growing at the edge of forest streamlets.

Note: *H. menziesii* shows a strong tendency to form distal innovations which all have fronds of about the same size. The exact number of innovations could not always be determined because the base of many-tiered herbarium specimens often appeared to consist of decayed fronds. Such many-tiered plants usually have rather short stipes and small fronds.

KEY TO THE SUBSPECIES

1. Margin of stipe leaves minutely crenulate to serrulate . . . . . ssp. **menziesii**
1. At least some of the stipe leaves bearing some large teeth near apex . . . . . ssp. **splendidum**

a. ssp. **menziesii.** — *Hypnum menziesii* W. J. Hooker (1818) t. 33; Schwaegrichen (1828) t. 222; C. Mueller (1851A) 506, 693, (1851B) 567. — *Isothecium menziesii* Bridel (1827) 376; Wilson in J. D. Hooker (1854) 105, *pro parte*; J. D. Hooker (1867) 465. — *Trachyloma menziesii* Mitten in Lindsay (1866) 281. — *Hypnodendron menziesii* Paris (1895) 604, (1904) 373. — *Sciadocladus menziesii* Lindberg *ex* Brotherus (1909C) 1168; Lindberg (1861) 374, *comb. inval.*; Reichardt (1870) 188; Jaeger in Jaeger et Sauerbeck (1880) 361; Cockayne (1921) 144, Brotherus (1924B) 436; Dixon (1929) 341; Sainsbury (1945) 186; Martin (1946B) 179, (1950) 490, 491, (1952) 204; Sainsbury (1955B) 317, t. 47 f. 2; Martin (1958)

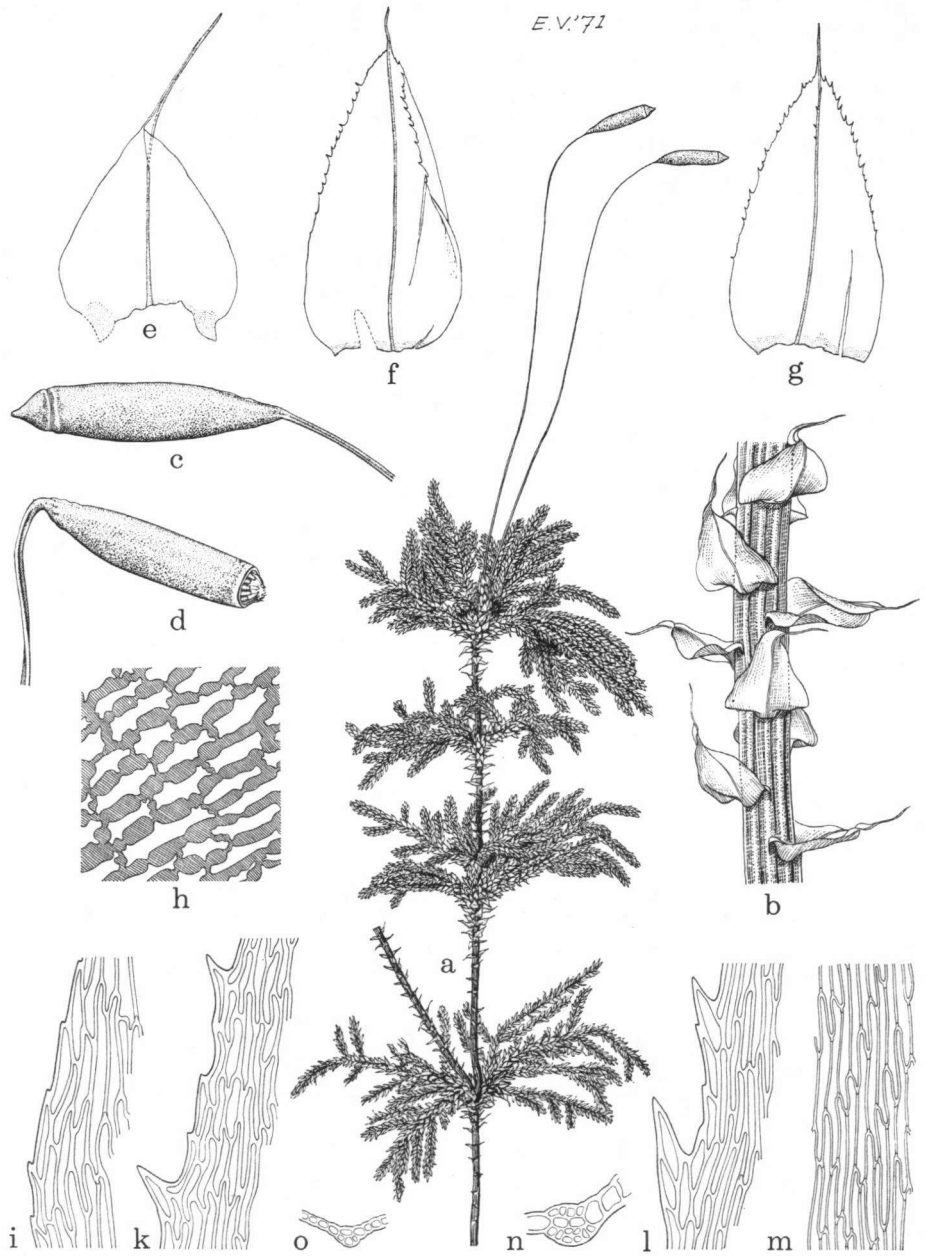

Fig. 15. *Hypnodendron menziesii*. a—i, l—o: ssp. *menziesii*; k: ssp. *splendidum*. — a: Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e: stipe leaf, × 17; f, g: branch leaves × 17; h: basal cells of stipe leaf, × 260; i, k: distal margins of stipe leaves, × 260; l: margin of branch leaf, × 260; m: areolation of branch leaf, × 260; n, o: cross sections of costae of branch leaves, × 260. (a, b, f: *Helms s.n.*; c: *Helms 34*; d: *Martin s.n.*; e, h: *Däll 749*; g: *Hügel s.n.*; i, l, m: *Matthews 43*; k: *Skottsberg 308*; n, o: *Healy 44454*).

112; van der Wijk et al. (1967) 371. — Type: *A. Menzies s.n.* (K holo, BM, H, S-PA), New Zealand, South Island, Dusky Sound.

Margin of *stipe leaves* crenulate to serrulate to almost entire; acumen 0.5—1.2 mm long. Costa in *branch leaves* bearing 5—13 dorsal teeth.

Distribution: Norfolk Island (?), New Zealand, Tasmania (?). Frequent in New Zealand. Apparently most common in Stewart I.; in the South I. almost confined to its wetter western half.

NORFOLK ISLAND: *Cunningham s.n.* (FH, H, L).

NEW ZEALAND. North Island. North Auckland: *Matthews 222* (BM). Mangonui: *Matthews s.n.* (CHR). Hokianga: *Jolliffe s.n.* (BM). Hokianga R.: *Bolton s.n.* (K). Ohaeawai: *Berggren 1652* (H, S-PA). Kerikeri R.: *Griffiths s.n.* (BM); *unknown coll. s.n.* (JE). Bay of Islands: *Cunningham 116* (K); *Wilkes s.n.* (US). Waipoua: *Allison 1863* (Allison), *1864* (Allison); *Cockayne 8103bis* (H, S-PA). Mangamuka: *Allison 773* (Allison). Wairoa R.: *Mossman 719* (NY). Little Barrier I.: *Hynes s.n.* (Allison); *Moore 564* (CHR); *Newhook s.n.* (Allison, K). Great Barrier I.: *Kirk & Hutton 4* (NY); *Knight s.n. p.p.* (PC). Waitakere Ra.: *Murray 14* (BM). Auckland: 7 collections. Manukau: *Sinclair s.n.* (BM). Waikato R.: *Jelinek 255* (W). Otaua: *Berggren 235A* (FH), *1647* (W). Coromandel Peninsula: *Matthews s.n.* (Allison). Moehau: *Moore 85* (CHR), *112* (CHR), *239* (CHR), *246* (CHR), *257* (CHR). Tokatea: *Zürm 27* (JE). Coromandel: *Hochstetter 259* (W); *unknown coll. s.n.* (S-PA). Thames: *Petrie 716* (CANTY, GRO, H, S-PA). Te Aroha: *Moore s.n.* (CHR). Tauranga: *Cameron 4006* (FH), *4023* (FH). Mamaku: *Fleischer B 88* (L). Mt. Akatarawas: *Martin 406.10 p.p.* (CHR); *Zotov 9125* (CHR). Field Hut: *Zotov 7467* (CHR). Orongorongo R.: *Zotov 7125* (CHR). Tematawai: *Zotov 6687* (CHR). Wellington: *Berggren 1650* (H); *Buchanan s.n.* (H). — South Island. Golden Bay: *Boor 102* (CANTY). Kahurangi Point: *Collett s.n.* (CHR). Karamea: *Foot s.n.* (BM). Westport: *Martin 407.4* (CHR). Lyell: *Allison 7165* (Allison). Buller Gorge, Waimea Stream: *Lash 32* (CANTY). Pelorus Valley: *Rutland 31* (CANTY). Picton: *Martin 406.5* (CHR). Westland: *Blotam s.n. p.p.* (H). Paparoa Ra.: *Helms 112* (BM). Runanga: *Martin Y 360* (CHR), *Y 364* (NICH). Greymouth: 9 collections. Te Kinga: *Barker 6776 p.p.* (CANTY). Kumara: *Brownlie 118* (CHR). Hokitika: *Blotam 5* (K); *Martin 406.3* (CHR); *Rossiter s.n.* (S-PA). Harihari: *Langridge 112* (Allison). Waiho: *Martin 407.* (CHR). Franz Jozef Glacier: *Lash 42* (CANTY). Bruce Bay: *Lash 48* (CANTY), *50* (CANTY). Otago: *Hector s.n.* (H, K); *Hutton 37 p.p.* (K). Dunedin: *Blotam s.n.* (H); *Kirk s.n.* (CANTY). Southland: *Blotam s.n.* (H). Milford Sound: *Lyall 14* (BM). Lake Te Anau: *Martin 407.12 p.p.* (Allison). Doubtful Sound, Precipice Cove: *Allan s.n.* (CHR). Ibid., Helena Falls: *Martin 407.9* (CHR). Dusky Sound: *Andrews s.n.* (BM); *Menzies 81* (BM), *s.n.* (BM, H, K, S-PA). Ibid., Supper Cove: *Zotov s.n.* (CHR). Chalky Inlet: *Lyall 193* (BM, NY). Puysegur Point: *Collett s.n.* (CHR). Riverton Hill: *Martin s.n.* (CHR). — Stewart Island: *Cockayne 8222* (BM, H); *Petrie s.n.* (BM). Port William: *Lyall 75* (BM). Garden Mound: *Martin 407.7* (CHR). Halfmoon Bay: *Bell 770* (H), *Lleland & Chase 309B* (BM, MO, US). Cedric Creek: *Martin 312.4 p.p.* (CHR). Oban: *Martin s.n.* (CHR). Paterson Inlet, Big Glory Harbour: 7 collections. West Creek: *Martin s.n.* (CHR). Port Pegasus, near Freezing Station: *Martin 407.8* (CHR), *407.11* (BO).

TASMANIA: *Gunn s.n.* (BM).

Ecology: See under the species; no data exist with regard to the altitudinal distribution.

Notes: 1. The stipe leaf illustrated by Schwaegrichen (1828) is exceptionally wide at the insertion.

2. Plants bearing more than 3 sporophytes are very rare; in this respect Hooker's (1818) description is rather misleading. I have not seen the aberrant specimens with many long capsules borne on short setae mentioned by Sainsbury (1955B), but have examined several other collections of that kind. In both *H. menziesii* and *H. kerrii* the number of sporophytes and the length of the seta are rather variable, but extremes are rare. The size of the capsule and the shape of the operculum are less variable.

3. Wilson (1854) referred to *Isothecium menziesii* as 'a Tasmanian moss', but the only Tasmanian specimen I came across was a Gunn collection of doubtful origin, and there are no other references to Tasmanian material in the literature. Therefore, I strongly doubt the occurrence of *H. menziesii* in Tasmania. Moreover, the only gathering from Norfolk Island by Cunningham appears to be identical to another Cunningham collection labelled 'Bay of Islands, New Zealand'. (See also p. 228).

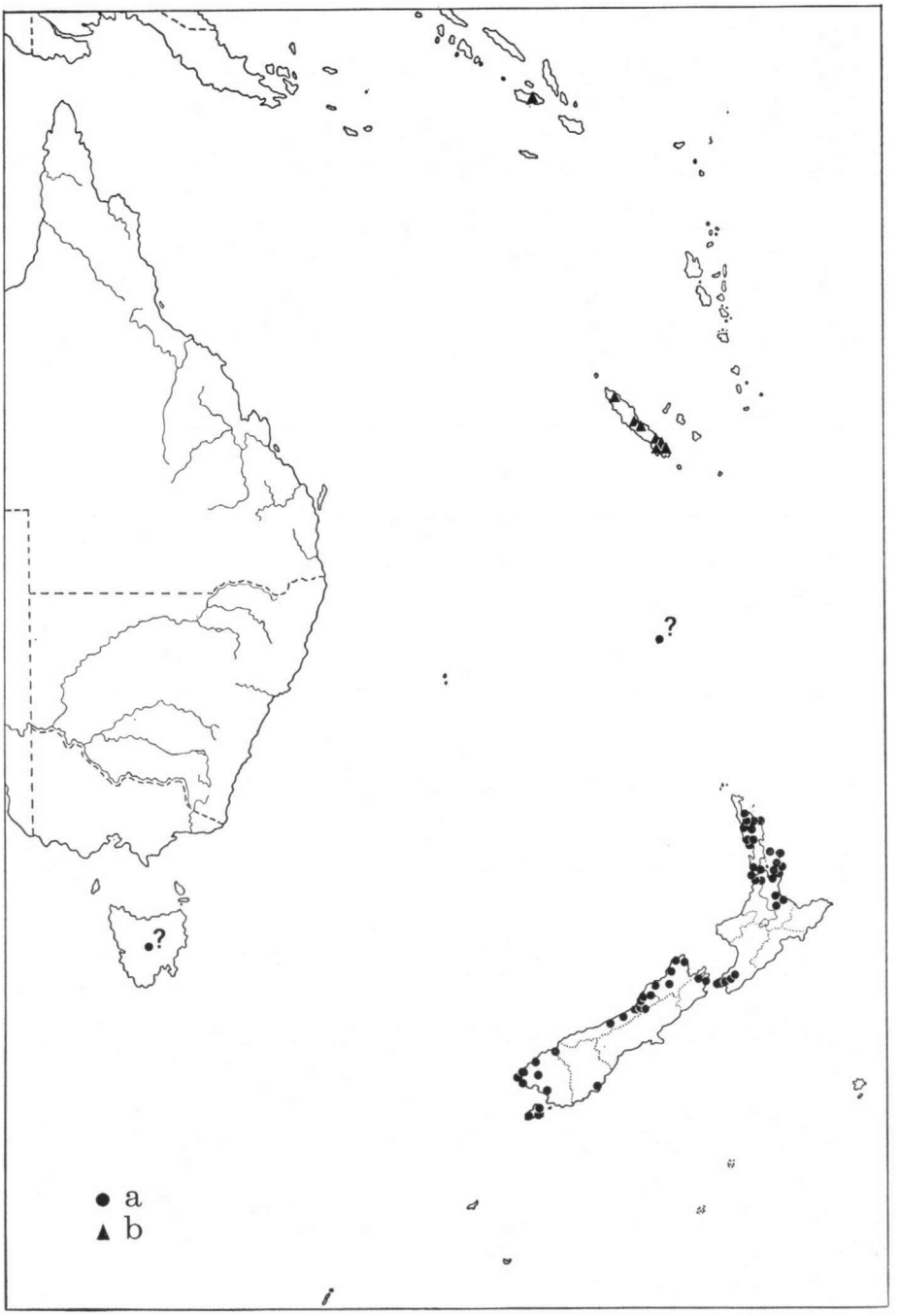

Fig. 16. Distribution of *Hypnodendron menziesii* ssp. *menziesii* (a) and ssp. *splendidum* (b).

b. ssp. **splendidum** (Besch.) Touw, *stat. nov.* — *Hypnodendron splendidum* Bescherelle (1873) 245; Paris (1895) 605, (1904) 374. — *Sciadocladus splendidus* Jaeger *ex* Brotherus (1906A) 26; Jaeger in Jaeger et Sauerbeck (1880) 361, *comb. inval.*; Brotherus (1909C) 1168, (1911) 42; Thériot (1922A) 466; Fleischer (1923) 1601; Brotherus (1924B) 436; van der Wijk et al. (1967) 371. — Syntypes: *Pancher 566, pro parte* (BM lecto, PC), New Caledonia, along rivulets in forest; *B. Balansa 2976* (BM, H, PC), New Caledonia, Mt. Mou, on moist soil, 1200 m; *Baudouin s.n.* (BM, L, PC), New Caledonia.

At least some of the *stipe leaves* bearing some strong teeth near the base of the acumen; acumen 0.3—0.9 mm long. Costa of *branch leaves* bearing 4—10 dorsal teeth.

Distribution: Solomon Islands (Guadalcanal), New Caledonia.

Solomon Islands. Guadalcanal. Mt. Popomanasiu: *van Zanten 682617* (GRO, L).

New Caledonia: *Baudouin s.n.* (BM, L, PC); *Pancher 566 p.p.* (BM, PC); *Le Rat 440* and *s.n.* (GRO, H); *unknown coll. s.n.* (NY, S-PA). Mt. Ignambi: *Compton 1596* (BM). Mt. Dogny: *Le Rat s.n.* (H). Dent de St. Vincent: *Le Rat s.n.* (H, PC). Mt. Mou: 10 collections. Mt. Dzumac: *Le Rat s.n.* (FH, GRO, L, S-PA). Mt. des Sources: *Skottsberg 276* (FH, H, S-PA). Nouméa: *Franc s.n.* (BM, FH, NY).

Ecology: See under the species; ssp. *splendidum* has been collected in New Caledonia at altitudes between 800 and 1200 m (10 reports), and in Guadalcanal between 2000 and 2200 m (1 report).

Notes: 1. According to Bescherelle *Hypnodendron splendidum* differs from *H. menziesii* as its stipe leaves are stronger toothed and its branch leaves have a longer acumen and a further extending costa. Of these characters only the first one is of some value, although strong teeth have not been found in all leaves examined. Some other very slight differences exist, as appears from the description given here. However, there are rather few collections available of ssp. *splendidum*, so one should not attribute much value to these quantitative differences. On the average, ssp. *menziesii* appears to have slightly shorter stipes and slightly broader fronds than ssp. *splendidum*.

2. I fail to understand on what grounds (other than geographical ones) Fleischer (1923) based his opinion that ssp. *splendidum* should be more closely allied to *Hypnodendron* sect. *Phoenicobryum* and *Braithwaitea* than *H. menziesii* ssp. *menziesii* and *H. kerrii* are.

8. Hypnodendron kerrii (Mitt.) Paris (1895) 604, (1904) 373. — *Trachyloma kerrii* Mitten (1859B) 86. — *Isothecium kerrii* J. D. Hooker (1867) 466. — *Sciadocladus kerrii* Jaeger *ex* Brotherus (1909C) 1168, f. 822; Jaeger in Jaeger et Sauerbeck (1880) 361, *comb. inval.*; Fleischer (1923) 1600; Brotherus (1924B) 436, f 383; Dixon (1929) 340; Allison (1931) 35; Sainsbury (1945) 186; Martin (1946A) 44, 56, (1946B) 179, (1952) 204; Sainsbury (1955B) 317, t. 48 f. 1; Martin (1958) 112; van der Wijk et al. (1967) 371. — Syntypes: *Kerr s.n.* (NY lecto, FH), New Zealand, Waiheke I. ('Waikeki'); *A. Sinclair s.n.* (BM, FH, NY), same locality; *W. Stephenson s.n.* (not seen), New Zealand, near Wellington. — **Fig. 17, 19.**

? *Isothecium heterophyllum* Colenso (1888) 240. — *Hypnodendron heterophyllum* Gepp in Paris (1900) 192; Paris (1904) 373. — Type: *W. Colenso s.n.* (not seen), New Zealand, Waipawa County, in shady forests near Dannevirke.

Hypnodendron helmsii C. Mueller *ex* C. Mueller (1898) 169; Paris (1895) 606, *nom. nud.*, (1900) 191; Brotherus (1924B) 436. — *Hypnum helmsii* C. Mueller *ex* Kindberg (1888) 19, *nom. nud.* — *Sciadocladus helmsii* Brotherus *ex* Paris (1909) 29. — Type: *R. Helms 6 pro parte* (B holo †, CANTY lecto, FH, GRO, H, JE, L, NY, PC, S-PA), New Zealand, Greymouth.

Hypnum menziesii non Hook.: Richard (1832) 55. — *Isothecium menziesii non* Brid.:

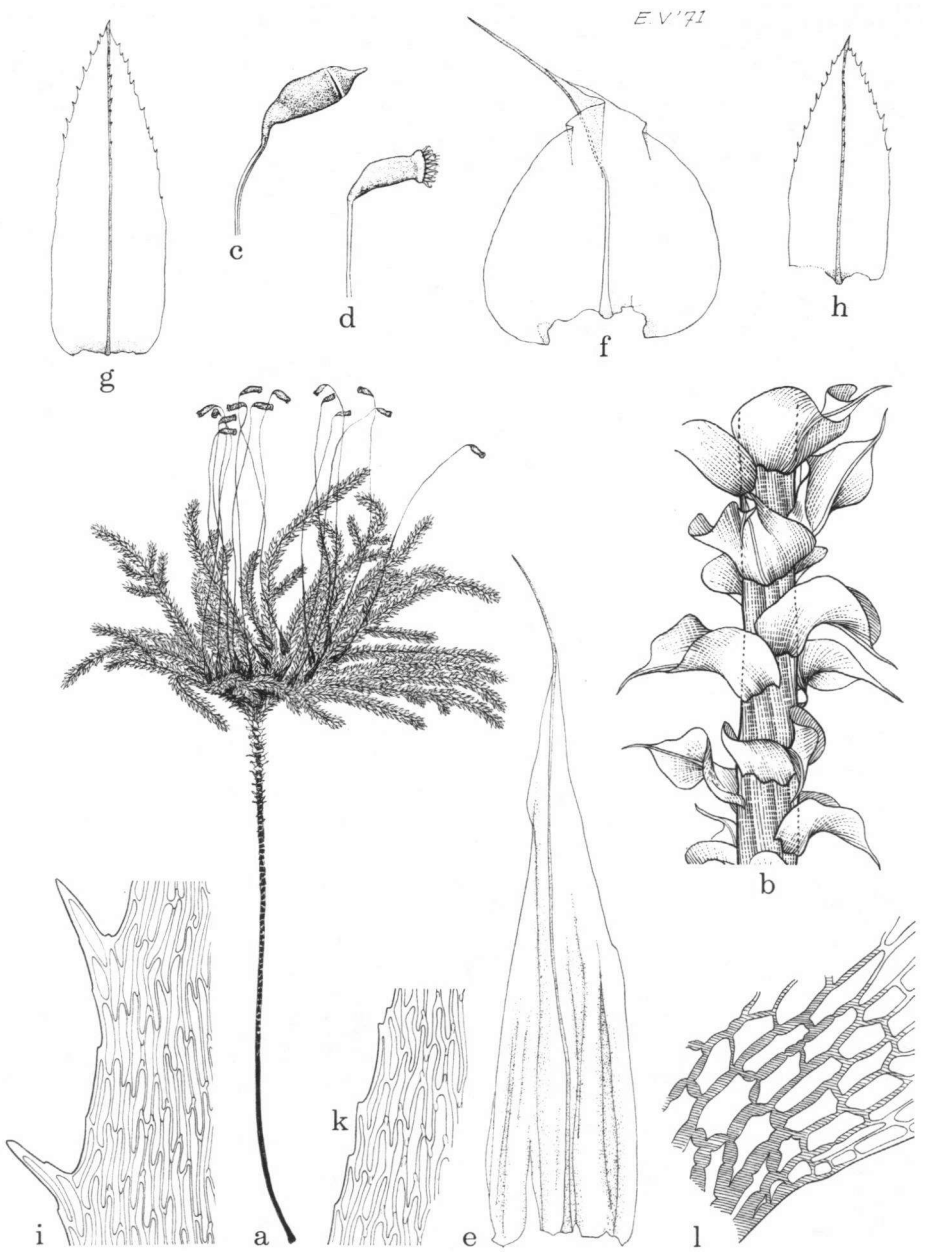

Fig. 17. *Hypnodendron kerrii*. — a: Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e: perichaetial leaf, × 17; f: stipe leaf, × 17; g, h: branch leaves, × 17; i: margin of branch leaf, × 260; k: distal margin of stipe leaf, × 260; l: basal cells of stipe leaf, × 260. (a, b: *Beckett 36B*; c—e: *Allison 242*; f, k, l: *Healy s.n.*; g: *Sowerby s.n.*; h: *Knight 73*; i: *Helms 6*).

Wilson in J. D. Hooker (1854) 105, *pro parte*. — *Sciadocladus menziesii non* Broth.: Reichardt (1870) 188, *pro parte*.

Plants up to 11 cm long, yellowish green to sordid green. Stipe up to 7(—11) cm long. *Frond* up to 5(—7.5) cm across, dense to rather loose, umbellate, subumbellate, or less frequently palmate, mostly simple, but often bearing one small *distal innovation*, exceptionally 3-tiered; branches as in *H. menziesii*. *Stipe leaves* 2.3—3.5 by 1.3—2.3(—2.7) mm, L/W ratio 1.2—2.1(—2.4); base broadly cordate, not decurrent; margin crenulate to serrulate, near base mostly flat; lamina cells *c.* 50—105 (—135) by 3—5 μ, L/W ratio *c.* 14—27, mostly bearing low papillae. *Branch leaves* as in *H. menziesii*, but more often complanate and less often distinctly arranged in five rows, 1.9—2.7(—3.3) by 0.8—1.3(—1.9) mm, L/W ratio (1.7—)2.0—2.4(—3.0); base abruptly narrowed; apex acute to very shortly apiculate or aristate, acumen up to 0.1(—0.3) mm long; costa percurrent to excurrent, bearing *c.* 6—15 strong dorsal teeth mixed with some much smaller ones; lamina cells *c.* 45—95(—135) by 3.5—5(—6) μ, L/W ratio *c.* 12—23, usually bearing small and narrow papillae, occasionally smooth.

Up to 8(—25) *sporophytes* on each frond. *Seta* (1—)1.5—4(—6) cm long, somewhat flexuose or almost straight, yellowish red to red or reddish brown. *Theca* horizontal or nearly so, straight or weakly curved, tumid, ovoid, 1.5—3(—4) mm long, yellowish brown to reddish brown or chestnut brown. *Cilia* 2—4. *Spores c.* 15—20 μ. *Operculum c.* 0.9—1.4 mm long, conical, apiculate to very shortly and bluntly rostrate. *Calyptra c.* 4—4.5 mm long.

Distribution: New Zealand. Widespread and apparently common all over the North and South Island, rare in Stewart Island.

New Zealand. North Island. Maungaroa: *Berggren s.n.* (S-PA). Mangonui: *Matthews 43* (FH). Waipoua: *Allison 1862* (Allison). Kaipara: *Blackwell 22* (BM). Warkworth: *Moore 219* (CHR). Little Barrier I.: *Moore s.n.* (CHR); *Newhook s.n.* (Allison). Great Barrier I.: *Hutton & Kirk s.n.* (BM, NY); *Kirk s.n.* (PC); *Moore s.n.* (CHR); *unknown coll. s.n.* (CHR). Waiheke I.: *Kerr s.n.* (FH, NY); *Sinclair s.n.* (BM, FH, NY). Auckland: *Knight s.n.* (BM, S-PA). Manukau: *Jolliffe s.n.* (K). Drury: *Hohenacker s.n.* (H). Coromandel: *Cheeseman 123* (CANTY). Puaiti Bush S. of Rotorua: *Allison 17* (Allison), *3259* (Allison). Lake Roto-iti: *Martin 406.6* (CHR). Taupo: *Allison Musci Sel. Crit. 242* (BM, BO, FH, JE, L, MO, NY, S-PA, US, W). Roto-a-Kui Bush: *Allison 3257* (Allison). Lake Waikaremoana: *Hodgson s.n.* (CHR); *Martin s.n.* (CHR). Taranaki: *Heywood 9* (BM), *9a p.p.* (BM). Mt. Egmont: *Gray 115* (BM). King Edward Peak: *Martin 268.25* (CHR). Wairoa: *Hodgson 514* (NY). Napier: *Garbari 9* (H). Manawatu R.: *Perry 104* (BM). Ohau R.: *Zotov 4817* (CHR). Mt. Akatarawas: *Martin s.n.* (CHR). Wellington: *Buchanan s.n.* (H); *Healy s.n.* (GRO, S-PA); *Hutton s.n.* (CANTY). Eastbourne: *Martin s.n. p.p.* (CHR). — South Island. Riwaka: *Healy s.n.* (CHR). Nelson: *Grant s.n.* (CANTY). Maitai: *Moore s.n.* (CHR). Korere: *Allan 66* (BM). Westport: *Martin s.n.* (CHR). Pelorus R.: *Martin s.n.* (CHR); *Rutland 16* (CANTY); *unknown coll. s.n.* (JE). Picton: *Pigott s.n.* (H). Hapuka: *Beckett s.n.* (BM, CHR, H). Kaikoura: *Beckett s.n.* (CANTY, GRO, MO). Westland: *Kirk s.n.* (CANTY). Greymouth: *Helms 6 p.p.* (CANTY, FH, GRO, H, JE, L, NY, PC, S-PA). Otira: *Martin 406.4* (CHR), *406.9* (BO, CHR). Kelly's Creek: *Martin 406.1* (CHR). Kelly's Ra.: *Beckett 1036* (CANTY, FH, L). Waiho: *Martin Y 363* (NICH). Fox Glacier and R.: *Jack s.n.* (Allison). Canterbury: *Sinclair & Haast s.n.* (K); *unknown coll. s.n.* (H). Oxford: *Beckett 36* (CANTY), *58* (US); *Thompson & Barker 6793* (CANTY). Waitati: *Berggren 1667* (H, S-PA). Rockwood Bush NE. of Rakaia Gorge: *MacMillan 68/343* (CHR). Alford Forest: *Beckett s.n.* (CHR); *Chapman s.n.* (CHR). Peel Forest: *Beckett s.n.* (CANTY, H). Kelsey's Bush: *Burrows s.n.* (CANTY). Waimate: *Beckett 36B* (BM, CANTY, H). Otago: *Buchanan s.n.* (BM); *Hector 37 p.p.* (K); *Oldham s.n.* (BM); *Petrie s.n.* (BM); *Rauson s.n.* (BM). Benmore: *Beckett s.n.* (CANTY). Herbert: *Allison 5164* (Allison). Morrison's Creek: *Simpson s.n.* (CHR). Mt. Cargill: *Bell 1600* (H); *Martin s.n.* (CHR); *Simpson 208* (CHR), *221* (CHR). Dunedin: 8 collections. Maungatua Ra.: *Allison 887* (Allison); *Bell 500* (H). Mouth of Taieri R.: *Martin 406.11* (CHR). Akatore: *Allison 1653* (Allison, BO, CHR). Lake Wakatipu: *Meiklejohn 677* (H, L). Mihiwaka: *Simpson s.n.* (CHR); *Simpson & Thompson 273* (CHR). Lake Gunn: *Zotov s.n.* (CHR). Lake Te Anau: *Martin 406.10* (BO). Lake Manapouri: *Setchell s.n.* (FH); *Simpson s.n.* (CHR). Spy R.: *Simpson 1117* (CHR). Dusky Sound, Supper Cove: *Allan s.n.* (CHR). Woodlaw: *Allison 1652* (Allison). Bluff: *Martin 268.15* (BO, CHR). South Coast: *Rauson s.n.* (BM). — Stewart Island: *Martin s.n.* (CHR). Pine Hill: *Bell 206* (H), *208* (H).

Ecology: See under the section. The very few data available with regard to the altitudinal distribution indicate the occurrence of *H. kerrii* from sea level up to 900 m at least.

Notes: 1. *H. kerrii* and *H. menziesii* are easily recognized by their sporophyte characters: the number of sporophytes per frond, the length of seta and theca, the shape of the operculum, and the position of the open capsule. Dixon (1929) correctly considered as unreliable all vegetative characters used up to that time as their variability showed a large overlap. He suggested that the degree of papillosity of the leaf cells might form a useful character for separating the two. He always found the cells of *H. kerrii* quite smooth, whereas those of *H. menziesii* 'projected very slightly at the back, at the cell apices, in a minute spiculose point'. This new character was in turn rejected by Sainsbury (1945, 1955B) as he had found distinctly papillate cells in *H. kerrii*. In my opinion both species usually have papillate leaf cells, but in *H. kerrii* the papillae are less distinct and as they lie above the walls of the adjacent cells they are easily visible only when strongly developed.

Sainsbury (1945, 1955A) held the opinion that *H. kerrii* and *H. menziesii* are unseparable in the sterile state. In my opinion a separation based on vegetative characters is always possible in full-grown plants. Very useful differential characters have been found in the shape of the stipe leaves and their insertion line. The latter character even serves to identify those plants in which the stipe leaves have fallen off, as is often the case. The following characters are somewhat less useful:

a. *H. menziesii* shows a strong tendency to form many distal innovations, resulting in plants bearing several superposed fronds of about the same size. In *H. kerrii* the fronds are mostly simple or they bear one much smaller innovation.

b. The papillae on the branch leaves of *H. kerrii* are small and narrow and have a long base. In *H. menziesii* they are often shorter and less easily visible.

c. In *H. kerrii* the branch leaves are abruptly narrowed at the base, gradually narrowed at the apex, and are not or very shortly apiculate. The leaves of *H. menziesii* are less abruptly narrowed at the base, more abruptly narrowed at the apex, are more strongly concave, and bear a longer apiculus. Along the smaller branches these differences become less apparent.

Further, small differences were found in the width of the stipe leaves and the length of the leaf cells. However, these characters are so variable that they are of little practical value. In *H. kerrii* the fronds are often less regularly and more loosely branched than in *H. menziessii*, whereas the branch leaves of the latter are more often arranged in distinct rows.

2. *Hypnodendron kerrii* has been confused with *H. menziesii*, *H. arcuatum*, and *H. marginatum*. *Sciadocladus kerrii* f. *aquatica* is nothing but an aquatic form of *H. marginatum*. It clearly shows the branching, colour, and leaf characters of that species. According to Dixon & Bartram (1937) the branch leaves are not bordered, but leaves of the type specimen do have a distinct border which is one to several cells in thickness and consists of very narrow cells.

3. *Hypnodendron helmsii* represents a very tall form of *H. kerrii*, having palmate to subumbellate fronds consisting of more or less complanate branches. Such plants have often been collected in very moist and shady situations.

Sect. Lindbergiodendron, *sect. nov.*

Stipes glaber. Frond pinnata. Folia caulina late patentia usque ad squarroso-recurvata. Folia acuta breviter aristata, grosse serrata. Theca sulcata. Spori 10—18 μ diam. Operculum obtuse rostratum.

Type species: *Hypnum arcuatum* Hedw.

Plants small to medium-sized, obliquely to horizontally projecting from the substrate. *Distal innovations* absent or very weak. *Stipe* tomentose at base only. *Pseudoparaphyllia* inconspicuous, appressed, often sparse or absent. *Frond* pinnate; branches complanate. *Stipe leaves* widely spreading to squarrose-recurved, ovate-oblong; insertion line concave; base broadly rounded, often shortly decurrent; apex acute; margin spinose-serrate with simple teeth; costa excurrent in a usually smooth arista; walls of basal cells incrassate, often orange coloured; alar cells indistinct. *Branch leaves* anisomorphous and asymmetrical, ovate-oblong; apex acute; margin, costa, and cells as in the stipe leaves, but walls of basal cells green.

Male gametoecia scattered. *Perichaetial leaves* smooth to weakly plicate. *Theca* sulcate to sharply costate, strongly inclined to horizontal. *Spores* 10—18 μ. *Operculum* bluntly rostrate.

Distribution: See under the species.

9. Hypnodendron arcuatum (Hedw.) Lindberg *ex* Mitten (1882A) 90, *excl. spec.*; Lindberg (1861) 374, *comb. inval.*; Dixon (1929) 342, *pro parte*; Allison (1931) 32, *pro parte*; Martin (1950) 490, *pro parte*; Sainsbury (1955B) 318, *pro parte*, t. 48 f. 3; van der Wijk et al. (1962) 532. — *Hypnum arcuatum* Hedwig (1801) 245, t. 62 f. 1—7; Palisot de Beauvois (1805) 61; Bridel (1812) 98; Schwaegrichen (1816) 208; Bridel (1819) 156. — *Pterygophyllum arcuatum* Bridel (1827) 348. — *Hypopterygium arcuatum* C. Mueller (1850) 13. — *Trachyloma arcuatum* Mitten (1859B) 86, *excl. spec.*; Mitten in Wilson in J. D. Hooker (1859) 206, *comb. inval. in syn.* — *Rhacopilum arcuatum* Jaeger in Jaeger et Sauerbeck (1876) 142; Hampe (1880) 52; Paris (1897) 1082. — *Isothecium spininervium* (Hook.) Wils. var. *arcuatum* Wilson in J. D. Hooker (1854) 105; J. D. Hooker (1867) 466; Buchanan (1874) 229. — *Hypnodendron spininervium* (Hook.) Jaeg. var. *arcuatum* Wils.: Jaeger in Jaeger et Sauerbeck (1880) 359; Paris (1895) 605, (1904) 374. — Type: *unknown collector*, 'Insulae Australes', absent from Hedwig's herbarium (see note 1); lectotype: Hedwig (1801) t. 62 f. 1—7. — **Fig. 18, 19.**

Plants small to medium-sized, mostly pale green and glossy. *Stipe* up to 5 cm long. *Frond* densely to loosely pinnate, up to 3(—4) cm wide; branches mostly simple. *Stipe leaves* ovate-oblong, 1.3—3.0 by 0.6—1.3 mm, L/W ratio 2.0—2.6; base broadly rounded, often very shortly decurrent; apex acute; margin near base recurved, upwards flat, coarsely serrate with up to *c.* 50 μ long, simple, spinose teeth; costa thin, greenish, bearing spinose dorsal teeth, excurrent in a short green to brownish arista which is either completely smooth or bears one or two spinose teeth near its base; lamina cells 50—150 by 3.5—7 μ, L/W ratio *c.* 10—25(—35), distinctly papillate; incrassate walls of basal cells strongly porate. *Branch leaves* ovate-oblong, the laterally spreading ones 1.9—2.7 by 0,7—1.3 mm, L/W ratio 1.8—2.5, dorsal leaves smaller; base rounded to cordate; apex acute; margin near base recurved, upwards flat, bearing numerous up to *c.* 60 μ long, simple, spinose teeth which often have orange tips; costa greenish, excurrent in a cuspidate to shortly aristate entire point bearing spinose dorsal teeth; lamina cells 40—100 by 4—8 μ, L/W ratio *c.* 6—20(—25), walls distinctly papillate.

Up to 3(—5) *sporophytes* per frond. *Seta* 1.5—3 cm long, thick, arcuate, orange to brownish. *Theca* curved, cylindrical, (2—)3.5—6 mm long, pale orange to dark brown, sulcate to sharply costate. *Cilia* (2—)4. *Operculum* 1.2—2.5 mm long. *Calyptra c.* 1.5—2 mm long.

Distribution: Norfolk I. (?), New Zealand, Campbell I. In New Zealand most often collected in the North Island; in the South Island not yet found in Fiordland.

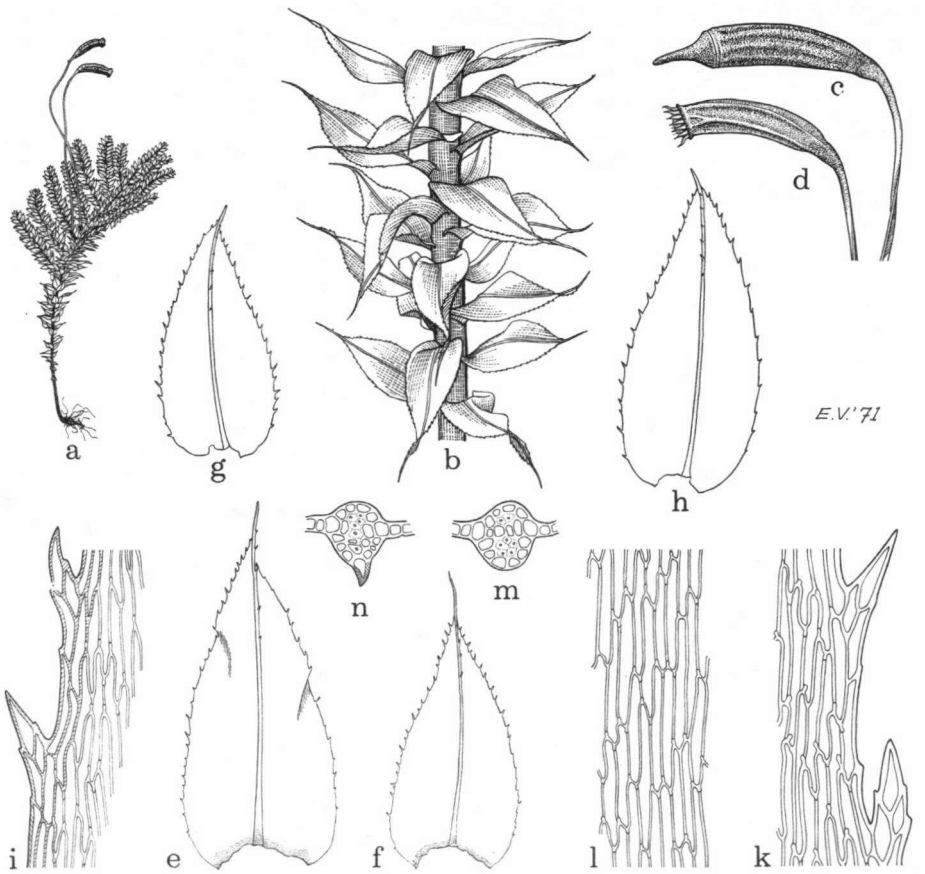

Fig. 18. *Hypnodendron arcuatum.* — a. Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e, f: stipe leaves, × 17; g, h: branch leaves, × 17; i: margin of stipe leaf, × 260; k: margin of branch leaf, × 260; l: areolation of branch leaf, × 260; m, n: cross sections of costae of branch leaves, × 260. (a, b, f: *Martin 268.3;* c, d, h, m, n: *Martin 268.2;* e: *Martin 268.20;* g: *Martin 41;* i—l: *Beckett 718*).

NORFOLK ISLAND: *Cunningham s.n.* (BM, H, L).

NEW ZEALAND. North Island. Auckland: *Jelinek 26* (BM); *Jolliffe s.n.* (BM); *Sinclair s.n. p.p.* (BM). Bay of Islands: *Berggren 1672* (NICH, S-PA). Waipoua: *Allison 1829* (Allison). Kaipara: *Blackwell 21* (BM). Warkworth: *Moore s.n.* (CHR). Little Barrier I.: *Petrie 718* (BM, CANTY, H, PC). Great Barrier I.: *Sinclair s.n.* (BM). Waiheke I. *Sinclair s.n.* (BM); *unknown coll. s.n.* (JE). Chelsea: *Moore s.n.* (CHR). Swanson: *Ashcroft s.n.* (W). Henderson: *Moore s.n.* (CHR). Manukau: *Sinclair s.n.* (BM). Coromandel: *Cheeseman s.n.* (CANTY). Moehau: *Matthews s.n.* (Allison). Mercury Bay: *Jolliffe s.n.* (BM). Waitomo: *Martin 268.33* (BO, CHR). Tuhua: *Hochstetter 260 p.p.* (W). Te Aroha: *Zürm s.n.* (JE). Between Lake Rotorua and Bay of Plenty: *Allison 2913* (Allison), *9765* (Allison). Lake Rotorua: *Allison 2910* (Allison). Puaiti S. of Rotorua: *Allison 164* (Allison). Rotorua - Atiamuri Rd.: *Allison 2917* (Allison). Maungapohatu: *Moore s.n.* (CHR). Kaukau (Okaihau ?): *unknown coll. s.n. p.p.* (W). Lake Waikaremoana: *van Zanten 681935* (GRO, L), *682147* (GRO, L). Tarawera: *Hill s.n.* (CHR). Wairoa: *Hodgson Musci Exsicc. Nov.-Zel. 45* (Allison, BM, CANTY, CHR, FH), *85* (FH). Patoka: *unknown coll. 9* (CHR). Matamau: *Beckett s.n.* (CANTY). Whakarara: *Sainsbury s.n.* (W). Rangiwahia S. of Taihape: *Wormald 39 p.p.* (Allison). Woodville: *Allison 7210* (Allison). Ohau-iti R.: *Zotov s.n.* (CHR). Mt. Bruce: *Gray 108* (BM), *2218* (BM). Hutt R. Valley: *Lyall 48* (BM). Wellington: *Buchanan s.n.* (H). Willon's Bush: *McEwan s.n.* (CANTY); *Mason s.n.* (CHR).

Khandallah Forest Reserve: *Martin 268.16* (BO, CHR). Rimutaka Ra.: *Kirk s.n.* (CANTY). Wairongomai R.: *Zotov 7250* (CHR). Hukio (Huteo?): *Knight 72 p.p.* (BM, H, NY). Taita: *Poole 31* (CHR). — South Island: Nelson: *Grant s.n.* (CANTY); *Oldham 342* (BM). Pelorus Sound: *Rutland s.n.* (CANTY). Jacob's Bay: *Barker 67120* (CANTY), *67122* (CANTY). Waikamarina R.: *Barker 67121* (CANTY). Picton: *Martin 268.3* (CHR), *268.11* (BO, CHR), *268.18* (CHR). Kaikoura: *Beckett s.n.* (H); *unknown coll. s.n.* (CANTY). Westland: *Brown s.n.* (BM, NY). 10 miles N. of Greymouth: *Moore 259* (CHR). Otira: *Martin 268.20* (CHR), *268.21* (CHR). Mt. Hercules: *Lash 59* (CANTY). Oxford: *Beckett 37* (CANTY), *718* (US). Akaroa: *MacMillan 68–68* (CHR). Peel Forest: *Barker 6984* (CANTY); *Beckett 219* (CANTY, JE, MO, US). Kakahu Bush: *Burrows s.n.* (CANTY). Waimate: *Beckett 1117* (FH). Dunedin: *Martin 268.1* (CHR), *268.2* (CHR), *268.14* (CHR), *268.36* (CHR). Maungatua Ra.: *Allison 1392* (Allison); *Thomson s.n.* (CANTY). Coastal ridge S. of Taieri R.: *Allison 1391* (Allison). Waipori Gorge: *Martin 268.32* (CHR). Leith Valley: *Bell 517* (CANTY, H). Mossy Falls (?): *Bell 651* (H). Bluff: *Allison 3491* (Allison). — Stewart Island. Oban: *Martin 268.4* (CHR). Glory Harbour: *Martin 268.7* (CHR). Pine Hill: *Bell 201* (H), *208* (H). Ryan's Creek: *Sinclair 44619* (CHR). Garden Mound: *Martin 268.27* = *328* (CHR). Ulva I.: *Barr 462* (Allison).
CAMPBELL ISLAND. Mt. Fizeau: *Vitt 3140* (L).

Ecology: Grows almost exclusively on wet banks of streams in forest, occasionally in other wet places such as swamps and sheltered rock faces in damp forests. The altitude of the collecting localities is seldom given on the labels; up to 750 m?

Notes: 1. Who collected the type specimen, where it was gathered, and where it is preserved — if it is still in existence — is not known. Already in 1816 Schwaegrichen remarked that the specimen could not be found in Hedwig's herbarium ('*plantam ipsam non inveni in herbario Hedwigii*'). Consequently, Hedwig's description and illustration remained the only sources of information — and confusion.

According to Hedwig (1801) *Hypnum arcuatum* was collected in '*Insulae Australes*' by a collector whose name was not given. In the 'Species Muscorum' eleven more species have been reported exclusively from '*Insulae Australes*': *Anictangium setosum*, *A. bulbosum*, *A. planifolium*, *Bryum macrocarpon*, *Hypnum microcarpon*, *H. tenuifolium*, *Leskea cristata*, *L. filiculaefolia*, *Neckera planifolia*, *Pterigynandrum ciliatum*, and *Weissia radians*. Of these, *Anictangium planifolium* and *Weissia radians* are species of uncertain identity. If the remaining species have been interpreted correctly New Zealand is the only area they have in common; two are even New Zealand endemics. If the assumption that all specimens came from the same island or group of islands is correct, then they must have been collected in New Zealand and in that case they were most likely collected by Banks (Cook's first voyage, 1769), the Forsters (Cook's second voyage, 1773), or Menzies (Vancouver's voyage, 1791). Menzies can be discounted, as his bryophyte collections were worked up by Hooker (1818—1820). Bridel suggested (1827) that the specimen of *Hypnum microcarpum* might have been collected by the Forsters. The only specimen I came across bearing G. Forster's name was one of *H. comosum*, a species unknown to Hedwig. Banks collected many bryophytes and his collection contains a specimen of *H. arcuatum*. Unfortunately, the label of that specimen in BM only bears the words 'Nova Zeelandia/ *Hypnum spininervium* Hook.', so there is no indication proving that Hedwig actually saw Banks's material.

2. Hedwig neither described nor illustrated the dorsal teeth of the costa. This must have led Hooker (1818) to the assumption that his new species *Hypnum spininervium* could be distinguished from *H. arcuatum* by its dorsal teeth. In fact, these are often more strongly developed in *H. arcuatum* than in *H. spininervium*. As Hedwig gave no particulars about the areolation it is not at all surprising to find that Mueller (1850) transferred *Hypnum arcuatum* to *Hypopterygium* sect. *Rhacopilum*, which was later raised to generic level (*Racopilum*, *Racopilaceae*). *Hypnodendron arcuatum* resembles the species of *Racopilum* macroscopically in having sulcate capsules and complanate branches bearing anisomorphous, aristate, and often coarsely toothed leaves. However, from Hedwig's data it is clear that his *Hypnum arcuatum* differs from the New Zealand species of *Racopilum* in

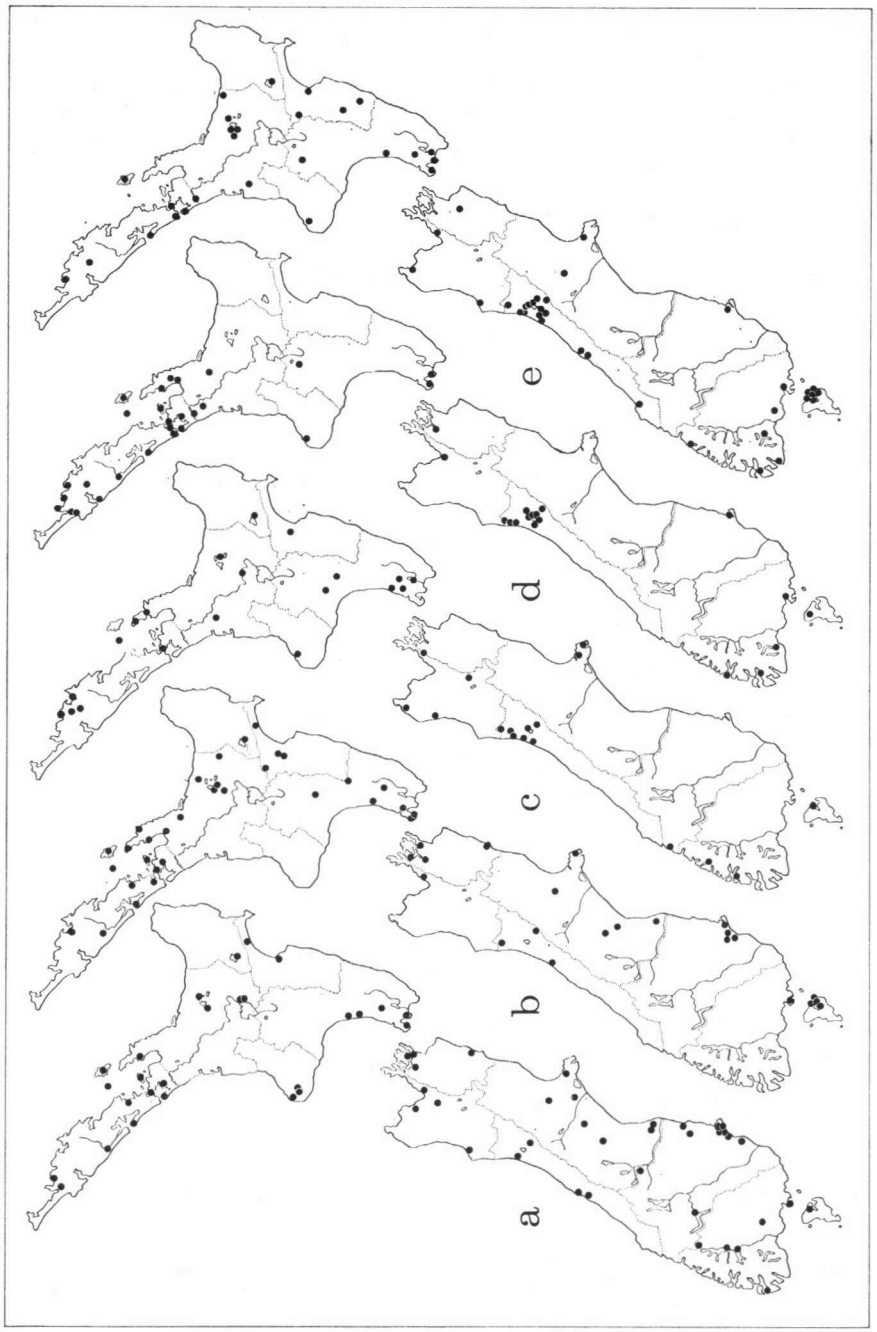

Fig. 19. Distribution of *Hypnodendron kerrii* (a), *H. arcuatum* (b), *H. marginatum* (c), *H. colensoi* (d), and *H. comatum* (e).

its habit, ramification, and leaf shape. On the other hand, his description and illustration perfectly match *Hypnodendron arcuatum* as defined here, and there is little doubt in my mind as to their identicity.

3. Jaeger (1876, 1880), followed by Paris (1895, 1904), accepted both *Racopilum arcuatum* and *Hypnodendron spininervium* var. *arcuatum*, overlooking the fact that they were based on the same type.

4. *H. arcuatum*, *H. spininervium*, and *H. vitiense* ssp. *australe* have often been confused, and as far as I could make out all plants identified as *H. arcuatum* from the New Hebrides and New Caledonia must be referred to either *H. vitiense* ssp. *vitiense* or other species not belonging to *Hypnodendron* at all. The Australian and Tasmanian plants are either *H. vitiense* ssp. *australe* or *H. spininervium* ssp. *archeri*. The combination *Trachyloma arcuatum* (Hedw.) Mitt. has been used exclusively for specimens of *H. vitiense* ssp. *australe*, and under his new combination *Hypnodendron arcuatum* (Hedw.) Mitten cited only specimens belonging to *H. vitiense* ssp. *australe*. However, the Code (art. 55) clearly indicates that the combination must be retained for *Hypnum arcuatum* Hedw.

5. The record from Norfolk I. might be based on a mislabelled specimen (see p. 228).

Sect. Hypnodendron

Hypnodendron A. *Euhypnodendron* Lindberg in Dozy et Molkenboer (1866) 132, *nom. illeg.* — *Hypnodendron* subg. *Euhypnodendron* Brotherus (1909C) 1169, *pro parte*; Fleischer (1923) 1610, '*Eu-Hypnodendron*'; Brotherus (1924B) 438, *pro parte*.

Hypnum Hedw. sect. *Hypnodendron* C. Muell. subsect. *Comatulina* C. Mueller (1851A) 503, *pro parte, nom. illeg.*

Plants medium-sized to tall, erect or projecting obliquely from the substrate. *Distal innovations* absent or weak and few in number. *Stipe* tomentose at base only, occasionally with a few scattered tufts of tomentum. *Pseudoparaphyllia* inconspicuous, appressed, often sparse. *Frond* palmate to subumbellate, occasionally pinnate or umbellate. *Branches* mostly strongly complanate. *Stipe leaves* appressed to obliquely spreading, narrowly triangular to deltoid, occasionally triangular-ovate; insertion line straight to concave; base not decurrent, not narrowed to cordate; apex acute to shortly acuminate; margin entire to coarsely serrate; costa ending in apex to percurrent or shortly excurrent; cells smooth to distinctly papillate; marginal and basal cells neither conspicuously enlarged nor strongly coloured, alar cells mostly indistinct. *Branch leaves* mostly very glossy, distinctly anisomorphous, asymmetrical, usually ovate-oblong; apex mostly acute to weakly acuminate; teeth simple or mixed; costa mostly percurrent; lamina cells mostly distinctly papillate; submarginal cells often indistinctly elongated, in *H. marginatum* forming a very distinct border of linear cells; alar and basal cells indistinct.

Male gametoecia scattered. *Perichaetial leaves* smooth to weakly plicate. *Theca* costate to sulcate, strongly inclined to horizontal, occasionally cernuous. *Spores* 10—19 μ. *Operculum* bluntly rostrate.

Distribution: As the family, but absent in Ceylon and Khasi Hills.

10. Hypnodendron spininervium (Hook.) Jaeg. — Fig. 20, 21.

For synonyms, literature, and type specimens see under the subspecies.

Plants small to medium-sized, erect to horizontally growing, mostly densely tufted, sordid green to brownish, dull to somewhat glossy. *Stipe* up to 5 cm long, occasionally tomentose. *Frond* palmate, occasionally pinnate, often untidy, up to 3.5 cm across; branches simple or sparsely branched, weakly to strongly complanate. *Stipe leaves* green, obliquely

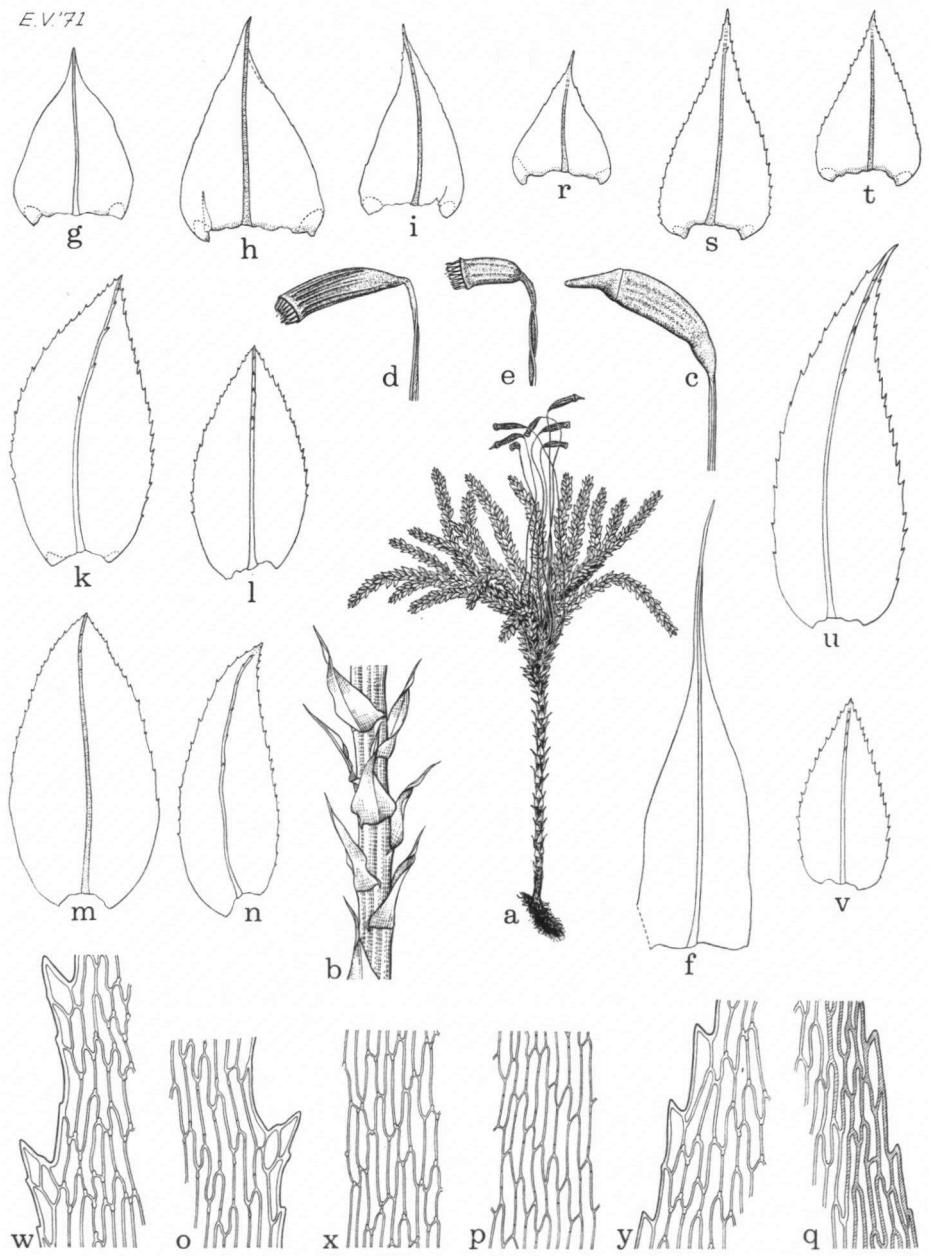

Fig. 20. a—q: *Hypnodendron spininervium* (a—d, f—h, k—m: ssp. *spininervium;* e, i, n—q; ssp. *archeri);* r—y: *H. microstictum.* — a: Habit, × 1; b: stipe, × 8; c—e: capsules, × 4; f: perichaetial leaf, × 17; g—i, r—t: stipe leaves, × 17; k—n, u, v: branch leaves, × 17; o, w: margins of branch leaves, × 260; p, x: areolation of branch leaves, × 260; q, y: margins of stipe leaves, × 260. (a, b: *Martin 268.4;* c, d, l: *Martin 268.12;* e, i, n—q: *Archer s.n.;* f: *Leland c.s. 211;* g: *Martin 268.30;* h, k: *Martin 268.40;* m: *Berggren 664;* r: *Dusén 317;* s: *Kunkel M 89;* t, v—y: *Schwabe 15e;* u: *Kunkel M 348*).

spreading, deltoid to triangular-ovate, 1.0—1.9 (—2.3) by 0.7—1.1 (—1.2) mm, L/W ratio 1.3—1.8; insertion line concave; base broadly rounded; apex acute to shortly acuminate; margin near base strongly recurved, upwards flat and almost entire to finely serrulate, occasionally serrate with up to 17 μ long simple teeth; costa strong, brownish, becoming indistinct in apex to percurrent, dorsally smooth or nearly so; lamina cells 50—185 by 4—12 μ, L/W ratio *c.* 6—20 (—25), walls almost smooth to distinctly papillate; papillae long and flat; marginal cells often having more strongly incrassate walls of a darker colour; alar cells forming a mostly distinct group of enlarged rectangular to hexagonal cells with strongly incrassate and often orange coloured walls; basal cells often somewhat orange coloured. *Branch leaves* ovate-oblong, the laterally spreading ones 1.5—2.5 (—2.9) by 0.7—1.4 mm, L/W ratio 1.8—2.3 (—2.5), dorsal leaves smaller; apex usually acute, occasionally bluntish; margin near base recurved, upwards flat, serrate with up to *c.* 30 μ long (but usually shorter) brownish simple teeth, often mixed with a few geminate ones; costa strong, often brownish, ending in apex to percurrent, bearing up to 8 dorsal teeth; lamina cells 35—85 by 3—7 μ, L/W ratio *c.* 6—17, walls usually smooth to indistinctly, sometimes distinctly papillate.

Up to 8 *sporophytes* per frond. *Seta* straight to flexuose, (1.5—) 2—4.5 cm long, pale orange to red or brown. *Theca* curved to almost straight, obconical to cylindrical, (1.5—) 2.0—5.0 mm long; neck often weakly strumose. *Cilia* 2—4. *Operculum* 1—2 mm long. *Calyptra c.* 1.5 mm long.

Distribution: Victoria, King I., Tasmania, New Zealand, Chatham Is.

Ecology: Terrestrial, on rocks, fallen logs, and banks of streams; in wet places in forests, near waterfalls, in swamps, and along pools, occasionally growing completely submerged. Data concerning the altitudinal distribution are scarce; up to 800 m?

Notes: 1. Very closely related to the South American *H. microstictum*, the main differences being the less strongly serrate and less distinctly bordered stipe leaves which have longer and less distinctly papillate cells and are less strongly contracted at base.

2. *H. spininervium* and *H. microstictum* deviate strongly from the other species belonging to sect. *Hypnodendron* by their stipe leaves which always spread distinctly from a concave insertion, have a strongly contracted base, a distinct group of alar cells, and recurved margins; the basal and alar cells are often more or less orange coloured. Moreover, the stipes are sometimes sparsely to rather densely tomentose, whereas they are always glabrous in *H. vitiense et al.*

KEY TO THE SUBSPECIES

1. Theca 3.5—5 mm long; seta 3—4.5 cm long . . . . . ssp. **spininervium**
1. Theca mostly 2.0—2.5 (—4) mm long; seta up to 3 cm long . . . . . ssp. **archeri**

a. ssp. **spininervium.** — *Hypnum spininervium* W. J. Hooker (1818) t. 29; Bridel (1827) 396; Schwaegrichen (1829) t. 258a; Richard (1832) 55; C. Mueller (1847) 803, (1851A) 507, 693, (1851B) 567; Hampe (1880) 51. — *Rhizogonium spininervium* Schimp. *ex* C. Muell. (1847) 803, *comb. inval. in syn.* — *Isothecium spininervium* Wilson in J. D. Hooker (1854) 105, *pro parte*; J. D. Hooker (1867) 466, *pro parte.* — *Hypnodendron spininervium* Jaeger in Jaeger et Sauerbeck (1880) 359; Reichardt (1870) 189, *comb. inval.*; Paris (1895) 605, (1904) 374; Brotherus (1909C) 1169, f. 823 A—E; Fleischer (1923) 1600; Brotherus (1924B) 438, f. 384 A—E. — Type: *A. Menzies s.n.* (K holo, S-PA), New Zealand, South Island, Dusky Sound.

Hypnodendron planifrons C. Mueller (1898) 170; C. Mueller *ex* Paris (1895) 606, *nom. nud.*,

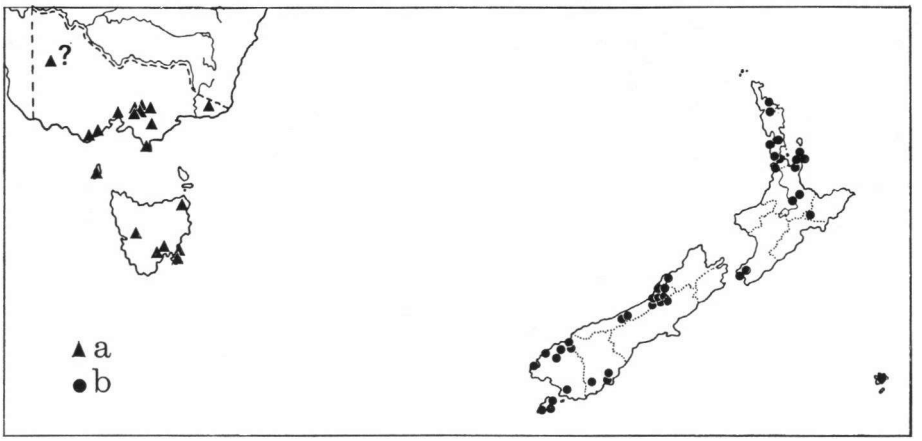

Fig. 21. Distribution of *Hypnodendron spininervium* ssp. *archeri* (a) and ssp. *spininervium* (b).

(1900) 192, (1904) 374; Brotherus (1909C) 1169, (1924B) 438. — Type: *R. Helms 4* (B holo †, H lecto), New Zealand, South Island, Greymouth.

Hypnodendron arcuatum (Hedw.) Mitt. *emend.* Dixon (1929) 342, *pro parte*; Allison (1931) 32, *pro parte*; Martin (1950) 490, *pro parte*; Sainsbury (1955B) 318, *pro parte.*

Fronds palmate, mostly dark sordid green. *Stipe leaves* having papillate to almost smooth cells. *Branch leaves* mostly shortly serrate. *Seta* (2.5—) 3—4.5 cm long. *Theca* 3.5—5 mm long, cylindrical, deeply grooved.

Distribution: New Zealand, Chatham Is. In the North Island of New Zealand less often collected than in the South Island and Stewart Island; in the South Island largely confined to its wetter western half.

New Zealand. North Island. Maungaroa: *Berggren 1675* (S-PA), *1686 p.p.* (H, S-PA). Okaihau: *Matthews s.n.* (CHR). Kauhau (Okaihau?): *unknown coll. s.n.* (W). Kaipara: *Mossman 721* (NY). Hukio (Huteo?): *Knight 72 p.p.* (BM, H, NY). Titirangi Ra.: *Swanberg s.n.* (S-PA). Auckland: *Leland et al. 211* (BM, FH, K, MO, US); *Sinclair s.n. p.p.* (BM). Otaua: *Berggren s.n.* (S-PA). Moehau: *Moore s.n.* (CHR). Coromandel: *Berggren 1673* (H, S-PA); *Hutton 39* (K). Hunua: *Moore 412* (CHR). Tuhua: *Hochstetter 260 p.p.* (W). Lake Rotorua: *Allison 576* (Allison, FH). Atiamuri: *Allison 25* (Allison). Lake Waikaremoana: *van Zanten 682146bis* (GRO, L). Field Hut: *Zotov s.n.* (CHR). Eastbourne: *Martin s.n. p.p.* (CHR). — South Island. S. of Charleston: *Lash 34* (CANTY). Westland: *Blotam s.n. p.p.* (H). Atarau: *Barker 69191* (CANTY). Greymouth: *Brownlie 211* (CANTY); *Helms 3* (H), *4* (H). Moana: *Beckett 1007B* (CANTY). Arahura: *Berggren 1671* (H, S-PA). Taramakau: *Berggren 1674* (H, S-PA). Inchbonnie: *Beckett 1007C* (CANTY). Jacksons: *Berggren s.n.* (S-PA). Kelly's Ra.: *Beckett 1007* (CANTY, FH). Kokatahi: *Wilson s.n.* (CANTY). Waiho: *Martin 268.31* (CHR), *268.41* (BO, CHR). Lake Matheson: *Martin 268.42* (CHR). Otago: *Buchanan s.n.* (H); *Hector s.n.* (H, NY). Deep Stream between Outram and Middlemarch: *Allison 9597* (Allison), *Linzey 3110* (Allison). Dunedin, Swampy Hill: *Martin 268.30* = *835* (Allison, BO, CHR). Clinton Valley: *Petrie 524* (H). Southland: *Bell 199* (H). Head of Milford Sound: *Allison 7450* (Allison). Milford Track: *Wormald 8* (Allison). George Sound, Lake Katherine: *Mason s.n.* (CHR). Lake Manapouri: *Martin 268.39* (CHR), *Simpson s.n.* (CHR). Doubtful Sound: *Simpson s.n.* (CHR). Ibid., Helena Falls: *Martin 268.37* (CHR), *268.40* (BO, CHR). Dusky Sound: *Menzies s.n.* (K, S-PA). Ibid., Supper Cove: *Zotov s.n.* (CHR). Bluff—Invercargill—Winton: *Berggren 1670* (H, S-PA, W). — Stewart Island. Port William: *Martin 268.23* (CHR). Halfmoon Bay: *Bell 707* (H). Kaipipi Track: *Martin 268.19=779* (CHR), *268.35* (CHR). Glory Harbour: *Martin 268.5* (CHR), *268.24* (CHR), *268.26* (BO, CHR). Lord's R.: *Martin 268.10* (CHR), *268.28* (CHR). Port Pegasus: *Martin 268.12* (BO, CHR), *268.22* (CHR), *268.34* (CHR). Rosa I.: *Martin 268.9* (BO, CHR).

Chatham Islands. Exact locality not given: *unknown coll. s.n.* (BM). Nairn R.: *Findlay s.n.* (CHR).

Notes: 1. The differences between ssp. *spininervium* and ssp. *archeri* are small, and plants without sporophytes cannot be named with certainty. As a rule, plants belonging to ssp. *archeri* are more loosely and irregularly branched than those of ssp. *spininervium* and they often are more flaccid and glossy.

2. According to Mueller (1898) *H. planifrons* C. Muell. should have tiered fronds, a feature rarely encountered in sect. *Hypnodendron*. However, the type specimen appeared to be no more than a swamp form of the present species with innovations sprouting from decaying old fronds.

3. New Zealand plants of *H. spininervium* and *H. arcuatum* are sometimes covered by mud and diatoms, and their older leaves may wear away up to the costa as in aquatic forms of *H. marginatum*. Some plants had apparently formed very compact turfs on muddy soil. These plants sometimes had almost indistinguishable stipes and erect crowded branches. Their stipe leaves were normal but the branch leaves were broad and flaccid with rather blunt and often somewhat cucullate apices. These plants differ from aquatic forms of *H. marginatum* in having wider, more glossy leaves which lack a distinct marginal border. On an average, their leaf cells are shorter than is usual in *H. spininervium*, but they are much longer than in *H. marginatum*.

b. ssp. **archeri** (Mitt.) Touw, *stat. nov.* — *Isothecium archeri* Mitten in Wilson in J. D. Hooker (1859) 206, t. 175 f. 8; Bastow (1887) 84. — *Trachyloma archeri* Mitten (1859B) 86. — *Hypnum archeri* Hampe in F. von Mueller (1880) 51. — *Hypnodendron archeri* Jaeger in Jaeger et Sauerbeck (1880) 359; Mitten (1882A) 90; Paris (1895) 603, (1904) 372; Brotherus (1909C) 1169; Rodway (1914) 211; Brotherus (1924B) 438. — Type: *Archer s.n.* (NY holo, K), Tasmania, Cheshunt, Ovens Creek.

Hypnodendron leiopyxis C. Mueller (1898) 169; C. Mueller *ex* Paris (1895) 606, *nom. nud.*, (1900) 192, (1904) 373; Brotherus (1909C) 1169, (1924B) 438; van der Wijk et al. (1962) 533. — Type: *J. G. Luehmann s.n.* (B holo †, H lecto, JE, S-PA), Australia, Victoria, Gippsland, Moe River.

Hypnum arcuatum Hedw. *emend.* Mitten (1856) 265, *pro parte*.

Plants often somewhat taller than in ssp. *spininervium*. *Fronds* often irregularly branched to broadly pinnate or palmate. *Stipe leaves* having distinctly papillate cells. *Branch leaves* serrulate to shortly serrate. *Seta c.* 1.5—3 cm long. *Theca c.* 1.5—2.5 (—4.0) mm long, obconical to shortly cylindrical, often only shallowly grooved.

Distribution: Victoria, King I., Tasmania.

Australia. Victoria. Dimboola: *Reader s.n.* (W). Near Cape Otway: *Walter s.n.* (BM, MEL). Apollo Bay: *von Mueller s.n. p.p.* (BM, H, MEL). Melbourne: *unknown coll. s.n.* (H, S-PA). Healesville: *Murdoch 702 p.p.* (BM). 50 miles E. of Melbourne: *Podolinsky s.n.* (JE). Warburton: *Guilfoyle s.n.* (MEL); *Melville 3822* (K). Fernshaw: *Berggren s.n.* (FH, L, NICH); *Campbell s.n. p.p.* (H). Black Spur: *Watts 333* (H). Moe R.: *Luehmann s.n.* (H, JE, S-PA). Wilson's Promontory, Sealer's Cove: *McVean 26564* (L); *von Mueller 165 p.p.* (MEL). Steepbank R.: *von Mueller s.n.* (MEL). East Gippsland: *Bäuerlen 74* (MEL).

King Island. Grassy: *Cameron 10* (MEL).

Tasmania: *Taylor 22* (H). Gould's Country: *Simson s.n. p.p.* (S-PA). Frenchman's Cap: *Moore 38 p.p.* (H, NY). Mt. Wellington, Sassafras Gully: *Beesley (Hb. Weymouth 287)* (BM). Guy Fawkes' Rivulet: *Weymouth 279 p.p.* (H). Tasman Peninsula, Willard Rivulet: *Weymouth 786 p.p.* (H). Ibid., Newman's Creek: *Weymouth 746 p.p.* (FH, H, NY). Cheshunt, Oven's Creek: *Archer s.n.* (K, NY). St Patrick's R.: *Gunn s.n.* (BM).

Notes: 1. Differing from all other representatives of sect. *Hypnodendron* by its very short capsules. The differences between ssp. *archeri* and ssp. *spininervium* have been discussed under the latter.

2. Occurring in the same localities and often collected mixed with but far less common

than *H. vitiense* ssp. *australe*. The latter is a more robust and rigid plant, having broadly palmate to subumbellate fronds, more glossy leaves, and longer capsules. The most reliable characters for separating the two are found in the stipe leaves.

11. Hypnodendron microstictum Mitten *ex* Jaeger in Jaeger et Sauerbeck (1880) 360; Mitten (1869) 566, *comb. inval.*; Paris (1895) 604, (1904) 373; Brotherus (1909C) 1169; Herzog (1923) 18; Brotherus (1924A) 444, (1924B) 438; van der Wijk et al. (1962) 533. — *Hypnum microstictum* C. Mueller (1874B) 619, *comb. inval in annot.* — Type: *Spencer 33/34* (NY holo, BM, K), Chili, Colchagua ('Colchaque'). — **Fig. 20, 22.**

Hypnum krausei C. Mueller (1874B) 619. — *Hypnodendron krausei* Jaeger in Jaeger et Sauerbeck (1880) 360; Paris (1895) 604; Dusén (1903A) 13, 16, 25, (1903B) 119; Paris (1904) 373; Brotherus (1909C) 1169, (1924B) 438; Reimers (1926) 57; Herzog (1938) 46, (1939) 28; Schwabe (1939) 43, 49; Herzog (1954) 78; Bartram (1957C) 34. — Type: *Krause s.n.* (B holo †, BM lecto, JE, K, NY, W), Chile, Prov. Valdivia, Corral, on rocks in gorge.

Plants rather small, erect to horizontally growing, mostly densely tufted, yellowish green to pale green and glossy, less frequently darker green to brownish and dull. *Stipe* up to 4.5 cm long, sometimes ill-defined, occasionally more or less tomentose. *Frond* loosely to densely pinnate, less frequently palmate (especially in plants bearing sporophytes), up to 2.5 (—3.5) cm across; branches weakly to often strongly complanate, flexuose, often fastigiate. *Stipe leaves* green, spreading obliquely, often only slightly different from the branch leaves, triangular-ovate to rather narrowly triangular-ovate, 0.9—2.3 (—2.5) by 0.8—1.3 mm, L/W ratio 1.3—2.3; insertion line concave; base cordate; apex acute to shortly acuminate; margin near base strongly recurved, upwards flat and serrulate to shortly serrate, occasionally almost entire; costa strong, percurrent to shortly excurrent, bearing 0—4 dorsal teeth; cells 30—100 by 6—8.5 μ, L/W ratio *c.* 5—15, distinctly shortly papillate; lamina cells along the margin occasionally more elongate and less papillate than the inner ones, thus forming a more or less distinct border; alar and basal cells as in *H. spininervium*. *Branch leaves* ovate-oblong, the laterally spreading ones 1.4—2.4 (—3.2) by 0.6—1.1 mm, L/W ratio 2.1—3.0 (—3.3), dorsal leaves smaller; base even more rounded than in *H. spininervium*, apex often narrower than in that species; margin bearing up to 30 (—40) μ long simple teeth that are concolourous with the inner lamina cells or slightly darker; costa strong, percurrent, bearing up to 7 dorsal teeth; lamina cells 30—60 by 5—7 μ, L/W ratio *c.* 6—10, walls strongly papillate with short papillae.

Up to 8 *sporophytes* per frond. *Seta* flexuose, 2.5—4 cm long, reddish. *Theca* weakly to strongly curved, narrowly cylindrical, 4.5—6 mm long, brown; neck often weakly strumose. *Cilia* 2—4. *Operculum* 2.5—3 mm long. *Calyptra c.* 3 mm long.

Distribution: Juan Fernandez group; South Chile and adjacent Argentina between 34° and 46° S. Lat.

Juan Fernandez group. Más Afuera. Quebrada del Mono: *Skottsberg 267 p.p.* (BM, H, NY, S-PA). — Más à Tierra. El Yunque: *Kunkel M 348* (S-PA). Valle Frances: *Kunkel M 89* (FH, H, S-PA).

Chile: *Spencer 49* (K). Serena: *Schumacher 2/h* (BP). Colchagua ('Colchaque'): *Spencer 33/34* (BM, K, NY). Angol: *Dusén 141* (GRO, L). San Leo: *Dusén 861* (H, S-PA). Lago Laualhue: *Claude-Joseph 5960* (FH). Queule: *Dusén 317* (H, L, S-PA). Corral: *Hosseus 40* (JE); *Krause s.n.* (BM, JE, K, NY, W); *Thaxter 45* (FH, L, US), *71* (FH). Lago Panguipulli: *Hollermayer 292* (W), *292a* (JE). Arique: *Lechler s.n.* (L, S-PA). Lago de Todos Santos: *Wolffhügel 5324* (JE). Rio Puelo: *Sparre 4311* (FH, S-PA). Puerto Montt: *Dusén 373* (H, S-PA). Calbuco I.: *Schwabe 74 p.p.* (JE). Chiloé, Chepu: *Godley 370* (H). Guaitecas I.: *Dusén 634* (S-PA), Puerto Low: *Dusén s.n.* (S-PA). Puerto Puyuhuapi: *Schwabe*, 6 collections (JE). Rio Aysen: *Dusén 512* (S-PA), *Musci Exsicc. Amer. 2224 p.p.* (BM, FH, L, S-PA, W).

Argentina. Lago Nahuel-huapi, Puerto Moreno: *Dusén 734* (H, S-PA). Puerto Blest: *Dusén 841* (S-PA).

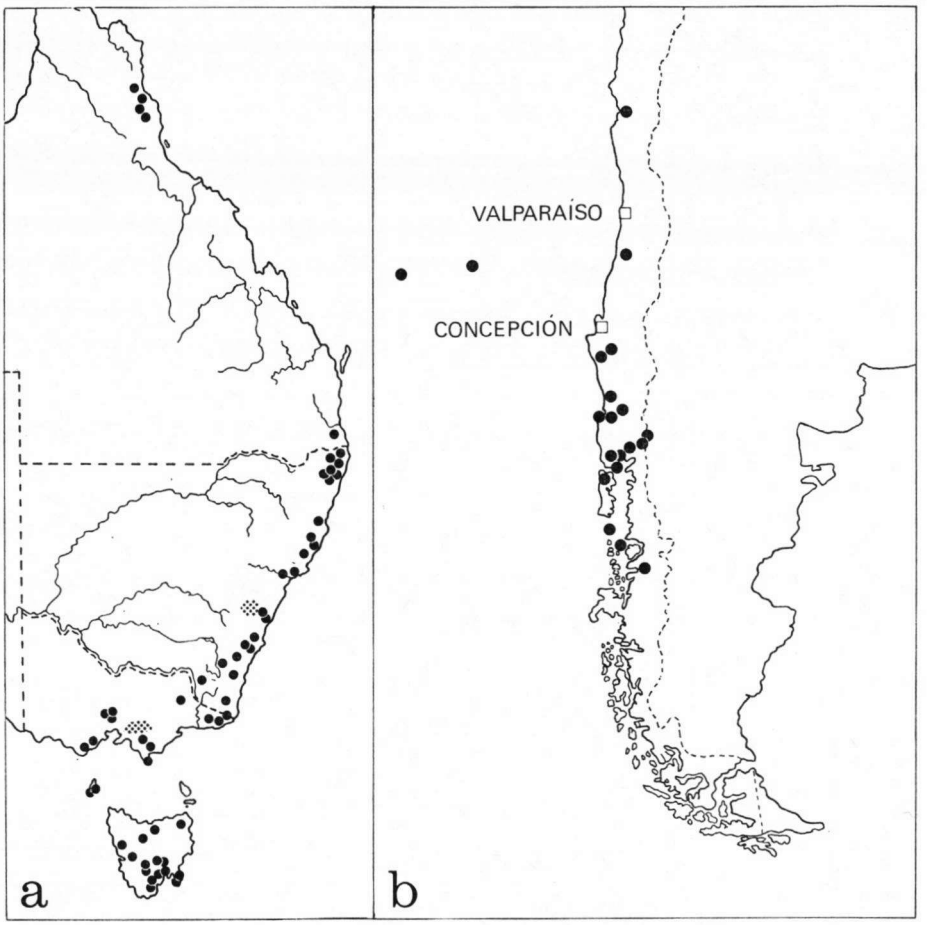

Fig. 22. Distribution of *Hypnodendron vitiense* ssp. *australe* (a) and *H. microstictum* (b).

Ecology: Terrestrial, on tree trunks and rocks in rain forests, along streams and in caves. In Màs Afuera collected up to 1100 m alt.; altitudinal distribution in South America unknown but presumably mainly growing in the lowland.

Notes: 1. The differences between *H. microstictum* and *H. spininervium* have been explained under the latter.

2. There is no reason to separate *H. krausei* from *H. microstictum*. The type specimens of both belong to the small form of the species, which is typical for the Chilean mainland north of 42° S. Lat. These plants are up to 6 cm high but are often considerably smaller. The stipe leaves measure *c.* 1.0—1.3 by 0.8—1.0 mm (L/W ratio *c.* 1.3—1.6) and bear 0—2 dorsal teeth; the branch leaves measure 1.4—1.6 by 0.6—0.75 mm (L/W ratio 2.1—2.3). Plants from Juan Fernandez are more robust and have stipe leaves measuring *c.* 1.5—2.5 by 0.7—1.3 mm (L/W ratio *c.* 1.8—2.3) and bearing 1—4 dorsal teeth. Their branch leaves are also more robust (1.9—3.2 by 0.7—1.1 mm, L/W ratio 2.3—3.3). In Patagonia south of 42° S. Lat. the small form has been collected together with plants transitional between it

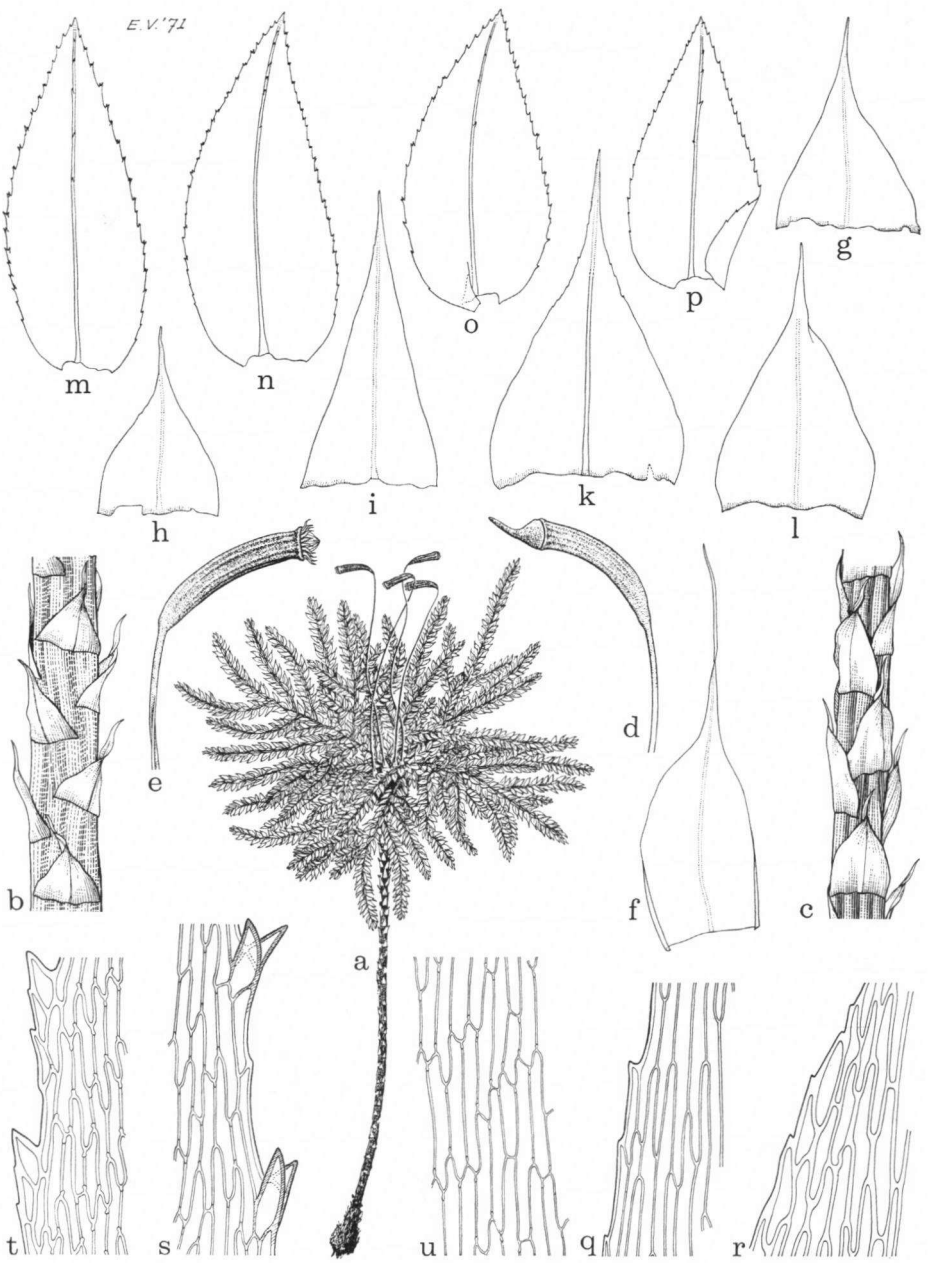

Fig. 23. *Hypnodendron vitiense*. a, b, f—i, m—o, q, s, u: ssp. *vitiense*; c—e, k, l, p, r, t: ssp. *australe*. — a: Habit, × 1; b, c: stipes, × 8; d, e: capsules, × 4; f: perichaetial leaf, × 17; g—l: stipe leaves, × 17; m—p: branch leaves, × 17; q, r: margins of stipe leaves, × 260; s, t: margins of branch leaves, × 260; u: areolation of branch leaf, × 260. (a, b: *Braithwaite 4457*; c: *Maiden s.n.*; d, e: *Forsyth s.n.*; f, h: *Merrill BS 6816*; g: *Dissing 2237*; i, m, q, s, u: *Robbins 2352*; k: *Oldfield 65*; l, p, r, t: *Pullen 4022*; n: *Smith 5173*; o: *Wang 1972*).

and the tall form from Juan Fernandez. A separation of these extremes appears therefore unjustified.

3. According to van der Wijk et al. (1962) *H. krausei* was reduced by Reimers (1926). This is incorrect, as Reimers only suggested its reduction to *H. microstictum*.

4. As in *H. spininervium* old stipes are occasionally rather densely clad by tomentum.

12. Hypnodendron vitiense Mitt. — **Fig. 22—24.**

For synonyms, literature, and type specimens see under the subspecies.

Plants medium-sized to tall, erect to occasionally horizontally growing, loosely tufted, usually very glossy, pale green to golden green or sordid green. *Stipe* up to 9 cm long. *Frond* irregularly palmate to subumbellate, less frequently pinnate, up to 6 (—7) cm across; branches sparingly branched to pinnate, complanate. *Stipe leaves* with appressed base and appressed to more or less spreading apex, narrowly to broadly triangular to triangular-ovate, 1.2—2.9 by 0.7—1.5 mm, L/W ratio 1.4—2.5, white to pale greenish or brownish, often very thin; insertion line straight or nearly so, angles closely appressed to the stipe; apex gradually to rather abruptly acuminate; margin subentire to weakly toothed near apex, teeth usually wide apart; costa thin, often ill-defined (especially near base), dorsally smooth, ending in apex, percurrent or shortly excurrent; lamina cells 65—210 by 6—12 μ, L/W ratio *c.* 10—25, smooth or nearly so; alar cells indistinct. *Branch leaves* ovate-oblong, laterally spreading ones 1.8—2.9 by 0.8—1.4 mm, L/W ratio 1.8—2.9, dorsal leaves smaller, apex acute to slightly acuminate; margin bearing simple teeth or a mixture of simple and geminate teeth, teeth up to 45 μ long, mostly much smaller, often orange or brownish; costa strong, ending in apex or percurrent, bearing up to 8 (—11) dorsal teeth; lamina cells 35—95 by 5—10 μ, L/W ratio *c.* 6—12 (—14), usually thin-walled and faintly to distinctly papillate.

Up to 18 *sporophytes* per frond. *Seta* flexuose to nearly straight, 2—4.5 cm long, brown to orange or reddish. *Theca* curved, narrowly cylindrical, 3.5—5.5 mm long, pale orange to pale brown, dark brown, or reddish. *Cilia c.* 2—4. *Operculum c.* 1.5—2.5 mm long. *Calyptra c.* 3—4 mm long.

Distribution and ecology: See under the subspecies.

Note: *Hypnodendron vitiense* has been divided here into two weak subspecies. North Queensland appears to be a transitional area where plants of both have been found. All plants from North Queensland are small and often depauperate. Sporophytes have not been found there. A number of specimens could not be placed, either because they combined characters of both subspecies, or because they were in bad condition. These specimens have been listed separately under ssp. *vitiense*.

KEY TO THE SUBSPECIES

1. Stipe leaves widest just above the insertion; geminate marginal teeth of branch leaves absent or few ssp. **australe**

1. Stipe leaves widest at insertion. Geminate teeth usually numerous, rarely few in number ssp. **vitiense**

a. ssp. **vitiense.** — *Hypnodendron vitiense* Mitten in Seemann (1873A) 401; Bescherelle (1894) 56; Paris (1895) 605, (1904) 375; Brotherus (1909C) 1169; Williams (1914) 376; Brotherus (1924B) 438; Dixon et Greenwood (1930) 300; Bartram (1938) 129, (1939) 154 f. 190, (1956) 394, (1961) 371; van der Wijk et al. (1962) 534; Noguchi (1963) 146; Schulze-Motel (1963) 444; van Zanten (1968) 144; van der Wijk et al. (1969) 699. — Type: *B. Seemann 842* (NY holo, FH, K), Fiji Islands.

Hypnum graeffeanum C. Mueller (1874A) 90. — *Hypnodendron graeffeanum* Jaeger in Jaeger et Sauerbeck (1880) 358; Bescherelle (1894) 56; C. Mueller (1896B) 332. — *Hypnodendron graeffei* C. Mueller *ex* Kindberg (1888) 18, *err. pro H. graeffeanum.* — Type: *E. Graeffe s.n.* (B holo †, NY lecto, S-PA), Fiji Islands, mountains of Ovalau, on trees.

Hypnodendron formosicum Cardot (1906) 147, f. 39; Brotherus (1909C) 1169, (1910) 161; Robinson (1914) 206, 210; Brotherus (1918) 222, (1924B) 438; Horikawa (1939) 364, f. 16; Wang (1960) 33; van der Wijk et al. (1962) 533. — Type: *U. Faurie 55* (PC holo, FH, GRO, H, K, S-PA), Formosa, Taitum.

Hypnodendron angustirete Dixon (1938) 16; Schultze-Motel (1963) 441; van der Wijk et al. (1962) 532, (1969) 699. — Type: *G. Eiffert 41* (BM holo, JE), New Guinea, Finisterre Ra., *c.* 800—1000 m.

Hypnodendron ambiguum Brotherus in Schumann et Lauterbach (1905) 34, *nom. nud.*; Fleischer (1917) 34; van der Wijk et al. (1962) 532; Schultze-Motel (1963) 441.

Hypnodendron arcuatum non (Hedw.) Mitt.: Brotherus (1906A) 26, (1909B) 31, (1911) 42; ? Dixon (1942B) 32.

Hypnodendron copelandii non Broth.: Thériot (1931) 137.

Trachyloma junghuhnii [*non* C. Muell.] Mitten (1861) 366, *nom. nud.* — *Hypnodendron junghuhnii non* (C. Muell.) Jaeg.: Herzog (1910) 122.

Hypnodendron macgregorii non Broth. et Geh.: Herzog (1926A) 339.

Hypnodendron samoanum non Mitt.: Bartram (1957B) 22.

Hypnodendron spininervium non (Hook.) Jaeg.: Brotherus et Watts (1915) 157; Thériot (1937) 129.

Stipe leaves triangular, up to 2.0 (—2.3) mm long and 1.1 (—1.4) mm wide, not narrowed at base to rarely slightly narrowed in some leaves, widest at insertion. Margin of *branch leaves* bearing simple and geminate teeth, the latter usually numerous, rarely few in number. *Seta* pale brown to yellowish brown, occasionally orange brown.

Distribution: Ryukyu Archipelago (Okinawa), Taiwan, Annam, Luzon, Negros, Mindanao, Borneo, Moluccas (Batjan), New Guinea, Bismarck Archipelago, Solomon Islands, New Hebrides, New Caledonia, Fiji Islands, Samoa group, N. Queensland. Apparently rare; most frequent in Melanesia.

RYUKYU ARCHIPELAGO. Okinawa. Mt. Yonaha: *7 collections.*

TAIWAN. Taitum: *Faurie 55* (FH, GRO, H, K, PC, S-PA). Tai-Ping Tsun: *Wang 1972* (L).

ANNAM. Liên-Chiên: *Poilane 7617a* (PC).

LUZON. Ifugao. Mt. Polis: *Tixier 1785* (L). Mt. Tabayoc: *Jacobs B 16* (L). — Benguet. Baguio: *Williams 1886* (FH, GRO, H, NY, US). Pauai: *McGregor BS 8681* (BM, H, K, NY). — Laguna: *Deguilla 18* (GRO); *Robinson 17094* (BO, GRO, H, K, L, NY, US). Mt. Maquiling: *Baker 2752* (BM, H, L); *Elmer 18359* (BM, BO, FH, H, KAG, S-PA, W); *Hadden 123* (FH); *Herklots P 6a* (BM). Mt. Banahao: *Iwatsuki et al.*, 12 collections (L, NICH).

NEGROS. Occidental. Mt. Canlaon: *Merrill BS 6816* (BM, BO, FH, GRO, H, JE, K, L, NY, US).

MINDANAO. Davao. Mt. Apo: *Mearns A* (BM, NY, US); *Robbins 3979* (L); *Williams 3169* (FH, H, NY, US).

MOLUCCAS. Batjan. G. Sibela: *Alston 16947 B* (BM).

NEW GUINEA. West New Guinea. Mt. Cyclops: *Cheesman 21 p.p.* (BM). — Territory of New Guinea. Yangoru: *Robbins 2352* (CANB, FH, L), *2354* (CANB, FH, L). Mt. Hagen Village: *van Zanten 68865* (GRO, L). Mountains near Madang: *Blum s.n.* (JE). Bogadjim: *unknown missionary s.n.* (JE). Finisterre Ra.: *Eddy 769* (BM, L); *Eiffert 40* (BM, JE), *41* (BM, JE), *48* (BM, JE); *Werner s.n.* (BM, JE). Mt. Herzog, Wagau: *Eddy 1768* (BM, L), *1779* (BM, L), *1825* (BM, L). Sattelberg: *Biro s.n.* (FH, H, L); *Nyman 117* (NY, S-PA); *Zahn s.n.* (FH, H, S-PA).

BISMARCK ARCHIPELAGO. New Ireland. Lelet: *Køie 2123* (L). Kalili: *Dissing et al. 2237* (L).

SOLOMON ISLANDS. Bougainville. Lake Loloru Crater: *Kajewski 2170D* (FH); *Schodde & Craven 3746A* (CANB). — Kolombangara: *Braithwaite 4457* (L). — Guadalcanal: *Braithwaite 4102* (L). Mt. Popomanasiu: *van Zanten*, 8 collections (GRO, L).

NEW HEBRIDES. Espiritu Santo. Santo Peak: *Robbins 3848* (L), *3849* (L). — Tongoa: *Bowie*

66 p.p. (H). — T a n a: *Aubert de la Rue 118* (FH, NICH, S-PA). — F u t u n a: *Gunn 300* (H), *902* (H). — A n e i t y u m: *Gunn 374* (H), *914* (H); *Remy s.n.* (NY).

NEW CALEDONIA: *Vieillard s.n.* (BM). Poindimié: *Le Rat s.n.* (H). Mt. Arago: *Bernier 1089* (H, PC), *s.n.* (PC). Mt. Rembai ('Pembai'): *Le Rat s.n.* (H). Mt. Dogny: *Le Rat 1540* (H). Mt. Mou: *Le Rat s.n.* (GRO, L, S-PA). Mt. Dzumac: *Le Rat 1044* (H). Mt. des Sources: *Le Rat 976* (H). Mt. des Koghis: *Franc s.n.* (FH, JE). Pic Malaoui: *Le Rat s.n.* (S-PA). Yahoué: *Franc s.n.* (FH). 'Thique Valley': *Williams 265* (FH). Tao: *Franc s.n.* (FH).

FIJI ISLANDS. Exact locality not given: *Seemann 842* (FH, K, NY). — V i t i L e v u. Nandarivatu: *Greenwood 680* (BM, FH). Mt. Victoria: *Greenwood 1208* (FH), *1219* (FH); *Selling 37* (FH); *Smith 5173* (FH, K, L, NY, S-PA, US, W). — K a n d a v u: *Kleinschmidt s.n.* (H). — O v a l a u: *Graeffe s.n.* (NY, S-PA). — T a v e u n i. Somosomo: *Smith 8371* (B, FH).

SAMOA GROUP. S a v a i i. Maugaloa and Central Savaii: *Reinecke 75* (FH). — U p o l u. Malua: *Hills 30* (BM). Afiamalu: *Irwin 268* (FH), *288* (FH). Tiavi: *Rechinger 2619* (H, W).

AUSTRALIA. Q u e e n s l a n d. Bellenden Ker Ra.: *Karsten 2* (MEL). Ravenshoe: *Sherrin 61* (BM). Atherton Tableland: *van Zanten 681234* (GRO, L), *681334* (GRO, L).

D o u b t f u l: AUSTRALIA. Q u e e n s l a n d. Mt. Lewis: *van Zanten 681190* (GRO, L). Bloomfield R. between Cooktown and Mossman: *Kaernbach 6* (BM, H, W). Kuranda: *Watts 278* (H). Mt. Bellenden Ker: *Flecker 3133* (BM). Yungaburra: *Watts 675* (H). Russell R.: *Sayer MEL 34523* (MEL). Babinda: *Watts 290* (H). Charmellan's Creek: *Watts 676 p.p.* (BM).

E c o l o g y: Terrestrial, on decaying logs, tree bases, and wet rocks; in rain forests. From sea level up to 2400 m; most collections have been gathered between 900 and 2200 m.

N o t e s: 1. The tallest plants of ssp. *vitiense* have been collected in New Guinea, the Bismarck Archipelago, the Solomons, and Fiji. Many plants from Fiji are less glossy than those from the other islands mentioned here. The Samoan plants are often smaller, and in this respect they correspond with those from the New Hebrides and New Caledonia. These, however, are often only slightly glossy or dull and their branches are often ascending instead of horizontally spreading. The New Caledonian plants approach those from North Queensland in being often small and more or less depauperate and in having stipe leaves which are occasionally slightly narrowed at base. In the Philippines both tall and small plants have been found. Here the number of geminate teeth varies considerably. The plants from Taiwan and the Ryukyus are again small. They are often only slightly glossy, loosely pinnate, and have few geminate teeth. As in Queensland, sporophytes have not been found there.

2. *Hypnodendron vitiense* can easily be recognized by its almost entire, triangular, and ± appressed stipe leaves. Nevertheless, it has often been confused with other species, and even with such widely different ones like *H. auricomum* and *H. diversifolium*. Mitten (1861) originally mistook Seemann's specimen from Fiji (the first collection of *H. vitiense*) for *H. junghuhnii*, which he reckoned to belong to *Trachyloma*. In 1873 he changed his opinion and based his new species *H. vitiense* on that same specimen. His diagnosis is very brief and contains no information about the stipe leaves. This might be the main reason why *H. vitiense* has long remained an obscure and misinterpreted species. Mueller (1874A) published a detailed description of *Hypnum graeffeanum*, clearly stating that *Trachyloma junghuhnii* Mitt. 1861 was the same species. Unfortunately, he too did not give any details concerning the margin of the stipe leaves.

3. Apparently, Cardot (1906) did not realize the close affinity between *H. vitiense* and his new species *H. formosicum* which he compared with *H. arborescens* (*H. subspininervium* ssp. *arborescens*). Reduction of *H. formosicum* was already suggested by Noguchi (1963).

4. I have not been able to find any essential difference between *H. vitiense* and *H. angustirete* Dix. which was compared by its author with *H. auricomum*. According to Dixon (1938) its branch leaf cells measure only 3—4 μ in width, but I only found cells 7—9 μ wide in the type specimen. I suppose Dixon was misled by the strongly plasmolized cell contents which are often more clearly visible than the thin and hyaline cell wall.

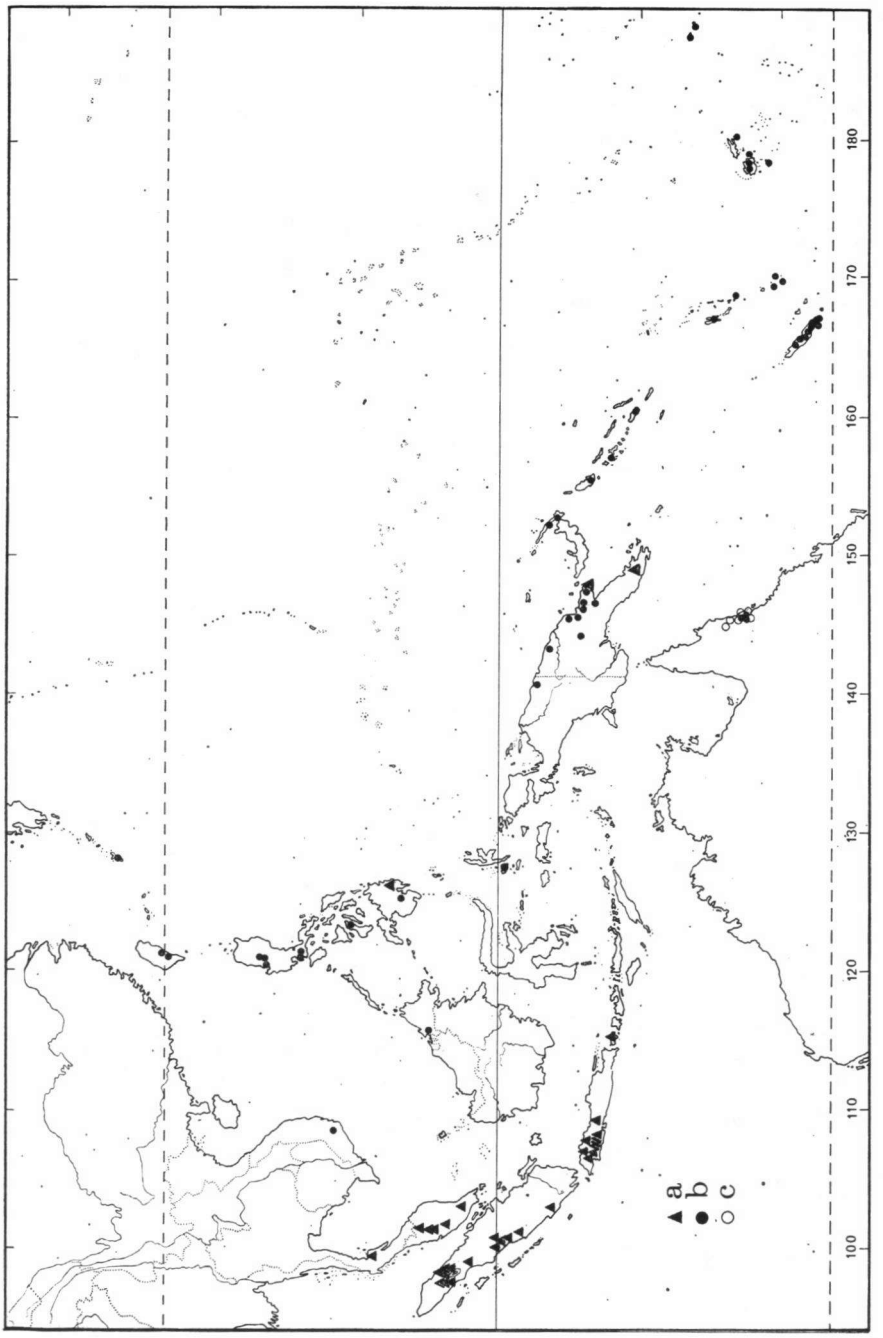

Fig. 24. Distribution of *Hypnodendron junghuhnii* (a) and *H. vitiense* ssp. *vitiense* (b); open circles (c) refer to Queensland collections of *H. vitiense* that could not be placed in one of the subspecies.

b. ssp. australe, *ssp. nov.*

Folia stipitis supra insertionem latissima. Dentes marginales foliorum ramorum raro bifidi.

Type: *L. G. Adams 1425* (L holo, B, BM, CANB, CHR, FH, MEL, NSW, P, TNS, US), Australia, New South Wales, slopes of Mt. Budawang, near Mongarlowe, creek-bed in tree-fern gully, damp rocks near waterfall, moderate shade.

Hypnodendron spininervium (Hook.) Jaeg. var. *pumilum* C. Mueller in C. Mueller et Brotherus (1900) 509, *nom. nud.*; Paris (1904) 374.

Hypnodendron whiteleggei C. Mueller *ex* Burges (1935) 84, *nom. nud. in syn.*

Hypnum arcuatum non Hedw.: Mitten (1856) 265, *pro parte.* — *Trachyloma arcuatum non* Mitt.: Mitten (1859B) 86, *quoad spec.* — *Hypnodendron arcuatum non* Mitt.: Mitten (1882A) 90; ? Dixon (1942B) 32; Sainsbury (1955A) 46.

Hypnum spininervium non Hook.: C. Mueller et Hampe (1855) 503; Hampe (1856) 213. — *Isothecium spininervium non* Wils.: Wilson in J. D. Hooker (1859) 206; Bastow (1887) 84. — *Hypnodendron spininervium non* Jaeg.: C. Mueller et Brotherus (1900) 509; Brotherus et Watts (1918) 567.

Stipe leaves triangular-ovate, up to 2.9 mm long and 1.5 mm wide, widest above the insertion. Marginal teeth of *branch leaves* simple or mixed usually with very few geminate ones. *Seta* yellowish brown to orange, red, or brown, usually tinged with orange or red at least. n=9; 2n=18 (Ramsay in Löve, 1967).

Distribution: E. Australia (Queensland, New South Wales, Victoria), Tasmania. In Queensland less frequent than elsewhere.

Australia. Queensland: *Bailey s.n.* (CANTY, H, JE, W). Cairns, Upper Mossman Creek: *Hawkins 1213* (BM). Mt. Bartle Frere: *var Zanten 681504* (GRO, L). Atherton Tableland: *Cruttwell 1180* (K). Toohey Creek: *Flecker 3373* (BM). Pimpama: *Wild s.n.* (CANTY, FH, MEL). — New South Wales. Tweed R.: *Forsyth 12* (H). Mt. Warning: *Guilfoyle s.n.* (MEL). Brunswick R., Myocum: *Watts 1570* (H), *1674* (H), *3848* (H). Richmond R.: *Camara 28* (MEL), *M 46* (JE); *Watts 1612* (CANTY), *4955* (BM). Tintenbar: *Maiden 37* (K); *Waterfall 303* (BM). Wilson's Creek: *Watts 2145* (H), *2193* (BM, H, JE), *2202* (H), *2208* (H). Alstonville: *Waterfall 306* (BM), *Watts 537* (H), *599* (H). Marshall's Falls: *Watts 600* (H), *1935* (H). Coolgardie Falls: *Watts 2035* (H), *2039* (H). Skinner's Creek: *Watts 829* (H). Clarence R.: *Rudder s.n.* (MEL, NY); *Wilcox s.n.* (W). Dorrigo: *Tindale 10221* (K). Pine Creek: *Mitchell A 194* (Allison). Bellinger R.: *Moore 19* (W). Bellinger and McLeay R.: *Rudder s.n.* (MEL, NY). Port Stephens: *Maiden 56* (K), *Watts 51* (NY), *52* (CANTY, NY). Hunter R.: *Rudder s.n.* (MEL). Blue Mountains: *Booth 6244* (BM), *Whitelegge 103* (MEL); *Woolls s.n.* (NY); *unknown coll. MEL 34551* (MEL), *MEL 34590* (MEL). Blackheath: *Forsyth s.n.* (S-PA); *Hamilton 788* (FH). Katoomba: *Fuller 84* (CANB). Megalong Valley: *Ramsay 1/65* (SYD), *70/64* (SYD). Zircon Creek: *Ramsay 42/65* (SYD). Jenolan Caves: *Blakeley 577* (H). Mt. Tomah: *Maiden s.n.* (CANTY, H, MEL, S-PA). Mt. Victoria: *Day s.n.* (CANB). Mt. Wilson: *Constable & Tindale M 10226* (FH, GRO, US). Paramatta: *von Mueller s.n.* (MEL). Sydney: *Whitelegge 101* (MEL), *102* (MEL). Illawarra: *Kirton 14* (H, MEL). Moss Vale, Fitzroy Falls: *Whitelegge 200* (MEL). Mt. Cambewarra: *Whitelegge 353* (H). Shoalhaven: *unknown coll. 83* (MEL). Mt. Budawang: *Adams 1425* (B, BM, CANB, CHR, FH, L, MEL, NSW, P, TNS, US). Clyde Mt.: *Bäuerlen 138* (H, JE); *Pullen 4022* (CANB, I). Tumbarumba: *Forsyth 780* (H). Brown Mt.: 6 collections. Lilyvale: *Forsyth 781* (H). Minmi: *Watts 4993* (H). Charley's Forest: *McVean 26518* (L). — Capital Territory. Cotter Valley: *Burbidge 7409* (CANB). — Victoria. Gippsland: *unknown coll. MEL 34574* (MEL). East Gippsland: *French s.n.* (H, MEL); *Merrall 4* (MEL); *Walter s.n.* (BM, FH, MEL). Apollo Bay: *von Mueller 42* (MEL), *75* (MEL); *Oldfield s.n.* (MEL). Otway Ra. NW. of Lorne: *Davis s.n.* (MEL). Mt. Juliet: *Sullivan 25* (MEL). Mirimba, Delatite R.: *Melville et al. 3270D* (K). Mt. Macedon: *unknown coll. 13 p.p.* (MEL). Mt. Disappointment: *unknown coll MEL 34591* (MEL). Head of Plenty R.: *Melville & Ashton 3937A* (K). Upper Hume R.: *von Mueller s.n.* (BM, MEL). Dandenong Ra.: 10 collections. Kallista: *Catcheside 53.62* (NICH, US). Gembrook: *Bastow 701* (BM). Healesville: *French Jr 4048* (FH); *Murdoch 702 p.p.* (BM); *Schauinsland 103* (H). Yarra R. Valley: *Thomas 12* (MEL); *unknown coll. s.n.* (BM, MEL). Fernshaw: *Berggren s.n. p.p.* (FH); *van Zanten 681762* (GRO, L). Black Spur: *Campbell s.n. p.p.* (H); *unknown coll. s.n.* (MEL). 50 miles E. of Melbourne: *Podolinsky s.n.* (JE). Bunyip R. near Beenak: *Willis MEL 34451* (MEL), *MEL 34534* (MEL). Nayook West: *Willis MEL 34481* (MEL). Noojee: *McVean 269104* (L). Moe: *von Mueller s.n.* (MEL). Yinnar: *Morrison s.n.* (MEL). Wilson's

Promontory, Sealer's Cove: *von Mueller 158* (MEL, NY), *165 p.p.* (MEL); *unknown coll. MEL 34548 p.p.* (MEL). Alberton: *Newton 28* (JE). Bogong High Plains, Middle Creek: *Skewes MEL 29925* (MEL), *34535* (MEL); *Willis MEL 34449* (MEL). Mt. Ellery: *Willis MEL 34000* (MEL). Mt. Drummer: *Wakefield MEL 34448* (MEL); *Willis MEL 34450* (MEL). Genoa R.: *Witherhead s.n.* (JE). Loutit Bay: *Luehmann s.n.* (MEL). Buffalo Ra.: *von Mueller 66* (MEL). Cumberland Valley: *Mauritzon s.n.* (S-PA).

KING ISLAND. Yarra Creek: *Cameron 33* (MEL). South coast: *Leschenault s.n.* (BM).

TASMANIA. Glengarry: *McLeod s.n.* (MEL). Gould's Country: *Robinson 396* (MEL); *Simson s.n. p.p.* (S-PA). Great Western Tiers Ra., Westmorland Falls: *Eastman s.n.* (BM). Lake Bellinger Track, Zeehan Railway: *Weymouth 603* (H). Frenchman's Cap: *Moore 38 p.p.* (H, NY). Mt. Field National Park, Russell Falls: *McVean 26766* (L). Styx R.: *Doing M 166* (L). Mt. Dromedary: *Weymouth 68* (MEL). Back R.: *Oldfield 65H* (BM, MEL), *86H* (H). Mt. Wellington: *Bastow 159* (CANTY); *Robbins 2622* (CANB), *Weymouth 146* (H), *928* (BM, H, K). Cascade (Rivulet?): *Bastow s.n.* (MEL). Brown's R.: *Taylor 86* (H). Guy Fawkes' Rivulet: *Weymouth 279 p.p.* (H, NY). Tasman Peninsula, Long Bay: *Taylor 87* (H). Ibid., Newman's Creek: *Weymouth 746 p.p.* (FH, H, NY, S-PA). Ibid., Willard Rivulet: *Weymouth 786 p.p.* (H). Ibid., Port Arthur, Safety Cove: *Willis MEL 34444* (MEL). Sawpit Creek: *Bastow s.n.* (MEL). Huon R.: *Hooker s.n.* (BM, H). Hartz Mt.: *Bufton 13* (H).

Ecology: On moist soil, decaying logs, and wet rocks, very often in or near streamlets; in rain forests and wet sclerophyll forest; from sea level up to 1500 m.

Notes: 1. Up to now the Australian and Tasmanian plants of *H. vitiense* have been wrongly assigned to *H. arcuatum*, *H. spininervium*, or *H. archeri*. Most descriptions and records based on Australian or Tasmanian specimens of these species refer to *H. vitiense* ssp. *australe*, others to *H. spininervium* ssp. *archeri*, and in some gatherings both species are present.

2. The differences between *H. vitiense* ssp. *australe* and *H. spininervium* ssp. *archeri* have been explained under the latter.

3. Most plants from Tasmania, Victoria, and the southern part of New South Wales are tall, and they often bear sporophytes. In N. New South Wales the plants are smaller and sporophytes have been collected less frequently there. The N. Queensland plants are often depauperate, irregularly pinnate, and fruiting examples have not yet been found.

4. Extreme aquatic forms as have been mentioned under *H. marginatum* and *H. spininervium* are apparently very rare in *H. vitiense*. Only one collection containing such plants was found (*Watts 4955* from New South Wales). Its stipe leaves and branch leaves were normal.

13. Hypnodendron junghuhnii (C. Muell.) Jaeger in Jaeger et Sauerbeck (1880) 358; Lindberg (1861) 374, *comb. inval.*; Lindberg in Dozy et Molkenboer (1866) 132, t. 231; Reichardt (1870) 189; Paris (1895) 604; Renauld et Cardot (1896) 107; Cardot (1897) 28, (1901) 117, 118; Paris (1904) 373; Usteri (1906) 390, 473; Brotherus (1909C) 1169; Giesenhagen (1910) 789; Cardot (1912) 177; Möller (1919) 330; Fleischer (1923) 1611, f. 254; Brotherus (1924B) 438; Dixon (1926) 46, (1932A) 32, (1933) 24, (1943B) 19, (1944) 92; Froehlich (1953) 84; Meijer (1954B) 16; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443. — *Hypnum junghuhnii* C. Mueller (1851A) 506, 693; Zollinger (1854) 27. — *Hypnodendron junghuhnianum* Mitten in Seemann (1873A) 401, *err. pro H. junghuhnii*. — Type: *F. W. Junghuhn s.n.* (B holo †, L lecto, BO, GRO), Sumatra, summit of Mt. Luburaja, 5850 ft. — **Fig. 24, 25.**

Hypnodendron junghuhnii (C. Muell.) Jaeg. f. *frondiformis* Fleischer (1923) 1613. — Type: *M. Fleischer 57* (FH holo), Sumatra, Mt. Sibajak, corticolous, 1500 m.

Hypnum reinwardtii Schwaegrichen (1828) t. 233, *pro parte, non typ.*; Hornschuch (1829) 722, *pro parte*, t. 41 f. a, Ib.

Plants tall to very tall, erect, loosely tufted, very glossy, pale green to sordid green. *Stipe* up to 12(—18) cm long. *Frond* palmate to subumbellate in robust plants, often more or less distinctly pinnate in weak ones, up to 8 (—9.5) cm across; branches pinnate to

weakly bipinnate. *Stipe leaves* appressed, deltoid to triangular, 1.6—3.0 by 1.0—2.0 mm, L/W ratio 1.1—1.9, sordid green to brown; insertion line straight or nearly so, angles closely apressed to the stipe; apex gradually to abruptly shortly acuminate; margin coarsely serrate to spinose-serrate, teeth often brownish, unequal, consisting of 1—4 cells, up to 75 μ long, often bearing small secondary denticulations; costa thin, often ill-defined, percurrent to shortly excurrent; lamina cells 50—140 (—170) by (3.5—) 5—8.5 μ, L/W ratio *c.* (6—) 10—20 (—23), walls usually very incrassate and porate, smooth or nearly so;

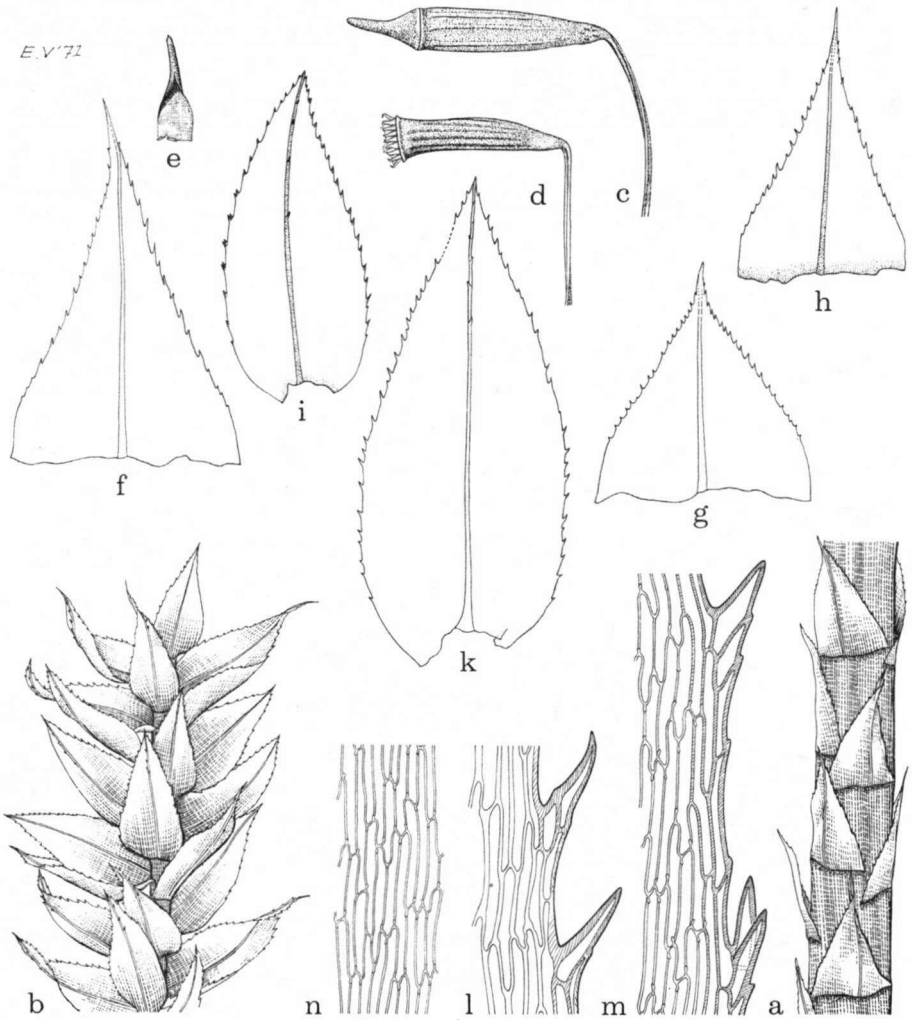

Fig. 25. *Hypnodendron junghuhnii.* — a: Stipe, × 8; b: apex of branch, × 8; c, d: capsules, × 4; e: calyptra, × 4; f—h: stipe leaves, × 17; i, k: branch leaves, × 17; l: margin of stipe leaf, × 260; m: margin of branch leaf, × 260; n: areolation of branch leaf, × 260. (a, c, k: *Schiffner 12477;* b: *Otto-Surbeck 377A;* d: *Bakhuizen van den Brink 3673;* e: *Fleischer s.n.;* f: *Schiffner Cr. Exsicc. 3892;* g: *Touw 11754;* h, i, l—n: *Junghuhn s.n.*).

alar cells indistinct. *Branch leaves* ovate-oblong; the laterally spreading ones (2.1—) 2.4—3.2 (—4.1) by 0.9—1.6 mm, L/W ratio (1.9—) 2.1—2.8, dorsal leaves smaller; apex acute; margin coarsely serrate as in the stipe leaves, teeth up to 75 μ long, often orange or brownish, mostly simple, often mixed with a few geminate ones which are most numerous at the convex side of the leaf; costa strong, percurrent, bearing up to 7 dorsal teeth; lamina cells 30—85 (—105) by 6—7.5 μ, L/W ratio *c.* 6—13 (—15), thin-walled, finely papillate.

Up to 25 (—45) *sporophytes* per frond. *Seta* flexuose to nearly straight, 3—6 cm long, yellowish-brown to reddish-brown, becoming pale brown or blackish when old. *Theca* slightly curved to almost straight, cylindrical, (4—) 4.5—6.5 mm long, pale brown to dark brown. *Cilia c.* 3—5. *Operculum* 2—2.5 mm long. *Calyptra c.* 3.5 — 4 mm long.

Distribution: Malay Peninsula, Sumatra, Java, Bali, Mindanao, E. New Guinea.

PENINSULAR THAILAND. Nakhon Si Thammarat. Khao Luang: *Hutoh T 12836* (NICH), *Kerr 302* (BM, K), *Touw 11754* (AAU, BKF, BM, C, CANB, EGER, GRO, L, NICH, US).

MALAY PENINSULA. Perak. G. Gerah: *Sheffield 28* (BM). — Pahang: *Ridley 177* (H), *185* (H). Cameron Highlands: *Henderson SFN 11723* (BM, SING, US); *Holttum SFN 23349* (SING). Tenom: *Ridley 128* (BM, K, SING). G. Tahan: *Ridley 1014* (BM, K, SING), *1034* (BM, K). Fraser's Hill: *Holttum SFN 11497* (BM, SING). G. Beremban: *Ridley 86* (SING), *116* (BM, SING).

SUMATRA. East Coast. Patani R.: *Staal 203* (BO, GRO), *204* (GRO); *van der Wijk 1563* (GRO, L). Dg. Sinabung: *Lörzing 8194* (BO, GRO). Dg. Sibajak: *Fleischer 57* (FH); *Renner 300* (JE). Dg. Singkut: *van der Wijk 1643* (GRO, L). Dg. Baroes: *Arens 425* (GRO, L); *Bartlett 8484* (BM, FH, MO, NY, US). Berastagi: *Otto-Surbeck 164* (L). Prapat: *van der Wijk 1846* (GRO, L). Dg. Sipiutu: *Troll s.n.* (JE). — Tapanuli. Aek Nalili: *Otto-Surbeck 377A* (L). G. Lubukraja: *Junghuhn s.n.* (BO, GRO, L). — West Coast. G. Singgalang: 9 collections. G. Marapi: 6 collections. G. Sago: *Meijer B 6963* (L), *B 9625* (L). Tindjulaut: *Micholitz 58* (H, K, L, S-PA). G. Kerintji 6 collections. — Benkulen. G. Dempo: *de Groot FRI 15840* (BM, BO).

JAVA. West Java. G. Salak: 12 collections. Depok: *Holle s.n.* (L, W). G. Gedeh and G. Pangrango: 46 collections. G. Patuha: *Jacobson 126 B* (BO, GRO); *Reinwardt s.n.* (L). G. Burangrang: *Bakhuizen van den Brink Sr 4468* (FH); *Hirschland s.n.* (L). G. Wajang: *Hochreutiner 1576* (L, PC); *Junghuhn s.n.* (BO, FH, GRO, H, L, S-PA); *Luitingh 25-11* (BO, GRO); *Rant BOG 799* (BO, GRO, L); *Warburg 3460* (FH, H). G. Kendang: *Koens 224* (BO). Kawa Manuk: *Harms s.n.* (FH, L); *Ridley 114* (BM); *Schiffner Cr. Exs. 3892* (B, BM, EGER, H, L, S-PA, US, W); *Wakker s.n.* (GRO, L); *Winkler 2004* (BM, K). G. Mandalagiri: *Lam 78* (BM, BO, GRO, L). — Central Java. G. Slamet: *Jeswiet 1215* (L).

LESSER SUNDA ISLANDS. Bali. G. Pala: *Sarip 328* (BM, BO, GRO, L).

MINDANAO. Davao. Mt. McKinley: *Edaño PNH 1156* (GRO, L, PNH).

NEW GUINEA. Territory of New Guinea. Yabim near Simbang: *Zahn s.n.* (S-PA). — Territory of Papua. Mt. Dayman: *Armit 622 p.p.* (H).

Ecology: Terrestrial and on rocks near streams, occasionally on decaying logs or tree bases. In rain forests and shrubberies from 900 up to 2900 m; most gatherings have been collected between 1500 and 2400 m.

Notes: 1. *H. junghuhnii* has been confused with *H. auricomum*, *H. vitiense*, and *H. samoanum*. It can be distinguished at once from the first mentioned species by its partially naked stipes, pale colour, usually palmate to subumbellate and very glossy fronds, strongly complanate branches bearing clearly anisomorphous leaves, more delicate sporophytes, deeply sulcate theca, etc. It is closely related to *H. vitiense* and *H. samoanum*, but is usually much taller and has densely and coarsely serrate stipe leaves of a harder texture. The stipe leaves of *H. vitiense* are entire to weakly and distantly serrulate, but aberrant forms of it may have stipe leaves that are shortly serrate near the apex with teeth that are less strong and less sharp than in *H. junghuhnii*. The branch leaves are also more coarsely serrate in *H. junghuhnii* than in *H. vitiense* and *H. samoanum*, and geminate teeth are absent or few in number.

2. *H. junghuhnii* is common and widespread in West Malesia. Judging from the few stations outside that area (in Mindanao and E. New Guinea) it might also occur on other

islands of the Lesser Sunda Islands, Celebes, and the Moluccas, which are all badly explored areas.

3. The epiphytic plants and those collected at low altitudes are smaller than the usual form and have loosely and usually pinnately branched fronds. Such a form has been described by Fleischer (1923) as f. *frondiformis*.

14. Hypnodendron samoanum Mitten *ex* Mitten in Seemann (1873A) 401; Mitten (1868) 192, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 360; Bescherelle (1894) 56; Paris (1895) 605, (1904) 374; Brotherus (1909C) 169, (1924B) 438; van der Wijk et al. (1962) 534. — Type: *T. Powell 107* (NY holo, BM, FH, K), Samoa, Tutuila, on trees and rocks in the beds of gullies, 100—2000 ft. — **Fig. 26.**

Hypnodendron vescoanum Bescherelle (1894) 55; Paris (1895) 605; Bescherelle (1898) 127, (1901) 12; Paris (1904) 375; Brotherus (1909C) 1169, (1924B) 438; Bartram (1931) 8, (1933B) 13, (1950) 269; van der Wijk et al. (1962) 534. — Syntypes: *J. Nadeaud 91* (BM lecto), Tahiti, Mt. Rereahu, 1100 m; *J. Lépine 3* (BM), Tahiti, in the mountains, 700 m; *Vesco s.n.* (BM, PC), Tahiti; *Vieillard et Pancher s.n.* (BM), Tahiti; *C. Wilkes s.n.* (BM, K, US), Tahiti and Eimeo (=Moorea).

Hypnum junghuhnii non C. Muell.: Nadeaud (1873) 16, *fide* Bescherelle (1894) 9.

Hypnum reinwardtii non Schwaegr.: Montagne (1848) 107.

Plants medium-sized to tall, densely tufted, dull green to dull rusty brown, more or less glossy. *Stipe* up to 8 cm long. *Frond* densely palmate to less frequently loosely pinnate, often irregular, up to 4 cm across; branches usually sparingly branched. *Stipe leaves* slightly to rather widely spreading near the base of the stipe, upwards all becoming rather widely spreading, narrowly triangular, (1.7—) 1.9—2.8 by (0.6—) 0.7—0.9 mm, L/W ratio (2.3—) 2.5—3.1 (—3.5), greenish to brownish; insertion straight to weakly concave; base slightly rounded; apex long and narrowly acuminate; margin coarsely serrulate to shortly serrate; costa strong, brown, upwards becoming ill-defined, mostly excurrent in a short arista; lamina cells 65—160 by 3.5—7.5 (—9) μ, L/W ratio *c.* (10—) 20—35, walls very incrassate, minutely and sometimes indistinctly papillate; marginal 2 rows of cells often somewhat narrower and forming a more or less distinct dark coloured border; alar cells short and wide, forming a small indistinct to rather well defined group. *Branch leaves* narrowly ovate-oblong, the laterally spreading ones 2.0—2.5 by 0.6—0.9 mm, L/W ratio (2.4—) 2.6—3.5, dorsal leaves smaller; apex acute to slightly acuminate; marginal teeth short, mixed; costa strong, percurrent to very shortly excurrent, bearing up to 10 dorsal teeth; lamina cells 30—60 by 4—7.5 μ, L/W ratio *c.* 6—12; walls incrassate, distinctly papillate, those of the marginal 2 rows of cells often more strongly incrassate.

Up to 12 *sporophytes* per frond. *Seta* straight to flexuose, 2.5—4.5 cm long, red to brown. *Theca* slightly curved, cylindrical, 3—4.5 mm long, pale yellowish brown to dark brown. *Cilia c.* 2—3. *Operculum c.* 2—2.5 mm long. *Calyptra* not seen.

Distribution: Samoa group, Society group, Marquesas.

Samoa group. Tutuila: *Powell 107* (BM, FH, K, NY).

Society group. Raiatea. Averaiti Valley: *Moore 74* (FH, L). — Moorea ('Eimeo'): *Wilkes s.n.* (BM, US). — Tahiti: *Lépine 3* (BM); *Nadeaud s.n.* (PC); *Quayle 96* (FH, L), *212* (FH); *Vesco s.n.* (BM, PC); *Vieillard & Pancher s.n.* (BM); *Wilkes s.n.* (BM, K, US). Mt. Rereahu: *Nadeaud 91* (BM). Mt. Pinai and Puaa Valley: *Nadeaud 431* (BM, FH, H, L, NY, PC, S-PA). Tarutu and Teapiri Valley: *Nadeaud 432* (W). Taiarapu Peninsula: *Nadeaud s.n.* (CANTY). Puairi: *Nadeaud s.n.* (CANTY). Miaa: *Temarii s.n.* (S-PA). Haapapa Dist.: *Temarii s.n.* (FH). Mt. Tereania: *Temarii s.n.* (CANTY). Taravao: *Temarii s.n.* (L, PC).

Marquesas. Nuku Hiva. Tovii: *Brown et al. 614 p.p.* (FH).

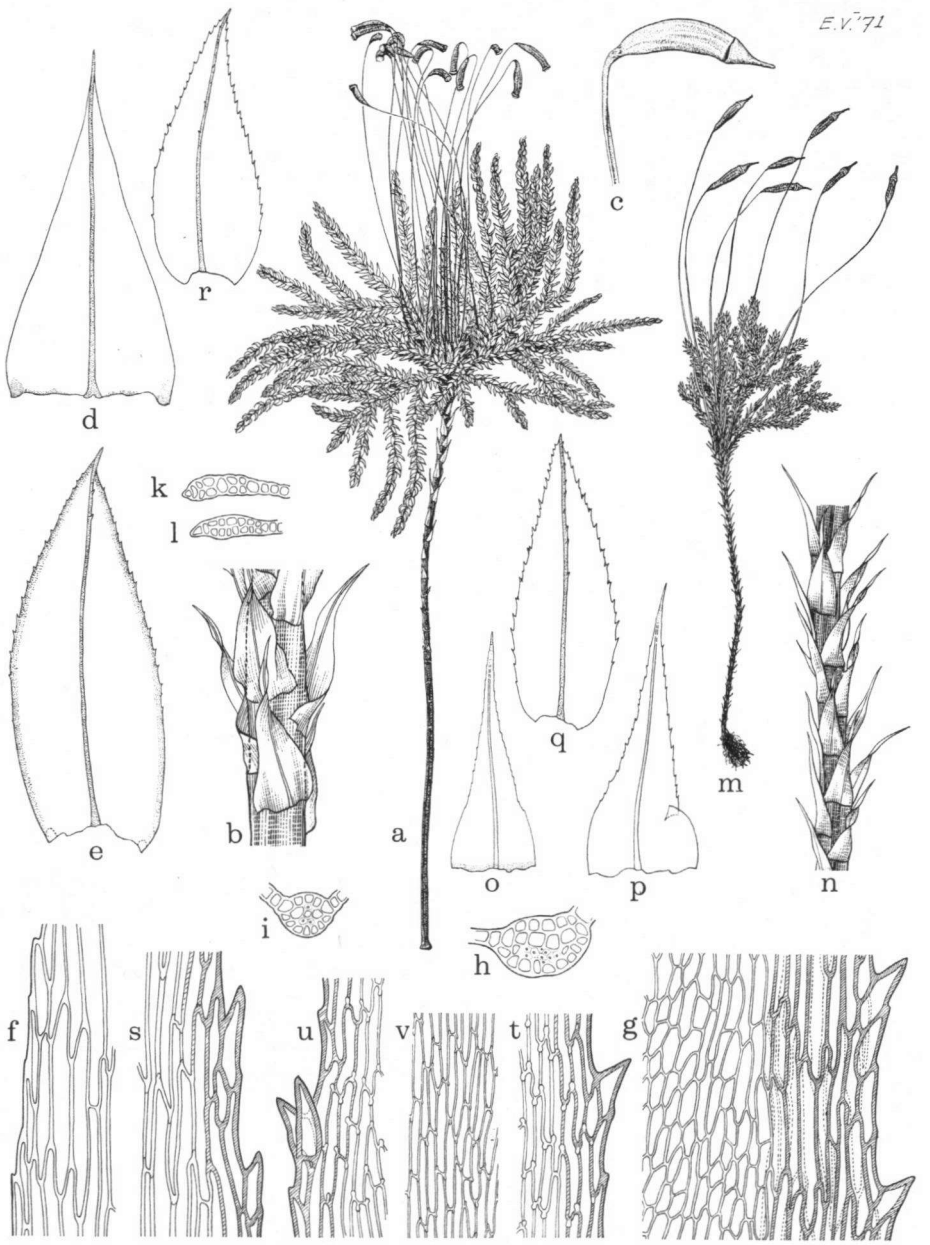

Fig. 26. a—l: *Hypnodendron marginatum;* m—v: *H. samoanum.* — a, m: Habits, × 1; b, n: stipes, × 8; c: capsule, × 4; d, o, p: stipe leaves, × 17; e, q. r: branch leaves, × 17; f, s: margins of stipe leaves, × 260; g, t, u: margins of branch leaves, × 260; h, i: cross sections of costae of branch leaves, × 260; k, l: cross sections of margins of branch leaves, × 260; v: areolation of branch leaf, × 260. (a—c: *Gupp s.n.;* d—g: *Beckett s.n.;* h—l: *Beckett 1012;* m, n, r: *Temarii s.n.;* o: *Powell 107;* p, q, s—v: *Nadeaud 431*).

Ecology: The very few data accompanying the herbarium specimens indicate that *H. samoanum* grows on trees and rocks in forests from near sea level up to 1100 m at least.

Notes: 1. It is regrettable that the present species must bear the name *H. samoanum*, as it appears to occur mainly in the Society group and has been collected only once in the Samoa group, where *H. vitiense* is the most frequently collected representative of the sect. *Hypnodendron*. Most common among the herbarium specimens is the form described by Bescherelle (1894) as *H. vescoanum*. The type specimen of *H. samoanum* represents a form having weakly toothed stipe leaves and glossy branch leaves with rather wide cells. *H. vitiense* differs from that form in its green colour and not widely spreading stipe leaves which are broader and have entire to serrulate margins. As a rule, *H. samoanum* is easily recognized by its fulvous colour and widely spreading, very narrow stipe leaves.

2. Bescherelle compared his new species *H. vescoanum* with the diagnoses of *H. vitiense*, *H. graeffeanum*, and *H. samoanum*. However, Mitten's rather brief description of the latter is insufficient for thorough comparison, and this is why some of Bescherelle's conclusions are incorrect.

3. The specimen from the Marquesas consists of a single sterile stipe bearing an immature frond.

15. Hypnodendron marginatum (Wils.) Lindberg *ex* Jaeger in Jaeger et Sauerbeck (1880) 360; Lindberg (1861) 374, *comb. inval.*; Paris (1895) 604, (1904) 373; Brotherus (1909C) 1170; Dixon (1912) 459; Fleischer (1923) 1600; Brotherus (1924B) 438; Dixon (1929) 343; Martin (1946A) 44, 56, (1946B) 175, (1952) 202, 203; Sainsbury (1955B) 319; Martin (1958) 113; van der Wijk et al. (1962) 533. — *Isothecium marginatum* Wilson in J. D. Hooker (1854) 106, t. 89 f. 2; J. D. Hooker (1867) 466, 473. — *Hypnum marginatum* J. D. Hooker et Wilson (1844) 554, *hom. illeg.*; C. Mueller (1851A) 508. — Type: *J. D. Hooker s.n.* (BM holo, H), New Zealand, Bay of Islands. — **Fig. 19, 26.**

Hypnum limbatum Sullivant (1855) 183. — *Sciaromium limbatum* Jaeger in Jaeger et Sauerbeck (1880) 292; Paris (1897) 1155, (1905) 238; van der Wijk et al. (1967) 372. — *Limbella limbata* C. Mueller *ex* Paris (1897) 1155, *comb. inval. in syn.*, (1905) 238; van der Wijk et al. (1964) 304. — Type: *C. Wilkes s.n.* (NY), New Zealand, on stones in the bottom of streams.

Sciadocladus kerrii (Mitt.) Broth. f. *aquatica* Dixon et Bartram (1937) 78, *comb. inval. sine descr. lat.* — Type: *S. Berggren 2576* (BM holo, CHR, H, L, S-PA, W), New Zealand, North Island, between Rotorua and Tarawera.

Plants tall to very tall, erect, loosely tufted, occasionally flaccid and more or less prostrate in aquatic forms, dull to slightly glossy, green with yellowish green to pale orange branch tips when young, becoming dark sordid green to brownish with age. *Stipe* up to 13 cm long. *Frond* umbellate to irregular and bushy, more or less distinctly pinnate in weak plants, up to 10 cm across; branches simple to densely pinnate, usually more or less complanate, tips often drooping. *Stipe leaves* often partially worn away, appressed to slightly spreading, triangular to narrowly triangular, 2.2—3.1 by 1.2—1.5 mm, L/W ratio 1.9—2.4, almost colourless to pale brownish; insertion line straight or nearly so, angles closely appressed to the stipe; base slightly rounded; apex gradually and weakly acuminate; margin entire to faintly denticulate or faintly serrulate with protruding cell apices; costa strong, shortly excurrent; lamina cells 85—180 by 5—10 μ, L/W ratio *c.* 15—25, walls very incrassate, smooth; alar cells $\pm$ indistinct; marginal cells somewhat shorter than the inner lamina cells. *Branch leaves* shrivelled when dry, weakly concave and erecto-patent when moist, mostly slightly anisomorphous, occasionally strongly so; the laterally spreading ones ovate-oblong, 2.3—3.1 by 0.8—1.25 (—1.4) mm, L/W ratio

(2.1—) 2.5—2.9, dorsal leaves smaller; apex shortly acuminate; margin with yellowish border reaching from the base to the apex, or ending a few cells below the apex, weakly serrate with short, simple, up to 25 μ long teeth; costa strong, percurrent, bearing up to 4 dorsal teeth; lamina cells opaque, irregularly elongate, 15—40 (—50) by 5—7.5 μ, L/W ratio *c.* 2.5—7, walls incrassate, smooth; several rows of cells along the leaf margin linear and often bistratose, the extreme marginal cells often short.

Up to 38 *sporophytes* per frond. *Seta* flexuose, 2—4 cm long, pale brown to red. *Theca* more or less curved, cylindrical, strongly inclined to cernuous, 3.5—6 mm long, brown. *Cilia c.* 2—4. *Operculum* 1.5—2 mm long. *Calyptra c.* 2.5—3.5 mm long.

Distribution: New Zealand, Chatham Is. Very rare in Stewart I., and in the South I. of New Zealand almost confined to the western half.

NEW ZEALAND. North Island. North Auckland: *Matthews 220* (BM). Whangaroa: *Fristedt s.r.* (S-PA). Maungaroa: *Berggren 1686 p.p.* (H, S-PA). Ohaeawai: *Berggren 1685* (H, S-PA, W). Bay of Islands: *Hooker 395* (BM, H); *Wilkes s.n.* (US). Little Barrier I.: *Smith s.n.* (Allison). Auckland: *Kirk s.n.* (Allison); *Knight 71* (H); *Sinclair s.n.* (BM). Moehau: *Moore 626* (CHR). Coromandel: *Cheeseman 122* (CANTY); *Hutton s.n.* (BM). Taotaoroa near Cambridge: *Sainsbury s.n.* (BM, L, NY, US, W). Between Rotorua and Tarawera: *Berggren 179* (FH, S-PA), *2576* (BM, CHR, H, L, S-PA, W). Tokano: *Berggren B 463* (FH). Atiamuri: *Allison 568* (Allison). Lake Waikaremoana: *Jardine & Sainsbury s.n.* (BM, L, NY, US, W); *van Zanten 682165* (GRO, L). New Plymouth: *Gupp s.n.* (NY). Piri Piri: *Beckett 851* (MO, S-PA). Te Pohue: *Hamilton s.n.* (CANTY). Hunterville: *Burgess 28* (BM). Feilding, Kitchener Peak: *Allan 17* (BM, CANTY). Waikanae: *Martin 269.5* (BO, CHR), *269.6* (CHR). Carterton: *Martin 269.1* (BO, CHR), *269.2* (CHR). Hutt Valley: *Lyall 40* (BM); *Pigott s.n.* (BM, H, S-PA). Wairarapa: *Bell s.n.* (H). — South Island. Paturau: *Moore s.n.* (CHR). Karamea: *Foot 84* (BM, FH). Rai Valley: *Lloyd 68* (Allison). Lake Roto-iti: *Sainsbury s.n.* (BM, PC). Westland: *Blotam s.n.* (H). Paparoa Ra.: *Helms s.n.* (BM). Atarau: *Barker 69190* (CANTY). Greymouth: *Gulliver s.n.* (CANTY); *Helms 7* and *s.n.* (BM, FH, H, JE, L, NY, S-PA, W). Blake: *Berggren 1684* (H, NICH, S-PA). Hokitika: *Gulliver s.n.* (CANTY). Moana, Lake Brunner: *Beckett 1012* and *s.n.* (B, BM, FH, JE, K, L, NICH, NY, S-PA, W). Jacksons: *Berggren s.n.* (GRO, S-PA). Canterbury: *Sinclair & Haast s.n.* (K). Christchurch: *Beckett 2623* (FH). Banks Peninsula: *unknown coll. 93* (BM). Otago: *Lyall 31* (NY); *Petrie 523* (CANTY, H, NY, W). Martin's Bay: *Brown s.n.* (BM). George Sound, Katherine Valley: *Mason s.n.* (CHR). Doubtful Sound: *Martin 269.3* = *925* (BO, CHR), *269.4* = *930* (CHR), *923* (Allison). — Stewart Island: *Lyall 313* (BM, K).

CHATHAM ISLANDS. *Cox s.n.* (CANTY, S-PA, US). Southeast Island: *Bell s.n.* (Allison, CHR, L).

Ecology: Terrestrial and on soil-covered rocks in boggy places in forests and damp shady edges of streams and lakes. Always growing under very wet conditions and confined to the wettest parts of New Zealand. The basal part is usually inundated and occasionally the whole plant grows submerged. Data on the altitudinal distribution are almost absent. Occurring from sea level up to at least 750 m.

Notes: 1. *H. marginatum* differs from all other species in its conspicuously bordered branch leaves that are dull and shrivelled when dry, bear few dorsal teeth, and have small opaque and smooth cells. This led Brotherus (1909C, 1924B) to accomodate it in a separate subgenus *Limbella*, together with some species from Hawaii which in my opinion do not belong to the *Hypnodendraceae* (see also under 'Excluded taxa'). The aberrant features of *H. marginatum* can be considered an adaptation to the aquatic habitat, and as the present species is very closely related in all other respects to *H. vitiense*, *H. junghuhnii*, and *H. samoanum*, this separation appears unjustified to me.

2. Typical plants have tall erect stipes bearing wide umbellate fronds; the fronds of young plants are often more or less pinnate. In very moist habitats the fronds are less regular: they often look bushy and untidy and often bear small distal innovations. Aquatic plants have short or almost indistinguishable and prostrate stipes and their fronds are flaccid and fastigiately branched. The branches can become very long. Thus, such plants completely lose the hypnodendroid growth form. Dixon (1929) mentioned,

that aquatic plants having strongly complanate branches had even been mistaken for *Fissidens*. Though the leaves of aquatic plants may be rather narrow (being up to *c.* 3 times as long as wide) their structure remains typical. The inner lamina cells soon wear away and of old leaves only the costa and the border remains, which gives the lower part of the plants a bristly appearance. The type specimen consists of small plants showing some characters of the aquatic form, but not extremely so. The type specimen of *Hypnum limbatum* represents an extreme aquatic form. In Bickham's collection (from an unknown locality in New Zealand) typical plants were found that had sprouted from the branches of a plant showing the features of the aquatic form.

3. Paris (1897), followed by van der Wijk et al. (1964), erroneously attributed the combination *Limbella limbata* to Mueller and also erroneously reported that New Zealand species from Hawaii. Mueller never made this combination, though in 1897 he suggested the transfer of *Hypnum limbatum* (and *Hypnum tricostatum* from Hawaii) to *Limbella*. Van der Wijk et al. (1964) further obscured the situation by referring to a publication in which *Limbella limbata* was not mentioned at all.

Sect. Tristichophyllum, *sect. nov.*

Stipes tomentosus, pseudoparaphyllia patentia conspicua. Frons umbellata. Folia grosse serrata. Folia caulina squarroso-recurvata, saepe longe decurrentia. Folia ramorum tristicha dimorpha. Theca sulcata. Spori 12—19 μ diam. Operculum obtuse rostrata.

Type species: *Hypnodendron diversifolium* Broth. et Geh.

Plants medium-sized to tall, erect. *Distal innovations* absent or weak and few. *Stipe* mostly bearing scattered tufts of tomentum. *Pseudoparaphyllia* conspicuous, spreading. *Frond* umbellate; branches complanate. *Stipe leaves* squarrose-recurved, broadly triangular-ovate; insertion line concave; base cordate, not to long-decurrent; apex narrowed to a long acumen; margin coarsely serrate to spinose-serrate with simple teeth; costa thin, becoming indistinct in apex to excurrent, smooth; cells smooth, basal cells strongly enlarged, walls incrassate, porate, often orange coloured; alar cells indistinct. *Branch leaves* ovate to ovate-oblong, tristichous, dimorphous, those of the lateral rows spreading, large and asymmetrical, those of the dorsal row more or less appressed, usually much smaller and symmetrical or nearly so; apex acute to shortly acuminate; margin as in stipe leaves; costa strong, ending in apex to percurrent; walls of basal cells green; alar cells indistinct.

Male gametoecia scattered. *Perichaetial leaves* smooth to weakly plicate. Theca sulcate, horizontal to cernuous. *Spores* 12—19 μ. *Operculum* bluntly rostrate.

Distribution: See under the species.

16. Hypnodendron diversifolium Brotherus et Geheeb in Brotherus (1898) 191; Paris (1900) 191, (1904) 373; Brotherus (1909C) 1169; Fleischer (1917) 34; Gepp (1917) 67; Herzog (1919) 293; Dixon (1922) 509; Brotherus (1924B) 438; Herzog (1926A) 339; Dixon (1942A) 9; Bartram (1945) 115, (1957A) 40, (1959) 90, (1960B) 485, (1962) 193; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443; van Zanten (1964) 291; Bartram (1965) 52. — Type: *W. E. M. Armit 628* (H holo, S-PA), New Guinea, Mt. Dayman, up to 9000 ft. — **Fig. 27, 28.**

Hypnodendron macgregorii Brotherus et Geheeb in Brotherus (1899A) 119; Brotherus (1909C) 1169; Fleischer (1917) 34; Brotherus (1924B) 438; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443. — Type: *W. MacGregor s.n.* (H holo, S-PA), British New Guinea, 9200 ft.

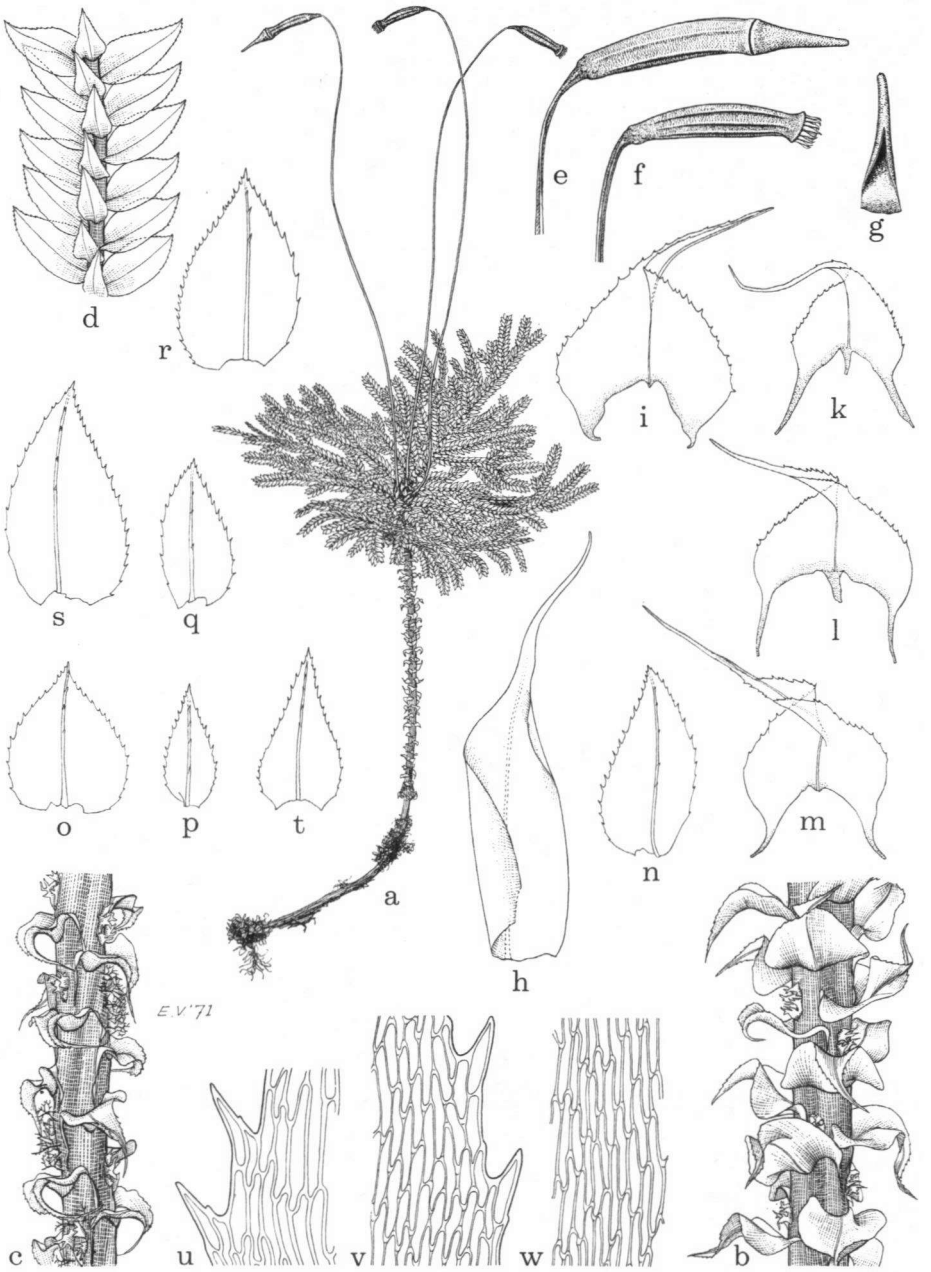

Fig. 27. *Hypnodendron diversifolium.* — a. Habit, × 1; b, c: stipes, × 8; d: detail of branch, × 8; e, f: capsules, × 4; g: calyptra, × 4; h: perichaetial leaf, × 17; i—m: stipe leaves, × 17; n, q—s: lateral branch leaves, × 17; o, p, t: dorsal branch leaves, × 17; u: margin of stipe leaf, × 260; v: margin of branch leaf, × 260; w: areolation of branch leaf, × 260. (a, b, d—f: *Eddy 1709;* c, h, l, p, q, u—w: *Williams 2658;* g: *Eddy 1696;* i, s, t: *Meijer B 6967;* k, n: *Carr 13021;* m: *Sinclair et al. 9017;* o: *Armit 628;* r: *Enriquez SFN 18146*).

Hypnodendron copelandii Brotherus (1905) 11, (1909C) 1169; Williams (1914) 376; Potier de la Varde (1923) 404; Brotherus (1924B) 438, (1928) 123; Dixon (1953A) 96; Bartram (1939) 154, f. 191; Dixon (1943B) 20; van der Wijk (1962) 532; van Zanten (1964) 291; Pócs (1965) 466. — Type: *E. B. Copeland 1030* (H holo, not seen, NY), Mindanao, Davao District, Mt. Apo, on mossy trees, 1600 m.

Hypnodendron copelandii Broth. var. *latifolium* Dixon (1935A) 96; van der Wijk et al. (1962) 532. — Type: *C. M. Enriquez SFN 18146* (BM holo, SING), Borneo, Mt. Kinabalu, near Lumu-Lumu, on ground, 5000 ft.

? *Mniodendron pygmaeum* C. Mueller (1902) 33; C. Mueller in Paris (1900) 250, *nom. nud.* — *Hypnodendron pygmaeum* Brotherus (1909C) 1169; Fleischer (1917) 34; Brotherus (1924B) 438; van der Wijk et al. (1962) 534; Schultze-Motel (1963) 443. — Type: *L. Loria s.n.* (B†), Southeast New Guinea, Moroko ('Mo-roka'), 1100 m.

Hypnodendron wrayi Brotherus *ex* Dixon (1926) 46, *nom. nud.*

Hypnodendron arborescens non (Mitt.) Mitt.: van Zanten (1964) 291.

Hypnodendron reinwardtii non (Schwaegr.) Jaeg.: van Zanten (1964) 292, *pro parte.*

Plants medium-sized to tall, mostly loosely tufted or isolated, green to pale brownish green, somewhat glossy. *Stipe* up to 7 cm long, erect or ascending, mostly bearing scattered tufts of tomentum, occasionally glabrous or completely tomentose. *Frond* mostly umbellate, occasionally palmate or loosely pinnate (in poorly developed plants), up to 5 (—7) cm across; branches mostly pinnate, occasionally simple or nearly so. *Stipe leaves* mostly strongly recurved, broadly ovate-triangular, 1.4—2.5 by 0.75—1.9 mm, L/W ratio 1.3—2.0, pale green to brownish green; base cordate, widely clasping, not decurrent to narrowly long-decurrent; apex narrow, concave; marginal teeth up to 50 μ long, sometimes recurved, subula mostly entire or nearly so; costa mostly ill-defined, often partially indistinct; lamina cells 60—115 by 5—7.5 (—12.5) μ, L/W ratio *c.* 9—23, smooth; marginal cells shorter, but not forming a distinct border; decurrent bands *c.* 6—8 cells wide, cells not markedly different from those of the leaf base. Latero-ventral *branch leaves* 0.7—1.9 (—2.2) by (0.3—) 0.4—1.1 (—1.4) mm, L/W ratio (1.1—) 1.4—2.4 (—2.8); base broadly rounded to cordate (at the distal side of the leaf at least); apex acute or gradually shortly acuminate, often more or less keeled; marginal teeth up to 45 μ long; costa ending in apex to percurrent, bearing up to 5 (—6) dorsal teeth; lamina cells 25—70 (—95) by *c.* 5 μ, L/W ratio 5—13 (—17), papillae very small, indistinct, sometimes absent.

Up to 12 *sporophytes* per frond. *Seta* 2.5—5 (—7) cm long, straight to flexuose, usually pale reddish brown. *Theca* slightly curved, cylindrical, 4.5—6 mm long, brown, usually distinctly sulcate near the orifice at least. *Cilia c.* 3. *Operculum* 2—3.5 mm long, brown. *Calyptra c.* 4—5 mm long.

Distribution: Annam, Malay Peninsula, Sumatra, Java, Borneo, Luzon, Mindanao, Celebes, Ceram, New Guinea, Solomon Islands (Guadalcanal). Everywhere rare and collected in few localities, somewhat more frequent in New Guinea.

Annam. Nhatrang: *Poilane 3491 p.p.* (H, PC).

Malay Peninsula. Perak. G. Bintang: *Sheffield 29* (BM); G. Batu Puteh: *Wray 301* (BM, BO, GRO, H, K, MEL, PC, SING, US, W).

Sumatra. Tapanuli. Dairi Lands: *Otto-Surbeck 274A* (L); Aek Nalili: *Otto-Surbeck 377B* (L). — West Coast. G. Sago: *Meijer B 6967* (L). Tindjulaut: *Micholitz 58A* (GRO, H, L).

Java. West Java. Nirmala: *Backer BOG 2080* (BM, BO, GRO, L). G. Pangrango: *Möller s.n.* (L, S-PA).

Borneo: *Balneti s.n.* (JE); *Everett s.n.* (NY). — Sabah. Mt. Tambuyokon: *Meijer B 11419* (L). Mt. Kinabalu: 8 collections. — Indonesian Borneo. G. Kemul: *Endert 4542 p.p.* (BM, L). Peak of Balikpapan: *Meijer B 1678* (BO, L), *B 1699* (BO, GRO, L), *B 2623* (GRO, L).

Luzon. Nuevo Vizcaya. Mt. Pulog: *Jacobs B 15* (L).

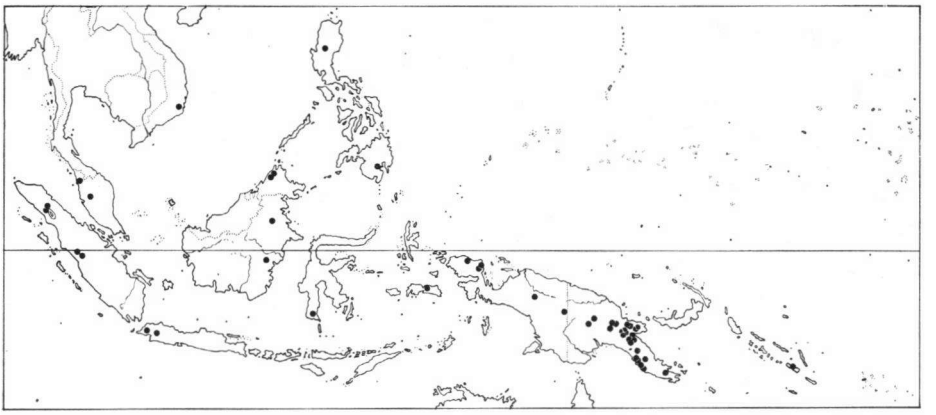

Fig. 28. Distribution of *Hypnodendron diversifolium*.

MINDANAO. Davao. Mt. Apo: *Copeland 1020* (FH, GRO, H, K, NY, S-PA, US, W), *1030* (NY); *Edaño PNH 12992* (GRO, PNH); *Williams 2658* (FH, H, NY, US).

CELEBES. Southwest Peninsula. G. Lompobattang (= Peak of Bonthain): *Everett 661* (BM, L, NY, SING).

CERAM. G. Binaija: *Stresemann 267A* (L), *282* (BO, GRO, JE, L).

NEW GUINEA. West New Guinea. Nettoti Ra., Mt. Nettoti: *van Royen & Sleumer 7380 p.p.* (L). Arfak Mts., Hatam: *Beccari 177 p.p.* (FH, GRO, H, L). Ibid., Lake Anggi Gita ('♀ Lake'): *Gibbs 5667* (BM, K, L). Central Mts., Swart Valley, Kadubaka: *Bergman M 53* (FH, L, S-PA), *M 75* (S-PA), *M 205* (FH). Star Mts., Mt. Antares: *van Zanten*, 6 collections. — Territory of New Guinea: *Wiesenthal s.n.* (GRO). 25 Miles NW. of Laiagam: *Robbins 3410* (CANB, FH, L). Mt. Hagen: *van Zanten 683129A* (GRO, L), *683143B* (GRO, L). Finisterre Ra.: *Eiffert 44* (BM, JE), *45* (BM, JE), *47 p.p.* (JE), *49* (BM, JE). Ibid., Daimandi: *Eddy 332* (BM), *373* (BM, L), *375* (BM). Ibid., Butemo: *Eddy 632* (BM, L). Ibid., Moro: *Eddy 1094* (BM), *1102 p.p.* (BM). Purosa: *Brass 31697* (FH, L). Kainantu, Waisa: *Eddy 2184* (BM), *2205 p.p.* (BM, L). Arau: *Brass 31926A* (FH). Mt. Elandora: *Eddy 2050* (BM, L), *2077 p.p.* (BM). Wau-Salamaua Rd.: *Womersley & Millar NGF 8431* (CANB, FH, GRO, L). Edie Creek: *Eddy 15* (BM), *45* (BM), *46* (BM), *48* (BM). Mt. Kaindi: *van Zanten 68234* (GRO, L), *68265* (GRO, L). Mt. Herzog, Wagau: *Eddy 1696* (BM, L), *1709* (BM, L), *1719* (BM). Matap: *Clemens 11290.3* (FH). Boana: *Clemens 41742.6* (FH). — Territory of Papua: *MacGregor s.n.* (H, S-PA); *Musgrave s.n.* (H). Ibiwara: *Vink 16934B* (L), *16939B* (L). Mt. Giluwe: *van Zanten 683286 p.p.* (GRO). Mt. Yule: *Kowald 1298 p.p.* (FH, H, NY, S-PA). Aroa R.: *Weiss s.n.* (H). Boridi: *Carr 13021 p.p.* (BM, FH, GRO, NY), *13033A* (FH, GRO, L). Uniri: *Carr 15256A* (L). Efogi: *van Zanten 683800* (GRO, L). Moroko ('Mo-roka'): *Loria 730 p.p.* (FH, JE, NY, W), *748 p.p.* (H), *1600 p.p.* (CANTY). Durigolo: *Clark 49* (BM, JE). Mt. Dayman: *Armit 628* (H, S-PA); *Brass 23391* (FH, L).

SOLOMON ISLANDS. Guadalcanal. Mt. Popomanasiu: *van Zanten 682650* (GRO, L).

Ecology: Usually growing on humous soil, less often on decaying logs and soil covered rocks, rarely epiphytic. When epiphytic, plants usually very small. In rain forests and other constantly moist and sheltered habitats; 800—3000 (—4000) m, most frequently collected between 1400 and 2700 m.

Notes: 1. *H. diversifolium* is one of the most beautiful and striking species among the *Hypnodendraceae*. As a rule, it can be recognized at once by the tristichous arrangement of its branch leaves. Small, weakly developed plants sometimes have loosely pinnate fronds and weakly differentiated latero-ventral and dorsal branch leaves. Such plants superficially resemble small specimens of *H. reinwardtii* and *H. subspininervium*, but the branch leaves of these are never clearly inserted in three rows. Moreover, nearly all small pinnate plants of *H. diversifolium* that I examined had long-decurrent stipe leaves, a feature never seen in the other two species mentioned above.

2. The type specimen of *H. pygmaeum* was destroyed. Mueller's description matches *H. diversifolium* very closely. The only Loria-collection bearing this name (no. *748*) consists of a mixture of poor specimens of *H. diversifolium*, *H. subspininervium* ssp. *arborescens*, *H. milnei* ssp. *parvum*, and *Racopilum sp.*

3. The relative width of the branch leaves, the decurrent bands of the stipe leaves, and the size of the plants are very variable and show regional differentiation. In every island or island group about the same total variation of the L/W ratio of the branch leaves was found; the variation per collection was often rather wide. If average values of the latter are compared, the Bornese plants appear to have branch leaves almost always twice as long as wide or less (L/W ratio 1.5—2.0 (—2.15)), whereas plants from the remaining part of West Malesia, Celebes, Ceram, and the Philippines often have proportionally narrower leaves (on the average only!). Plants from New Guinea show intermediate values.

As in several other species of *Hypnodendron* the specimens of this species from the Malay Peninsula, Sumatra, and Java are often taller than those from elsewhere. In addition, they often have somewhat more distinctly papillate cells, lack decurrent bands or have a few shortly decurrent leaves. Only Micholitz's plants from Tindjulaut, Sumatra, have many shortly decurrent leaves, as was found in most plants from Borneo (including the type specimen of *H. copelandii* var. *latifolium*). In Stresemann's plants from Ceram the decurrent bands vary from short to long along the same stipe. *Everett 661* from Celebes has very long and narrow bands and all Philippine plants have very long and usually wide bands, often reaching the insertion of the next lower leaf. The type of *H. copelandii* belongs here. In New Guinea plants of all types occur together. The type specimen of *H. diversifolium* consists of only one rather small stipe bearing an open, sparsely branched frond. The stipe leaves are very long-decurrent; the branch leaves are extremely broad in relation to their length (L/W ratio 1.1—1.3). In the type specimen of *H. macgregorii* decurrent bands are completely lacking. In plants from New Guinea no correlation was found between the length of the decurrent bands and the L/W ratio of the branch leaves. The plants from the Solomons (only one collection) agree with those from Borneo in having stipe leaves that are shortly or not at all decurrent and wide branch leaves.

Judging from these data *H. diversifolium* has its centre of variation in New Guinea and has a number of marginal segregates which are so weakly demarcated that they should not be given a formal status as subspecies or varieties. However, the gatherings from these marginal areas are few in number and originate from a very few collecting localities. Much additional material from other places is needed to check this opinion.

Sect. Mniodendropsis, *sect. nov.*

Sect. *Comosae* similis, sed stipes glaber, frons plerumque palmata, folia dentibus geminatis atque simplicibus, theca in parte distali subcostata vel sulcata.

Type species: *Hypnodendron milnei* Mitt.

Plants medium-sized to tall, erect. *Distal innovations* absent or weak and few. *Stipe* tomentose at base only. *Pseudoparaphyllia* inconspicuous, appressed, sparse or absent. *Frond* mostly palmate; branches not or weakly complanate. *Stipe leaves* widely spreading to squarrose-recurved, often caducous, triangular-ovate to triangular-ovate-oblong; insertion line concave to straight; base rounded, not or shortly decurrent; apex gradually to rather abruptly narrowed to a narrow acumen; margin near base flat to narrowly recurved, upwards flat, serrate; costa percurrent to excurrent in a stout arista; lamina cells short and wide, smooth; marginal cells shorter, often bistratose, forming a dark coloured border;

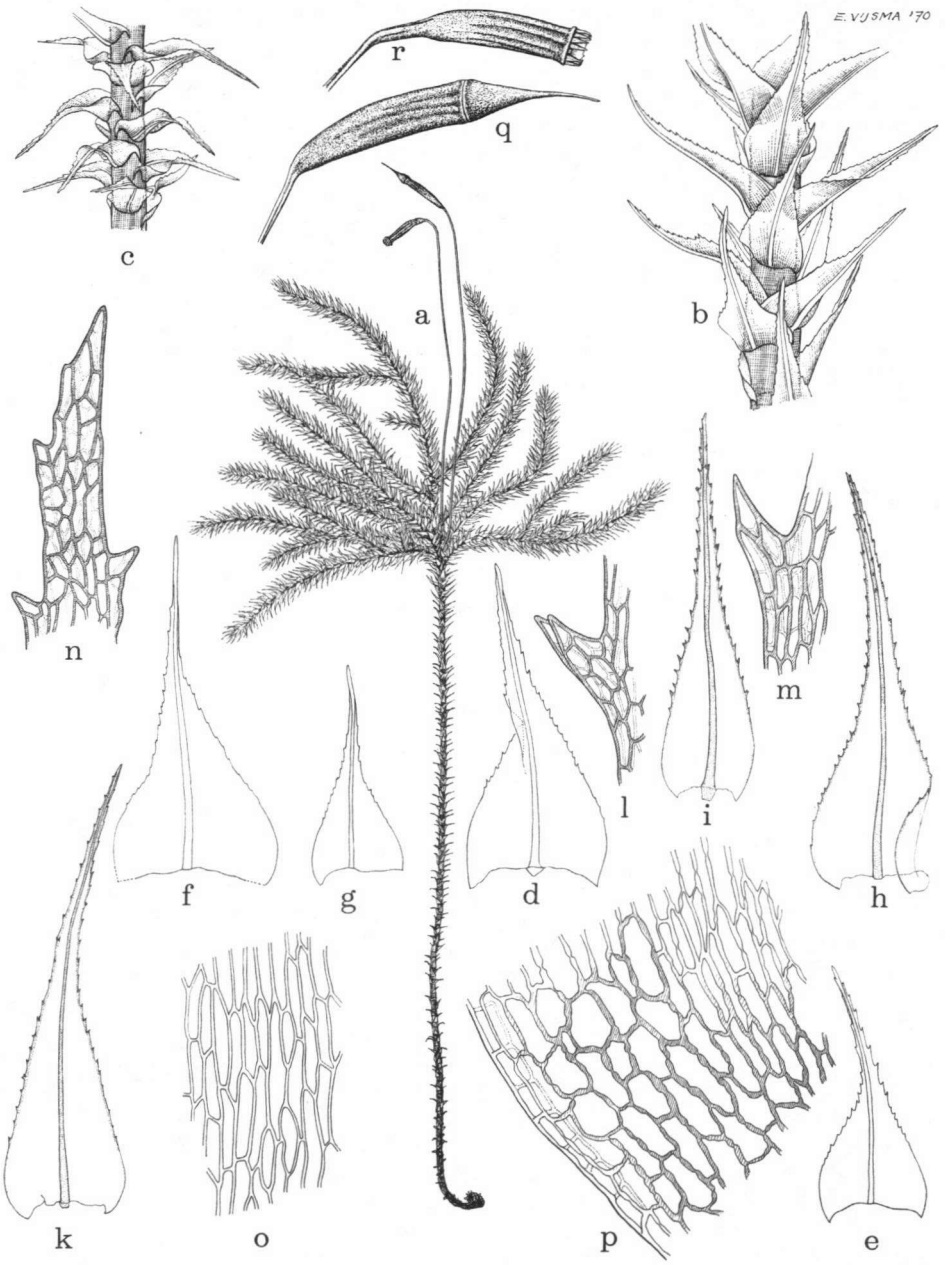

Fig. 29. *Hypnodendron milnei* ssp. *korthalsii*. — a: Habit, × 1; b, c: stipes, × 8; d—g: stipe leaves, × 17; h—k: branch leaves, × 17; l, m: margins of branch leaves, × 260; n: apex of branch leaves, × 260; o: areolation of branch leaf near the apex of the leaf, × 260; p: alar cells of branch leaf, × 260; q, r: capsules, × 4. (a: *Fleischer s.n.*; b: *Bakhuizen van den Brink 3643*; c, e, i, q, r: *Clemens 40219*; d, h, l, m, o: *de Vriese s.n.*; f: *Elmer 14191*; g: *Kjellberg 39M*; k: *Edaño PNH 12946*; n, p: *Elmer 15067*).

basal cells hardly differentiated; alar cells enlarged, weakly to strongly differentiated. *Branch leaves* isomorphous or nearly so, triangular-ovate to triangular-ovate-lanceolate; apex narrowly acuminate; margin as in the stipe leaves, teeth mixed; costa percurrent to shortly excurrent; cells of lamina, margin, and base as in the stipe leaves; alar cells enlarged, forming a conspicuous group.

Male gametoecia scattered. *Perichaetial leaves* deeply plicate. *Theca* horizontal to cernuous, distal half weakly costate to sulcate. *Spores* 12—18 μ across. *Operculum* sharply rostrate.

Distribution: See under the species.

17. Hypnodendron milnei Mitt. — **Fig. 29—31.**

For synonyms, literature, and type specimens see under the subspecies.

Plants medium-sized to tall, loosely tufted, dark sordid green, becoming brownish or blackish green with age, slightly glossy. *Stipe* up to 12 cm long. *Frond* up to 9 cm across, mostly open, mostly palmate, sometimes pinnate; branches simple to loosely pinnate, flexuose. *Stipe leaves* persistent and widely spreading to squarrose from an appressed base, or caducous and widely spreading, longitudinally plicate when dry, triangular-ovate to triangular-ovate-oblong, (1.4—) 1.7—3.0 by 0.7—1.3 (—1.7) mm, L/W ratio (1.6—) 1.8—2.6 (—2.9); base rounded, weakly to rather strongly narrowed, not to shortly decurrent; apex weakly canaliculate; margin distinctly to indistinctly bordered from the widest part of the leaf upwards, bearing up to 75 μ long simple teeth, occasionally mixed with a few geminate ones; costa strong, often dark brown, dorsal teeth 0—2; lamina cells 20—70 by 3—10 μ, L/W ratio *c.* 4—15, walls mostly strongly incrassate, smooth, often porate; marginal cells dark coloured and having more strongly incrassate walls, often bistratose in the apical part of the leaf. *Branch leaves* often secund, mostly longitudinally striate to plicate when dry, 1.7—3.7 (—4.3) by 0.6—1.1 (—1.4) mm, L/W ratio 2.1—4.1 (—5.2); base broadly rounded to cordate; apex gradually narrowed to a long, narrow, and somewhat canaliculate acumen, slightly twisted when dry; margin above the leaf insertion narrowly recurved and almost entire, upwards flat and strongly to rather indistinctly bordered, coarsely serrate with up to 65 μ long simple teeth mixed with geminate ones, the latter most numerous near apex, teeth often brown-tipped; costa strong, bearing up to 9 dorsal teeth; lamina cells 10—70 by (2—) 3—10 μ, L/W ratio *c.* 4—10, shorter and often irregular in the apical part of the leaf, walls thin to strongly incrassate, mostly smooth, occasionally weakly papillate; marginal cells as in the stipe leaves, mostly at least partly bistratose in the apical part of the leaf; alar cells mostly strongly enlarged with highly incrassate walls, mostly forming a conspicuous group.

Up to 9 *sporophytes* on each frond. *Seta c.* 3—5 cm long, straight to flexuose, pale brown to orange, red, or dark brown. *Theca* mostly slightly curved, cylindrical, 4.5—8 mm long, pale to greyish, orange, reddish, or dark brown, weakly ribbed to sulcate in its distal half, occasionally almost smooth, mostly constricted below the orifice. *Cilia* 2—5. *Operculum c.* 2.5—4 mm long. *Calyptra c.* 3—5 mm long.

Distribution: Malesia, Solomon Islands, New Hebrides, île des Pins (?).

Ecology: Usually growing on boulders in and along streams and torrents, less often terrestrial and on rocks in rain forests; ssp. *parvum* has also been observed growing epiphytically and on decaying logs. From below 300 m up to 2100 m.

Notes: 1. Superficially resembling the species of sect. *Comosa* and formerly placed with these in the genus *Mniodendron* but differing in having naked stipes, palmate fronds without distal innovations, wide cells, geminate teeth, less strongly sulcate theca, etc. Very rarely the stipes may bear a few small tufts of tomentum (as in other species normally having glabrous stipes). The branches are often very long; in some Javanese specimens they had apparently reached the substrate and bore a tuft of rhizoids at their tip.

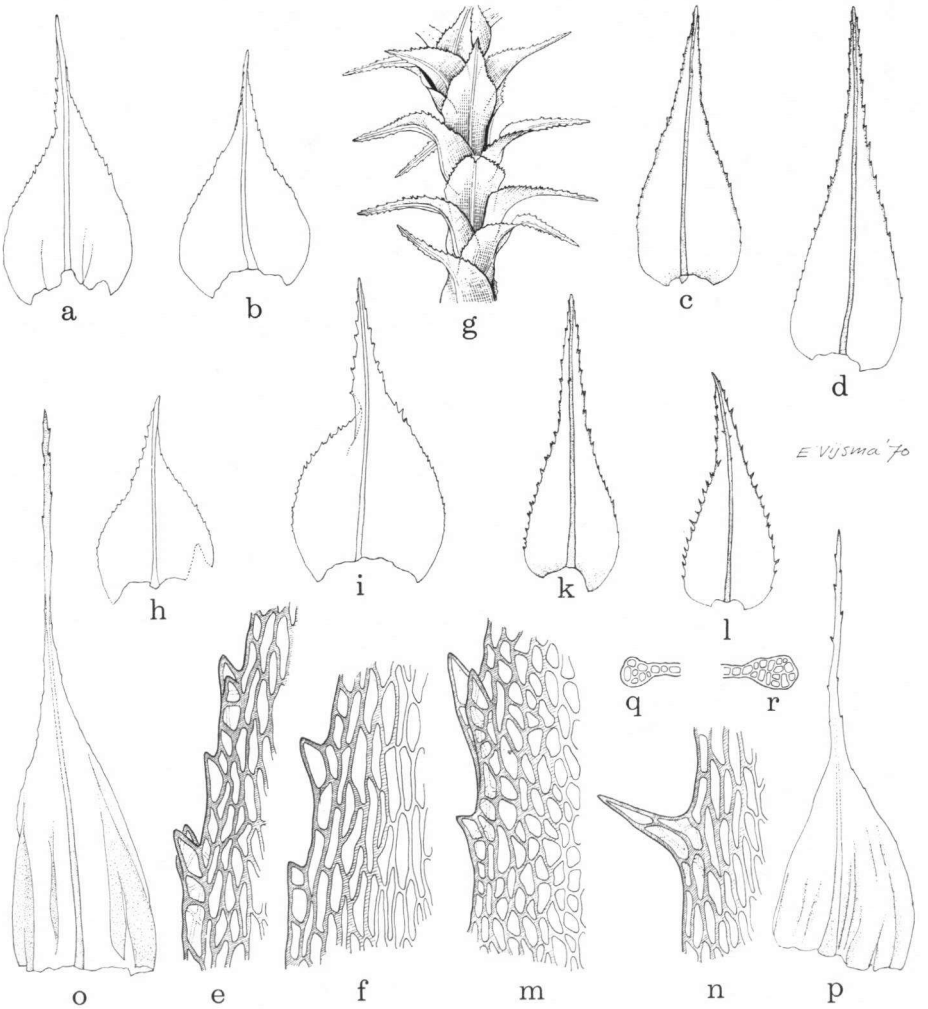

Fig. 30. *Hypnodendron milnei*. a—f: ssp. *milnei*; g—p: ssp. *parvum*; q, r: ssp. *korthalsii*. — a, b, h, i: Stipe leaves, × 17; c, d, k, l: branch leaves, × 17; e, f, m, n: margins of branch leaves, × 260 (e, m: near leaf apex; f, n: near base of apical part); g: stipe, × 8; o, p: perichaetial leaves, × 17; q, r: cross sections of margins of branch leaves, × 260. (a, d: *van Zanten s.n.*; b, c, e, f: *Milne 365*; g, i, k, o, p: *Schram BW 13407*; h: *Kloss 39*; l—n: *Cheesman 21*; q, r: *Fleischer s.n.*).

2. The leaf border is most strongly developed in the middle part of the branch leaves. Its cells have more strongly incrassate walls than the inner lamina cells. The cells of the outermost 1—2 rows are on an average shorter than the inner lamina cells, whereas those of the adjacent rows are often narrower than the inner lamina cells. Areas of bistratose cells are found near the base of the stronger teeth; when the border is strongly developed (as in ssp. *korthalsii*) it is entirely bistratose in the middle and apical part of the leaves.

3. The wide basal part of the stipe leaves occupies at least half of the length of the leaf in

ssp. *milnei* and ssp. *parvum*. As a rule it is closely appressed to the stipe, whereas the apical part is widely spreading to strongly squarrose. In ssp. *korthalsii* the basal part of the stipe leaves is shorter and often slightly appressed only; the apical part is rarely distinctly squarrose. The branch leaves show the same variation, but it is less easily observed as these leaves are more gradually narrowed.

KEY TO THE SUBSPECIES

1. Wide basal part of the stipe leaves measuring half of the length of the leaf or less ssp. **korthalsii**
1. Wide basal part of the stipe leaves measuring at least half of the length of the leaf 2
2. Lamina cells in the apical part of the branch leaves irregularly rounded to angular or elongate, many of them ± isodiametric. Marginal teeth strong, up to 75 μ long . . . . . ssp. **parvum**
2. Lamina cells in the apical part of the branch leaves elongate to linear. Marginal teeth up to 35 μ long ssp. **milnei**

a. ssp. **milnei.** — *Hypnodendron milnei* Mitten in Seemann (1873A) 401, (1882B) 103. — *Mniodendron milnei* Paris *ex* Paris (1905) 263, (1896) 822, *comb. inval.*; Brotherus (1909C) 1172; Brotherus et Watts (1915) 157; Brotherus (1924B) 439; van der Wijk et al. (1964) 395, (1969) 775. — Type: *G. Milne 365* (NY holo, BM, FH, H, K, L), New Hebrides, Aneityum.

Mniodendron gunnii Brotherus et Watts (1915) 157, *nom. nud. in syn.*

Mniodendron lilliei Brotherus et Watts (1915) 157, *nom. nud. in syn.*

Stipe up to 8 cm long. *Stipe leaves* persistent, patent to squarrose from an appressed base, 1.7—2.2 by 0.9—1.25 mm, L/W ratio 1.8—2.1; base measuring 0.55—0.7 of the length of the leaf; teeth mostly simple, up to 27(—32) μ long. *Branch leaves* 2.1—2.9 by 0.65—0.9 mm, L/W ratio 2.6—3.8; base measuring 0.5—0.6 (—0.7) of the leaf length; marginal teeth up to 35 μ long; lamina cells in the apical part of the leaf *c.* 12—40 by 3—7 μ, most cells at least 5 times as long as wide; border rather weak, bistratose part interrupted, submarginal cells narrow. *Sporophytes* not seen.

Distribution: Solomon Islands, New Hebrides. île des Pins (?).

Solomon Islands. Guadalcanal. Mt. Popomanasiu: *van Zanten 682586* (GRO, L).
New Hebrides. Aneityum. Exact locality not given: *Gunn 170* (H), *187* (H), *690* (H), *700* (H), *915* (H); *Milne 365* (BM, FH, H, K, L, NY)
île des Pins. *McGillavray s.n.* (BM).

Notes: 1. In ssp. *korthalsii* the length of the teeth is very variable, and some plants have teeth as short as in ssp. *milnei*.

2. Some doubt exists as to the occurrence of *H. milnei* in île des Pins (see p. 228).

b. ssp. **parvum** (C. Muell.) Touw, *stat. nov.* — *Mniodendron parvum* C. Muell. *ex* C. Mueller (1902) 133; C. Mueller in Paris (1900) 250, *nom. nud.*; Brotherus (1909C) 1172; Fleischer (1917) 34; Brotherus (1924B) 439. — *Hypnodendron parvum* Dixon (1922) 494; Brotherus (1925) 531; van der Wijk et al. (1962) 533; Schultze-Motel (1963) 443. — Type: *L. Loria s.n.* (B holo †); lectotype: *L. Loria 1638* (BM holo, FH, W), New Guinea, Port Moresby, Moroko ('Mo-roka'), 1300 m.

Mniodendron milnei (Mitt.) Par. f. *papuana* Fleischer (1917) 35; Schultze-Motel (1963) 445. — Type: *C. L. Ledermann 12886* (FH holo), New Guinea, Felsspitze, terrestrial in mountain forest on moist soil, 1400—1500 m.

Mniodendron korthalsii Par. *sensu* van Zanten (1964) 292.

Mniodendron milnei (Mitt.) Par. *sensu* van Zanten (1964) 292.

Stipe up to 8.5 cm long. *Stipe leaves* persistent, mostly strongly squarrose from an appressed base, (1.4—) 2.1—2.5 (—3.0) by (0.85—) 1.1—1.2 (—1.7) mm, L/W ratio 1.6—1.9 (—2.1); base measuring 0.55—0.7 of the leaf length; teeth up to 75 μ long. *Branch leaves* 1.7—2.8 (—3.6) by 0.6—1.0 (—1.4) mm, L/W ratio 2.1—3.6; base measuring (0.4—) 0.5—0.6 of the leaf length; marginal teeth up to 65 μ long; lamina cells in the apical part of the leaf *c.* 10—35 by 3—10 μ, mostly less than four times as long as wide; border weakly to strongly differentiated, bistratose part continuous to interrupted. *Seta* 3—5 cm long. *Theca* 5—8 mm long.

Distribution: New Guinea, presumably most common in its western part.

New Guinea. West New Guinea. Wandammen Peninsula, Wondiwoi Mts.: *Mayr 321* (BO); *Schram BW 13407A* (L). Nassau Mts.: *Docters van Leeuwen 10984* (BO, FH, GRO, L). Mt. Carstensz: *Kloss 39* (BM), *40* (BM). Mt. Cyclops: *Cheesman 21* (BM); *van Royen 3609* (GRO, L). Orion Mts., Tenmasigin: *van Zanten 312* (BM, CANB, GRO, L). Star Mts., Mt. Antares: *van Zanten 337B* (L), *343* (GRO, L), *505d* (GRO, L). — Territory of New Guinea. Felsspitze: *Ledermann 12886* (FH). Finisterre Ra., Butemo: *Eddy 675 p.p.* (BM, L), *681 p.p.* (BM), *682 p.p.* (BM). Ibid., Moro: *Eddy 908* (BM). — Territory of Papua. Owen Stanley Ra., The Gap: *McDonald 4* (H), *6* (BM, H). Moroko ('Mo-roka'): *Loria 747* (H), *748 p.p.* (H), *768 p.p.* (K), *780* (H), *1604* (S-PA), *1638* (BM, FH, W).

Notes: 1. *Mniodendron parvum* was validly published by Mueller (1902) and based on material cited as 'Nova Guinea austro-orientalis, Mo-roka, 1100 m, Aug. 1893: Lamberto Loria. Hb. Levier'. Dixon (1922) apparently did not know this publication and considered *M. parvum* a *nomen nudum*. He described it as a new species in *Hypnodendron* typifying it by a Kloss specimen. As Mueller's herbarium was destroyed in Berlin a lectotype had to be chosen from the remaining duplicates. Loria's collection contains several specimens identified as *M. parvum* by Mueller. Their labels all literally bear the indications Mueller mentioned except that the altitude is given as 1300 m instead of 1100 m. This gives rise to the question whether these plants really belong to the original collection. All Loria specimens (of other species as well) I saw from Moroko bear labels on which the altitude is given as 1300 m, whereas Mueller gave 1100 m for all of them. Therefore, I suppose an error has crept in somewhere, and feel rather safe in chosing one of these Loria specimens as a lectotype which takes precedence over the neotype chosen by Dixon.

2. In ssp. *parvum* the marginal teeth are always much longer than in ssp. *milnei*. In ssp. *korthalsii* the teeth are about the same length but it differs in the shape of its leaves. The lamina cells of the apical part of the branch leaves often have extremely incrassate collenchymatous walls. They are very variable in shape and size, but the majority are short and wide. In that character ssp. *parvum* differs from both of the other subspecies. The border is usually distinct, but was found to be almost indistinguishable in plants of one collection.

3. The branch leaves of *Schram BW 13407* showed simple and geminate teeth mixed with a number of stellate ones, which have not been found in any other species.

c. ssp. korthalsii (Bosch et Lac. *ex* Par.) Touw, *stat. nov.* — *Mniodendron korthalsii* Bosch et Lac. *ex* Paris (1905) 263; van den Bosch et van der Sande Lacoste in Lindberg in Dozy et Molkenboer (1866) 139, t. 236, *comb. inval.*; van der Sande Lacoste in Miquel (1867) 299; Jaeger in Jaeger et Sauerbeck (1880) 357, *pro parte*; Mitten (1891) 190; Mitten et Wright in Stapf (1894) 259; Paris (1896) 822; Brotherus (1909C) 1172; Möller (1919) 330; Fleischer (1923) 1615; Brotherus (1924B) 439, (1926) 285; Herzog (1926B) 348; Dixon (1934A) 28, (1935A) 98; Bartram (1939) 156, f. 192; Noguchi (1963) 147; van der Wijk et al. (1964) 395. — Lectotype: *H. Kuhl et J. C. van Hasselt s.n.* (L holo, BM, GRO, MEL, S-PA), Java, Mt. Gedeh, 6000 ft.

Mniodendron mindanense Brotherus (1913B) 1975. — Type: *A. D. E. Elmer 14191 pro*

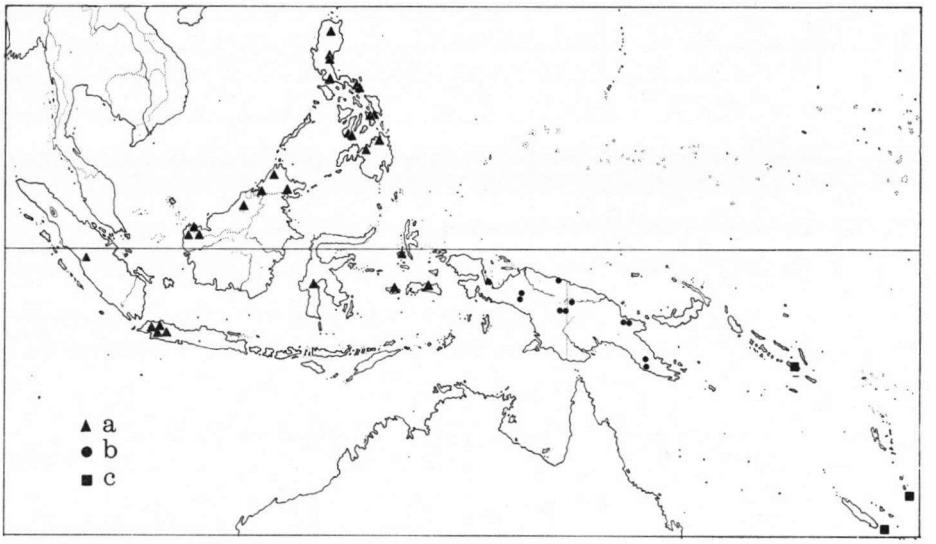

Fig. 31. Distribution of *Hypnodendron milnei* ssp. *korthalsii* (a), ssp. *parvum* (b), and ssp. *milnei* (c).

parte (H holo, BO, FH, GRO, L, MO, PC, W), Mindanao, Agusan Prov., Cabadbaran, Mt. Urdaneta.

Mniodendron deningeri Brotherus et Herzog in Herzog (1926A) 346; Herzog (1926B) 353; van der Wijk et al. (1964) 394. — Type: *K. Deninger s.n.* (JE holo, BM, GRO, H), mountains of Buru, below 700 m.

Stipe up to 12 cm long. *Stipe leaves* persistent and widely spreading to somewhat squarrose-recurved from an appressed base, or caducous and widely spreading, 1.6—3.0 by 0.7—1.3 mm, L/W ratio 1.8—2.6 (—2.9); base measuring 0.35—0.5 of the length of the leaf; teeth up to 70 μ long. *Branch leaves* (1.7—) 2.3—3.7 (—4.3) by 0.6—1.1 mm, L/W ratio 2.6—4.1 (—5.2); base measuring 0.35—0.5 of the leaf length; teeth up to 55 μ long; lamina cells in the apical part of the leaf (10—) 14—37 (—47) by (2—) 3—8 μ, most cells more than 5 times as long as wide; border strong, bistratose part mostly continuous. *Seta* 3—4.5 cm long. *Theca* 4.5—7.5 mm long.

Distribution: Sumatra, Java, Borneo, Luzon, Negros, Leyte, Mindanao, Celebes, Batjan, Buru, Ceram.

SUMATRA: *Teijsmann s.n.* (FH, GRO, H, L, S-PA).

JAVA. West Java. G. Salak: *Bakhuizen van den Brink Sr 3643* (FH, L); *Kurz 157* (BO, GRO, H, L); *Schiffner Cr. Exs. 3974* (B, BM, EGER, H, L, S-PA, US, W); *Teijsmann s.n.* (GRO, H, L). G. Megamendong: *Zippelius s.n.* (GRO, L). G. Gedeh and G. Pangrango: 12 collections. G. Tjikurai ('Tjiqurra'): *Reinwardt s.n.* (L).

BORNEO. Sabah. Mt. Kinabalu: *Clemens 28152* (BM), *34276A* (FH), *40219* (FH); *Haviland 1430* (K, MEL); *Iwatsuki 1719* (L, NICH). G. Lumaku: *Nooteboom 1127 p.p.* (L). Tawau R. Forest Reserve: *Meijer B 10714* (L), *B 10804* (L), *B 12061* (L). — Sarawak. Mt. Dulit: *Richards M 1073* (BM, GRO, L), *M 1116* (BM, GRO, L), *M 1159* (GRO). Lundu: *Micholitz 317 p.p.* (FH, H, JE, K, NY, PC). Mt. Penrissen: *Everett 676* (BM, NY, SING). — Indonesian Borneo. Songkong Ra. near Sambas: *Schäfer 8* (BM, JE).

LUZON. Kalinga. Mt. Masingit: *Ramos & Edaño BS 37520* (BM, BO, FH, GRO, H, L, W), *BS 37535* (H, K, NY, PC). — Aurora: *Santos 387* (FH). Baler: *Santos £70* (FH). — Laguna. Mt. Banahao: *Iwatsuki et al. 14081* (L); *Robinson BS 9854* (BM, H, K, NY). — Albay. Mt. Malinao: *Edaño*

PNH 37221 (L, PNH), *PNH 37236* (L, PNH). — Sorsogon. Mt. Bulusan: *Edaño & Gutierrez PNH 40556* (PNH); *Elmer 15067* (BM, BO, FH, GRO, H, K, KAG, L, NICH, NY, S-PA, W); *Sinclair & Edaño 9625* (GRO, PNH).

Negros. Oriental. Cuernos de Negros: *Elmer 9977* (BM, BO, FH, GRO, H, L, MO, NY, US, W). Lake Balinsasayao: *Chapman 22* (FH); *Edaño PNH 12946* (GRO), *PNH 13119* (GRO).

Leyte: *Wenzel 493* (BM, FH). Lake Danao: *Edaño PNH 12808* (GRO). Mt. Janagdan: *Edaño PNH 12820* (GRO).

Mindanao. Lanao. Maria Cristina Falls: *Ebalo 1187* (FH). — Agusan. Mt. Urdaneta: *Elmer 14191 p.p.* (BO, FH, GRO, H, L, MO, PC, W).

Celebes. Southwest Peninsula. Todjambu: *Kjellberg 39M* (BM, BO, FH, GRO, S-PA).

Batjan: *de Vriese & Teijsmann s.n.* (BO, GRO, H, L)

North Buru: *Deninger s.n.* (BM, GRO, H, JE).

Ceram: *de Vriese s.n.* (BO, GRO, H, L).

Notes: 1. Jaeger (in Jaeger et Sauerbeck, 1880), as was already remarked by Dixon in a herbarium note, considerably mixed up facts when he stated that *Mniodendron korthalsii* Bosch et Lac. was a nomenclatural synonym of *Hypnum korthalsii* Dozy et Molk. (= *Trismegistia lancifolia* (Harv.) Broth. var. *korthalsii* (Dozy & Molk.) Fleisch.).

2. Van den Bosch and van der Sande Lacoste (1866) listed many collections of their new species *Mniodendron korthalsii*, but did not indicate a type specimen. All collections except the one made by Korthals could be traced. The illustration was mainly based on the collection the authors received through Rochussen (of whom no botanical collections are known). This collection has not been chosen as a lectotype because it is composed of various gatherings by unknown collectors, maybe from different places.

3. The beautiful plate in Bryologia Javanica shows inaccuracies in the details concerning the areolation, the teeth, and the structure of the capsule's surface. Open capsules are rarely completely smooth and they have never been found to be entirely sulcate. Besides, the stipe leaves depicted are strongly squarrose, which is not the usual situation in ssp. *korthalsii*.

4. Several differential characters of the present subspecies have already been discussed under ssp. *milnei* and ssp. *parvum*. In ssp. *korthalsii* the border is usually strong and bistratose, the branch leaves may reach a somewhat greater length than in the other subspecies, and the costa of the stipe leaves extends further.

5. The present subspecies is the most widespread and polymorphous one. Robust plants have persistent stipe leaves which are mostly closely appressed at base; the branch leaves measure 2.4—3.7 (—4.3) mm. The type specimen of *Mniodendron korthalsii* belongs here. Comparatively small plants may have caducous leaves, which often are almost completely spreading, and branch leaves measuring (1.7—) 2.3—3.0 mm. That form is represented by the type of *M. deningeri*. The authors of *M. deningeri* obviously overlooked *M. korthalsii* and *M. milnei* as they considered their new species the only one of the genus lacking tomentose stipes. These extremes are connected by many intermediates such as the type specimen of *M. mindanense*. Robust plants having persistent stipe leaves predominate in Java, whereas small ones having caducous leaves appear to predominate in Borneo, Luzon, and Mindanao. From the other islands too few collections are known to permit any conclusion in this respect. The branch leaves of the Philippine plants often bear comparatively few geminate teeth.

6. Mitten & Wright (in Stapf, 1894) included Aneityum (New Hebrides) in the area of *Mniodendron korthalsii*. As only *M. milnei* (= *Hypnodendron milnei* ssp. *milnei*) has ever been found there, Mitten apparently had reached the conclusion that his species and *M. korthalsii* were conspecific.

7. The Japanese record of *Mniodendron korthalsii* (van der Sande Lacoste, 1867) was

based on a presumably mislabelled von Siebold specimen, originating from Malesia (see p. 227).

Sect. Comosa

(Hampe) Touw, *comb. nov.* — *Hypnum* Hedw. sect. *Comosa* Hampe (1871) 395. — *Hypnum Comosa* Hampe (1867) 78, (1852) 70, *pro parte, nom. nud.* — *Mniodendron* Lindb. *ex* Kindberg (1899) 393; Lindberg (1861) 375, *nom. nud.*, in Dozy et Molkenboer (1866) 136, *pro parte*; Jaeger in Jaeger et Sauerbeck (1880) 355, *pro parte*; Paris (1896) 821, (1905) 262; Dixon (1929) 343, *pro parte*; Bartram (1939) 155, *pro parte*; Sainsbury (1955B) 319. — *Mniodendron* Lindb. *ex.* Kindb. sect. *Eu-Mniodendron* Brotherus (1909C) 1171, *pro parte, nom. illeg.*; Fleischer (1923) 1617; Brotherus (1924B) 439, *pro parte.* — Lectotype species: *Hypnum divaricatum* Reinw.

Mniodendron Lindb. *ex.* Kindb. sect. *Comatulina* Brotherus (1909C) 1172, *pro parte*; Fleischer (1923) 1615, *excl. spec.*; Brotherus (1924B) 439, *pro parte.* — *Hypnum* Hedw. subsect. *Comatulina* C. Mueller (1851A) 503, *pro parte, typ. excl.* — Lectotype species: *Hypnum comosum* Labill.

Dendromnium Lindberg *ex* Juel (1918) 52, *nom. nud.*

Plants small to tall, erect. *Distal innovations* often present, often strong and forming several tiers above each other. *Stipe* covered with tomentum. *Pseudoparaphyllia* small, spreading. *Frond* umbellate; branches not or weakly complanate. *Stipe leaves* widely spreading to squarrose-recurved, often longitudinally plicate or striate, narrowly triangular to deltoid, occasionally triangular-ovate; insertion line concave; base mostly cordate to auriculate, occasionally rounded, often shortly decurrent; apex shortly to long-acuminate; margin near base strongly recurved and entire to serrate, upwards flat and serrulate to serrate with simple teeth; costa mostly percurrent to aristate, occasionally ending in apex, mostly dorsally smooth; cells smooth to papillate with long and usually rather indistinct papillae; marginal cells often shorter than the inner ones; alar cells enlarged, mostly forming a conspicuous group, walls thin or incrassate and coloured; basal cells weakly differentiated, mostly green, often bearing rhizoids. *Branch leaves* isomorphous and symmetrical or nearly so, often secund, often longitudinally plicate to striate, triangular ovate-lanceolate to very narrowly triangular, occasionally ovate; apex often very narrow, mostly gradually acuminate; margin recuved below, serrate with simple teeth; costa mostly strong, ending in apex to excurrent; areolation as in the stipe leaves, but alar cells less distinct from the inner lamina cells.

Male gametoecia often grouped together in a flat to somewhat convex disk. *Perichaetial leaves* plicate to almost smooth. *Theca* sulcate, inclined to cernuous. *Spores* 12—20 μ. *Operculum* sharply rostrate.

Distribution: As the family, but absent in several marginal areas, viz. Khasi Hills, Taiwan, Ryukyus, New South Wales, and South America.

Notes: 1.The present section comprises most species formerly accomodated in the genus *Mniodendron*. Unfortunately that name is antedated on the infrageneric level by *Hypnum* sect. *Comosa* Hampe. Hampe included in it '*H. comosum, H. divaricatum*, etc.' but did not select a type species. Lindberg (1861) gave no description of *Mniodendron* but mentioned as species *M. comosum, M. divaricatum*, and *M. comatum*, again without designating one of these as a type. Kindberg did not mention any species at all with his diagnosis. Of the species mentioned above Brotherus (1909C) incorporated *M. divaricatum* and *M. comatum* in sect. *Eu-Mniodendron*. Therefore, *Hypnum divaricatum* Reinw. (= *Hypnodendron dendroides*) has been chosen as lectotype of *Hypnum* sect. *Comosa* and *Mniodendron*.

2. The species of sect. *Comosa* have been subject to much confusion and error, which finally led to the insertion in Index Muscorum (van der Wijk et al., 1964) of three Australasian species under one name which has to be applied to a Malesian species.

The first specimen belonging to an Australasian species was collected in 1792 or 1793 in Tasmania by Labillardière, who himself named it *Hypnum comosum* (Labillardière 1807). In 1803 Bridel had already misidentified the same specimen as *Bryum dendroides*, a pre-starting point name (Swartz, 1781) given to a Javanese specimen belonging to the species for which the name *Mniodendron divaricatum* (Reinw.) Lindb. *ex* Card. came into current usage. The authors of Index Muscorum maintained the last mentioned name for the Indo-Pacific species and they erroneously attributed the combination *Mniodendron dendroides* (Brid.) Wijk et Marg. to the Tasmanian species. As Bridel definitely stated that by *Bryum dendroides* no other species was meant but the one Swartz described, the epithet '*dendroides*' has to be used for the Malesian species, thus leaving *Hypnum comosum* as the oldest available legitimate name for the Tasmanian one. Bridel's description can be applied to both species — at least to the plants available to him.

As a note on his diagnosis of *Isothecium colensoi* Wilson (1859) stated: 'overlooked as a variety of *I. comosum* in the "Flora of New Zealand" '. However, he did not explain that the diagnosis of var. β consisted of a mixture of features of *Hypnodendron comatum* and *H. colensoi*, the description of the sporophyte being entirely based on the first mentioned species. I suppose that this omission has contributed much to Hooker's (1867) reduction of *I. colensoi* to *I. comatum*. Hooker's description of *I. comatum* contains characters of both species. Rodway (1914) apparently interpreted the species mainly from literature and did not examine the type specimens. His interpretation is fully erroneous, as his *Mniodendron comatum* and *M. comosum* are forms of *H. comosum* var. *sieberi*, and *Mniodendron sieberi* in his flora is *H. comosum* var. *comosum*. Small wonder that he doubted whether these species should be considered specifically distinct!

Dixon (1929) correctly reduced *Isothecium tomentosum* and *Mniodendron brevisetum*, but failed to distinguish *Hypnodendron comatum* and *H. colensoi*. He was struck by the occurrence of two types of sporophytes in a single species but evidently did not notice the peculiar crystals in the costa of *H. colensoi*, or attributed no taxonomic value to that character. These crystals were already observed by Wilson (1859), who described the costa as being 'punctulate'. Later authors obviously overlooked or misinterpreted that part of the diagnosis.

Dixon (1929) also paid insufficient attention to the variability of *H. comosum*. He did not examine the type specimen of var. *sieberi*, and I strongly suspect that he did not see the type of var. *comosum*, as his description of the species holds true only for var. *sieberi*, the only form known to occur in New Zealand at that time. The differential characters he mentioned between *Mniodendron comosum* (= *H. comosum* var. *sieberi* as understood here) and *M. comatum* (= *H. comatum* + *H. colensoi*) do not hold for *H. comosum* var. *comosum*. Therefore, it is not al all surprising to find that Sainsbury (1945) confessed to being unable to distinguish *M. comosum* from *M. comatum* according to the characters Dixon mentioned. He supposed they were identical, an opinion which was strengthened by the results of his (1955A) examination of Tasmanian plants belonging to sect. *Comosa*. In my opinion these plants presumably all belong to the varieties of *H. comosum*. Thus, Sainsbury arrived at the conclusion that only one variable species was involved in Tasmania and in New Zealand. That view was accepted by the authors of 'Index Muscorum', who in turn contributed to the confusion by applying the combination *Mniodendron dendroides* to it, as has been mentioned before.

Owing to this confusion a number of publications have had to be left out of consideration

here, as the identity of the specimens on which they are based could not be ascertained.

18. Hypnodendron comatulum (Broth.) Touw, *comb. nov.* — *Mniodendron comatulum* Geheeb *ex* Brotherus in Brotherus et Watts (1918) 567; Brotherus (1925) 531; Dixon (1942B) 32; van der Wijk et al. (1964) 394. — Syntypes: *W. W. Watts 676 pro parte* (H lecto, BM, MEL), Queensland, Charmellan's Creek, on Gordon's Track from Ravenshoe to Tully Falls; *Pentzke s.n.* (H), Queensland, Mt. Armit.—**Fig. 32, 33.**

Plants small, pale green, dull to somewhat glossy. *Distal innovations* absent (?). *Stipe* up to *c.* 4 cm long. *Frond* up to 3 cm across, rather dense, mostly umbellate, sometimes palmate or pinnate; branches ± horizontal, simple or sparsely branched. *Stipe leaves* imbricate, triangular-ovate, *c.* 1.6—1.9 by 0.8—0.95 mm, L/W ratio *c.* 1.9—2.1; base broadly rounded; apex gradually weakly acuminate; margin near base flat to slightly recurved and serrulate, in the distal half of the leaf closely serrate with up to *c.* 18 μ long teeth; costa mostly thin, ending in apex, dorsally smooth or bearing up to *c.* 4 small teeth; lamina cells *c.* 50—100 by 3—4 μ, L/W ratio *c.* 15—30; marginal cells rhomboid to elongate or irregular; alar cells forming an ill-defined group of shortly rectangular to hexagonal inflated cells, in old leaves often partly having orange coloured walls. *Branch leaves* ovate, concave, *c.* 1.7—2.6 by 0.7—1.2 mm, L/W ratio *c.* 1.8—2.3; base rounded; apex acute to shortly acuminate; margin in the basal third of the leaf entire or nearly so, upwards densely serrate with up to 15 (—20) μ long teeth; costa ending in apex, occasionally percurrent, bearing many small dorsal teeth; lamina cells *c.* 25—75 by 3—4 μ, L/W ratio *c.* 7—20; walls strongly incrassate, often porate; marginal cells as in the stipe leaves; alar cells very ill-defined, forming a small group of somewhat inflated cells.

Up to *c.* 4 *sporophytes* on each frond. *Seta c.* 2—3 cm long, arcuate, yellowish with an orange to reddish basal part. *Theca* horizontal, weakly curved, shortly cylindrical, *c.* 2.5—4 mm long, pale brown, sulcate to costate, constricted below the orifice. *Cilia* 2—4. *Operculum c.* 2—2.5 mm long, yellow to pale brown. *Calyptra c.* 3.5 mm long.

Distribution: North Queensland.

Australia. Queensland. Mt. Armit: *Pentzke s.n.* (H). Mt. Lewis: *van Zanten 681379* (GRO, L). Bellenden Ker Ra.: *Bailey s.n.* (H). Mt. Bartle Frere: *Flecker 863* (BM), *6390* (Allison, BM); *van Zanten 681470* (GRO, L). Atherton Tableland S. of Ravenshoe: *van Zanten 681299* (GRO, L). Charmellan's Creek: *Watts 676 p.p.* (BM, H, MEL). Rockingham Bay: *Dallachy s.n.* (MEL); *unknown coll. 8* (MEL).

Ecology: On moist rocks in rain forest.

Note: This interesting Queensland endemic differs noticeably from the other species of the present section in having proportionally short and wide leaves which have more strongly curved margins than usual, thin costa, ill-defined alar cells, short lamina cells, and pale coloured sporophytes.

19. Hypnodendron camptotheca (Par.) Touw, *comb. nov.* — *Mniodendron camptotheca* Duby in Besch. *ex* Paris (1905) 262; Duby in Bescherelle (1873) 243, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 356; Paris (1896) 821; Brotherus (1906A) 26, (1909B) 31, (1909C) 1172, (1911) 42, (1924B) 439; van der Wijk et al. (1964) 394; Tixier (1969B) 298. — Type: *Pancher 566 pro parte* (BM holo, H, L, S-PA), New Caledonia, on sheltered soil in forest, 500 m. — **Fig. 32, 33.**

Plants densely tufted, small to medium-sized, pale green to sordid green, somewhat glossy. *Stipe* up to 3.5—(4.0) cm long. *Frond* simple or tiered, up to 2.5 cm across, umbellate, fasciculate, palmate, or pinnate; branches mostly simple, flexuose. *Stipe leaves* very narrowly triangular, 2.1—3.0 by 0.6—0.95 mm, L/W ratio 2.9—3.9; base rounded

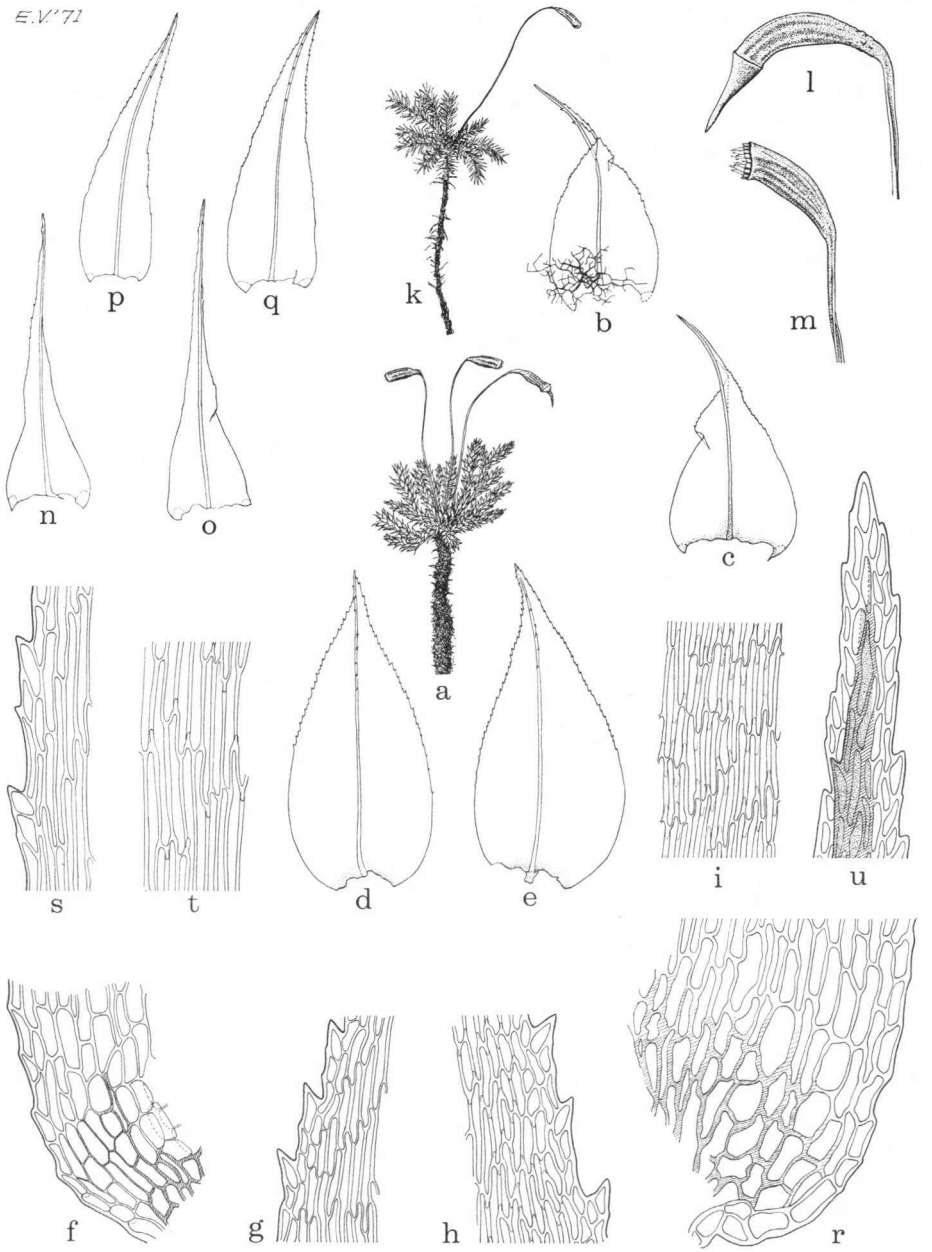

Fig. 32. a—i: *Hypnodendron comatulum;* k—u: *H. camptotheca.* — a, k: Habits, × 1; b, c, n, o: stipe leaves, × 17; d, e, p, q: branch leaves, × 17; f, r: alar cells of stipe leaves, × 260; g, s: margins of stipe leaves, × 260; h: margin of branch leaf, × 260; i, t: areolation of branch leaves, × 260; l, m: capsules, × 4; u: apex of branch leaf, × 260. (a, c: *van Zanten 681299;* b, d—i: *van Zanten 681470;* k—n, r, s: *Franc MNCE 18;* o: *Franc s.n.;* p, t, u: *Pancher 566;* q: *Robbins 3734*).

to cordate, little narrowed; apex very narrow, gradually long-acuminate; margin near base entire to weakly crenulate, near apex serrulate to serrate with up to 12 μ long teeth; costa excurrent in a short and sharp arista, dorsally smooth or bearing a few small teeth; lamina cells 50—160 by 3—4 μ, L/W ratio *c.* 20—45, walls smooth to very weakly papillate; marginal cells rhomboid to linear; alar cells forming a small group of somewhat inflated cells having incrassate and occasionally orange coloured walls. *Branch leaves* narrowly triangular-ovate-lanceolate, slightly homotropous, 2.0—2.3 (—2.7) by 0.5—0.8 mm, L/W ratio (2.8—) 3.6—4.0 (—4.4); base rounded, little narrowed; apex acute, concave; margin near base entire or nearly so, upwards serrate with up to 12 μ long teeth; costa narrowing upwards, ending in apex to percurrent, bearing many small dorsal teeth; lamina cells 50—110 by 2—4 μ, L/W ratio *c.* (12—) 15—33, walls usually moderately incrassate and weakly papillate; marginal cells as in the stipe leaves; alar cells forming a small group of inflated cells with incrassate walls.

Up to *c.* 2 *sporophytes* per frond. *Seta c.* 2.5—4.5 cm long, arcuate to straight, pale brown to blackish brown. *Theca* usually inclined to horizontal, curved, obconical to cylindrical, gradually narrowed towards the base, *c.* 2.5—5.5 mm long, pale brown to blackish brown, sulcate to angular, weakly or not at all constricted below the orifice. *Cilia* 2—4. *Operculum c.* 2—3.5 mm long. *Calyptra* not seen.

Distribution: New Caledonia.

New Caledonia: *Franc s.n.* (FH, PC); *Krieger s.n.* (BM, W); *Pancher 566 p.p.* (BM, H, L, S-PA); *Vieillard s.n.* (BM, NY); *unknown coll. 8* (H, NY, PC). Koumac: *Compiène 1218* (H). Mé Areimbo: *Le Rat s.n.* (H). Mt. Rembai ('Perrbai'): *Le Rat s.n.* (H). Mt. Dzumac: *Le Rat 577* (H), *Schmid CR 5* (PC). Mt. Bon Secours: *Robbins 3734* (L). Mt. des Koghis: *Franc s.n.* (JE). Pic Malaoui: *Le Rat s.n.* (H). Thi R.: *Le Rat s.n.* (FH, GRO, L). St Louis: *Le Rat s.n.* (GRO, H). Nouméa: *Franc, Musci Nov.-Caled. Exsicc. 18* (FH, GRO, H, JE, L, NY, PC, S-PA, US, W). La Coulée R., Pouéta Est: *Bernier 322* (H, PC). Baie du Sud: *Franc s.n.* (FH, JE).

Ecology: On decaying logs, tree trunks, rocks, and occasionally terrestrial; in forests; from sea level up to *c.* 1200 m.

Note: *H. camptotheca* differs from the other species of sect. *Comosa* by the very short marginal teeth, very narrow and basally little narrowed stipe leaves, and by its branch leaves which are wide and acute instead of acuminate at the apex and have a shorter and upwards narrowing costa. Like the New Zealand and South Australian species it has obconical capsules which are weakly or not at all constricted below the orifice.

20. Hypnodendron colensoi (Hook. *f.* et Wils.) Mitten (1882A) 90. — *Isothecium colensoi* J. D. Hooker et Wilson in J. D. Hooker (1859) 207, t. 176 f. 1; Bastow (1887) 84. — *Mniodendron colensoi* Bescherelle (1873) 244, *'collensoi', comb. inval.* — Type: *Gunn s.n.* (BM holo, H), Tasmania. — **Fig. 19, 34.**

Isothecium comosum (Labill.) Brid. var. β Wilson in J. D. Hooker (1854) 106, *comb. inval., pro parte.* — Type: *A. Menzies 80 pro parte* (BM), New Zealand, Dusky Bay.

Isothecium comatum (C. Muell.) J. D. Hooker (1867) 467, *pro parte, excl. typ.* — *Mniodendron comatum* (C. Muell.) Par., *pro parte, excl. typ.*: Reichardt (1870) 189; Hampe et Geheeb (1881) 27.

Plants small to medium-sized, densely tufted, usually pale green, somewhat glossy. *Stipe* erect, up to 4 (—5.5) cm long. *Frond* often many-tiered, up to 3(—3.5) cm across, open to dense, palmate to umbellate; branches simple to sparsely pinnate, fastigiate to horizontal, usually straight or nearly so, hardly or not at all attenuate. *Stipe leaves* narrowly triangular, 2.7—3.9 by 0.9—1.5 mm, L/W ratio 2.4—3.4; base more or less widened, usually very broadly cordate; apex gradually acuminate; margin near base almost entire, upwards serrulate, near apex sparsely serrate with up to *c.* 17 μ long teeth; costa shortly

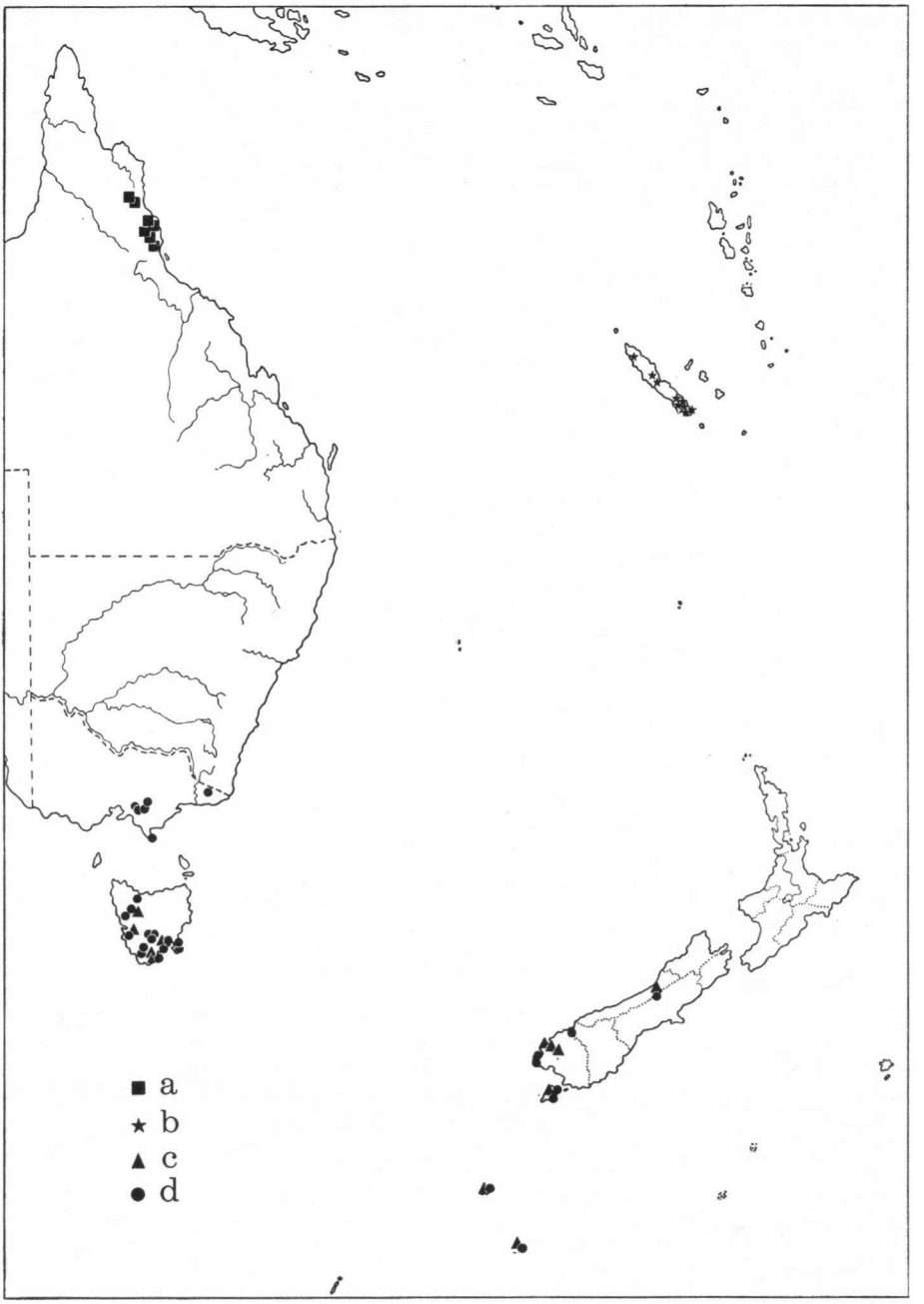

Fig. 33. Distribution of *Hypnodendron comatulum* (a), *H. camptotheca* (b), *H. comosum* var. *comosum* (c), and *H. comosum* var. *sieberi* (d).

excurrent, dorsally smooth or nearly so; lamina cells 50—135 by 3—4 μ, L/W ratio *c.* 15—30, walls moderately to strongly incrassate, usually weakly papillate; marginal cells up to *c.* 45 μ long; alar cells forming a large group, walls thin to somewhat incrassate; epidermal cells of the basal part of the costa filled with one or few hyaline crystals. *Branch leaves* triangular-ovate-lanceolate, erecto-patent to slightly homotropous, 2.2—3.0 (—3.4) by 0.65—1.0 (—1.1) mm, L/W ratio 3.0—4.0 (—4.6); base broadly cordate; apex gradually long-acuminate; margin near base almost entire, upwards sharply serrate with up to *c.* 25 μ long teeth, and often slightly darker coloured than the inner part of the lamina; costa stout, green, occasionally brownish, bearing many small dorsal teeth; arista short, serrate to spinulose; lamina cells 40—100 by 3 —4(—5) μ, L/W ratio *c.* 10—20 (—30), walls mostly weakly papillate; marginal cells shortened and slightly widened; alar cells inflated, rectangular, walls thin to moderately incrassate; crystals in costa cells present and distributed as in the stipe leaves.

Up to 3(—6) *sporophytes* per frond. Costa cells of *perichaetial leaves* containing crystals. *Seta* (2.5—) 3.5—4.5 (—5.5) cm long, flexuose to straight, pale red to dark brown. *Theca* horizontal to cernuous, weakly curved, usually shortly cylindrical, sometimes obconical, 3.5—5.5 mm long, orange brown to dark reddish brown, deeply sulcate, weakly or not at all constricted below the orifice. *Cilia* 2—4. *Operculum c.* 2.5—3.5 mm long. *Calyptra c.* 4—5 mm long.

Distribution: New Zealand, Australia (?), Tasmania (?). In New Zealand most frequent in the North Island, strongly decreasing southward.

Australia. New South Wales. Mt. Tomah: *Cunningham s.n.* (NY). — Victoria. Mt. Disappointment: *unknown coll. MEL 34591* (MEL).

Tasmania.: *Gunn s.n.* (BM, H).

New Zealand. North Island. North Auckland: *Cunningham s.n.* (L); *Matthews s.n.* (FH). Ororua: *Petrie s.n.* (CANTY). Mangonui: *Matthews 38 p.p.* (FH). Awanui: *Petrie 590 p.p.* (CANTY, H, S-PA). Kaitaia: *Petrie s.n.* (CANTY). Whangaroa: *Fristedt s.n.* (GRO, S-PA). Hokianga: *Berggren 1689* (H), *Jolliffe s.n.* (BM). Ohaeawai: *Berggren s.n. p.p.* (S-PA). Kahikanui near Whakapara: *Setchell 135* (PC). Waipoua: 8 collections. Kaipara: *Blackwell 23* (BM); *Mossman 720 p.p.* (NY). Little Barrier I.: *Wormald s.n.* (Allison). Great Barrier I.: *Kirk s.n.* (CANTY, NY); *Knight s.n.* (BM). Waiheke I.: *Jolliffe s.n.* (K); *Milne 32* (K); *Sinclair s.n.* (BM, H, K, NY). Waitakere Ra.: *Cheeseman 61* (CANTY); *Hochstetter 215* (W); *Kirk 4* (Allison); *Moore 407* (CHR). Titirangi Ra.: *Beccari 36* (GRO). Auckland: *Colenso s.n.* (NY); *Hatch s.n.* (Allison); *Jelinek 25* (BM); *Knight s.n.* (H, S-PA); *Sinclair s.n.* (BM). Manukau: *Sinclair s.n.* (BM). Drury: *Hochstetter 208* (W); *Jelinek 221* (W), *244* (W). Ohakau: *Matthews s.n.* (CHR). Waikato R.: *unknown coll. s.n.* (NY). Coromandel Peninsula: *Martin 312.11* (CHR); *Matthews s.n.* (Allison); *Mitchell s.n.* (Allison). Coromandel: *Hochstetter 256* (W); *Hutton 39* (K). Thames: *Petrie s.n.* (CANTY, MO, US). Ngaruawahia: *Petrie 590 p.p.* (CANTY, NY). Matamata: *Jardine & Sainsbury s.n.* (L, NY, US, W). New Plymouth: *Gupp s.n.* (NY). Tongariro National Park: *Allison 483* (Allison). Port Nicholson: *Sinclair s.n.* (K). Wellington: *Buchanan s.n.* (H). — South Island. Wairoa: *Mossman s.n.* (FH). Pelorus: *unknown coll. s.n.* (H). Westland: *Blotam s.n.* (H). Paparoa Ra.: *Helms s.n. p.p.* (BM). Runanga: *Martin Y 360* (NICH). Greymouth: 6 collections. Lake Hochstetter: *Brownlie 320* (CANTY). Lake Brunner: *Barker 69142 p.p.* (CANTY). Mt. Te Kinga: *Barker 6776 p.p.* (CANTY). Kumara: *Brownlie 374* (CANTY). Taramakau: *Berggren 1691* (H, S-PA, W), *2570* (BM). Inchbonnie: *Barker 68231* (CANTY). Otago: *Petrie s.n.* (H). Dunedin: *Kirk s.n.* (CANTY). Secretary I.: *Baylis s.n.* (Allison). Dusky Sound: *Lyall 53 p.p.* (NY); *Menzies 80 p.p.* (BM). Waiharihiri R.: *Henry s.n.* (Allison). Bluff—Invercargill—Winton: *Berggren 1690 p.p.* (H, S-PA). — Stewart Island. Mt. Anglem: *Martin 312.16* (BO).

Ecology: On moist soil, decaying logs, occasionally on rocks; in rain forests. Judging from the few indications on the labels of the herbarium specimens *H. colensoi* usually grows at low altitudes: 0—300 (—1000) m.

Notes: 1. The most striking features of the present species are the few sporophytes on each frond, the long seta, and above all the crystals in the costa cells. These crystals most probably consist of calcium oxalate, and have been found in all specimens of *H. colensoi*,

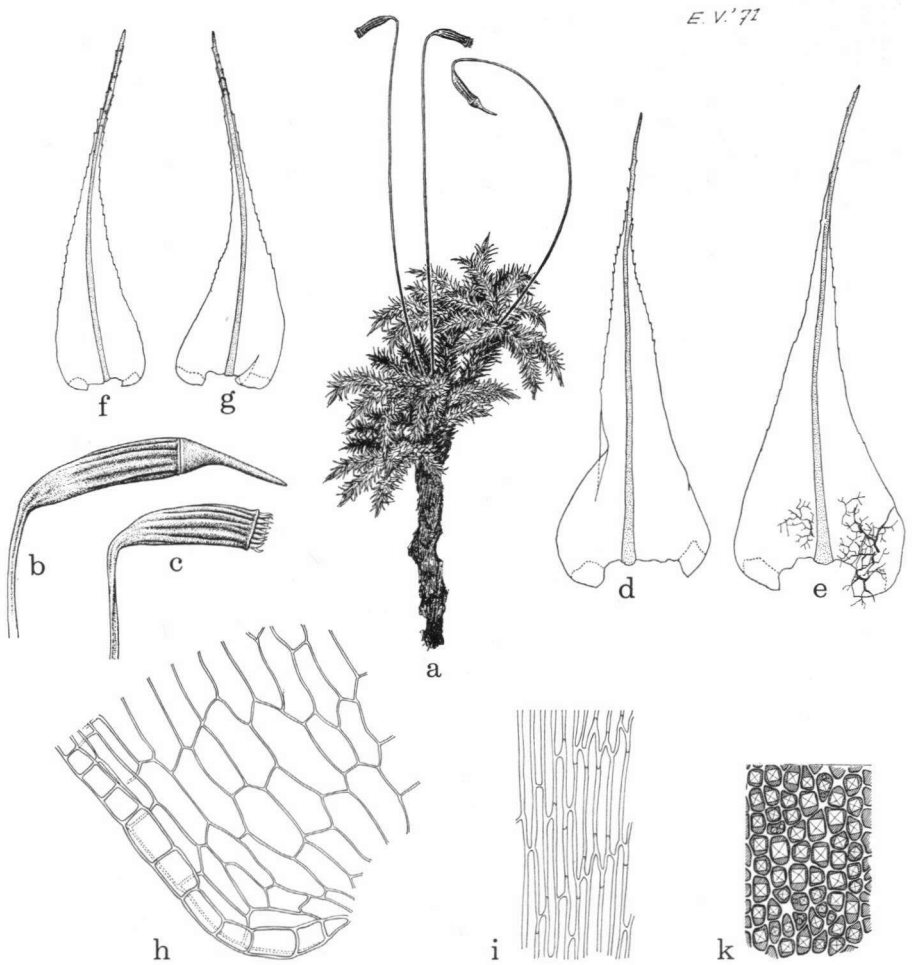

Fig. 34. *Hypnodendron colensoi*. — a: Habit, × 1; b, c: capsules, × 4; d, e: stipe leaves, × 17 (the rhizoids in e are not attached to the leaf); f, g: branch leaves, × 17; h: alar cells of branch leaf, × 260; i: areolation of branch leaf, × 260; k: crystals in costa of stipe leaf, × 260. (a: *Helms 8;* b, c, i: *Helms s.n.;* d, f, h, k: *Allison 743;* e, g: *Gunn s.n.*).

but not in any other species of *Hypnodendron*. *H. colensoi* occurs in the same habitat and has often been collected together with *H. comatum* which has more numerous sporophytes borne on shorter setae and forms plants which are taller and have distinctly umbellate fronds consisting of usually densely pinnate branches. Small plants of *H. comatum*, however, may strongly resemble *H. colensoi* in habit, branching, and leaf shape. The latter has the stipe leaves somewhat widened at base, the walls of the alar cells of the branch leaves are as strong as or thinner than those of the lamina cells, and the costa of the branch leaves is a little less strong and paler green.

2. The type and only collection from Tasmania was collected by R. C. Gunn, and one Australian collection was gathered by A. or R. Cunningham. However, it seems that the

labels of these collectors are not always reliable (see p. 228). The data accompanying the only remaining Australian collection are incomplete. Therefore, the occurrence of *H. colensoi* outside New Zealand remains rather doubtful.

3. See note 2 under the section.

21. Hypnodendron comatum (C. Muell.) Mitt. *ex* Touw, *comb. nov.*; Mitten in Seemann (1873A) 401, *comb. inval.* — *Hypnum comatum* C. Mueller (1851B) 566, (1851A) 692. — *Isothecium comatum* J. D. Hooker (1867) 467, *pro parte.* — *Mniodendron comatum* Lindberg *ex* Paris (1905) 262; Lindberg (1861) 375, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 356; Paris (1896) 821; Brotherus (1909C) 1172, (1924B) 439; Dixon (1929) 345, *pro parte*; Sainsbury (1945) 186, (1955A) 46. — Type: *S. Mossman 720, pro parte* (B holo †, NY lecto, BM, H), New Zealand, Kaipara, on tree trunks and humid rocks. — **Fig. 19, 35.**

Isothecium comosum (Labill.) Brid. var. *β* Wilson in J. D. Hooker (1854) 106, *comb. inval., pro parte.* — *Mniodendron comosum* Par. *sensu* Sainsbury (1955B) 321, *pro parte.* — Type: *A. Menzies 80 pro parte* (BM), New Zealand, Dusky Bay.

Mniodendron brevisetum Reichardt *ex* Paris (1905) 262; Reichardt (1870) 189, t. 34, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 355; Brotherus (1909C) 1172, (1924B) 439. — *Mniodendron brevifolium* Reichardt *ex* Paris (1896) 821, *err. pro M. brevisetum* Reichdt. — Syntypes: *F. von Hochstetter 257* (W lecto, S-PA), New Zealand, Waikato; *id. 284* (W), New Zealand, Nelson.

Isothecium tomentosum Colenso (1888) 242. — *Hypnodendron tomentosum* Gepp in Paris (1900B) 192; Paris (1904) 375. — Type: *A. Hamilton s.n.* (not seen), New Zealand, Highlands, interior north of Napier.

Plants medium-sized to tall, mostly loosely tufted, pale green, yellowish green, or sordid green, becoming brownish with age, somewhat glossy. *Stipe* erect or ascending, up to 8 (—11) cm long. *Frond* bearing up to 2 (exceptionally 5) tiers of distal innovations, but mostly simple, up to 6 (—7) cm across, dense, rounded, umbellate, less often palmate; branches more or less densely pinnate to irregularly bipinnate, horizontally spreading, decurved, attenuate. *Stipe leaves* as in *H. colensoi*, but (2.6—) 3.4—4.2 by (1.0—) 1.2—1.6 mm, L/W ratio 2.2—3.0; base broadly cordate, not enlarged; lamina cells 50—135 (—160) by 3—4 *μ*, L/W ratio *c.* 15—30 (—45), walls smooth to weakly papillate; marginal cells 30—50 *μ* long, walls more strongly incrassate than those of the inner lamina cells; alar cells as in *H. colensoi*, but forming a smaller group and having thin to incrassate walls. *Branch leaves* as in *H. colensoi* but (2.0—) 2.4—3.1 by 0.6—1.1 mm, L/W ratio 2.7—3.4 (—4.8); base broadly rounded to cordate; costa stronger, green to brownish; lamina cells 40—120 by *c.* 3 *μ*, L/W ratio *c.* 15—35, walls smooth to weakly papillate; marginal cells as in *H. colensoi*, mostly more distinct; alar and basal cells having strongly incrassate, often orange coloured walls.

Up to 16(—26) *sporophytes* on each frond. *Setae* (1.5—) 2.0—3.0 (—3.5) cm long, straight or nearly so, orange to red or brown, often entwined. *Theca* horizontal to cernuous, weakly curved, obconical to shortly cylindrical, (2.2—) 2.5—3.8 (—4.5) mm long, orange, red, or dark brown, deeply sulcate, weakly or not at all constricted below the orifice. *Cilia* 2—4. *Operculum c.* 1.5—3.0 mm long. *Calyptra c.* 3.5—4.5 mm long.

Distribution: Norfolk I. (?), New Zealand. Frequent in all humid parts of New Zealand, most common in the southern part of the country.

Norfolk Island. *Cunningham s.n.* (BM, NY).

New Zealand. North Island. North Auckland: *Matthews 221* (BM). Mangonui: *Matthews 38 p.p.* (FH). Ohaeawai: *Berggren 1687* (H). Papakauri: *Berggren 1688* (S-PA). Kaipara: *Blackwell 24* (BM); *Mossman 720 p.p.* (BM, H, NY). Great Barrier I.: *Hutton & Kirk 24* (NY), *Kirk s.n.* (CANTY). Waitakere

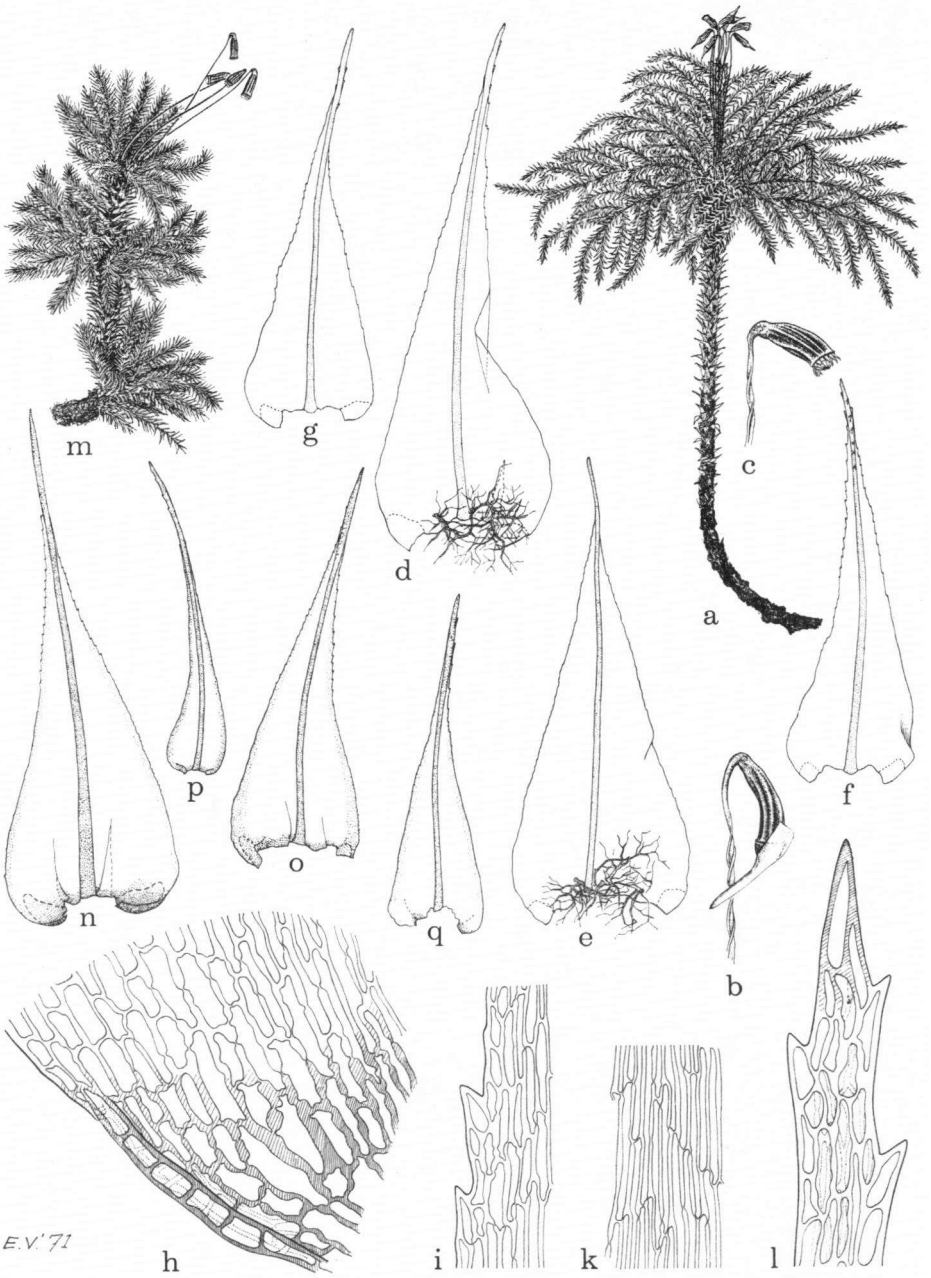

Fig. 35. a—l: *Hypnodendron comatum;* m—q: *H. comosum* var. *comosum.* — a, m: Habits, × 1; b, c: capsules, × 4; d, e, n, o: stipe leaves, × 17; f, g, p, q: branch leaves, × 17; h: alar cells of branch leaf, × 260; i: margin of branch leaf, × 260; k: areolation of branch leaf, × 260; l: apex of branch leaf, × 260. (a, b: *Martin s.n.;* c: *Martin 312.2;* d, f, h—l: *Martin 312.17;* e: *Lam 6956;* g: *Hochstetter 257;* m: *unknown coll. s.n.;* n: *Tennant 6;* o, p: *Labillardière s.n.;* q: *Krone s.n.*).

Ra.: *Cain & Brooker s.n.* (Allison); *Fryer s.n.* (CHR); *Lam 6956* (L); *Murray 15* (BM). Auckland: *unknown coll. 77* (S-PA). Manukau: *Jolliffe s.n.* (K). Waikato R.: *Hochstetter 257* (S-PA, W). Aranatai S. of Te Kuiti: *Lam 7041* (L); *Walker s.n.* (US). Mamaku: *Een s.n.* (S-PA); *Fleischer B 73* (B), *B 89* (L); *Poole 4* (CHR); *Setchell 127* (PC). Rotorua: *Varekamp 48* (L). Mt. Ngongotoha: *Tilden 113* (BM, FH, K, MO, US). Lake Roto-iti: *Jolliffe s.n.* (K). Mt. Edgecumbe: *Sinclair s.n.* (K). Lake Waikaremoana: *van Zanten 682146* (GRO). Mt. Egmont: *Allan 87* (BM). Taranaki: *Heywood 9a p.p.* (BM). Kaweka Ra., Puketitiri: *Brownlie s.n.* (Allison); *Meebold 46* (JE). Te Pohue: *Beckett 856* (CANTY, FH, K, MO, S-PA, US); *Bell s.n.* (S-PA); *Hamilton s.n.* (CANTY, H). Takapau: *Hill s.n.* (CHR). Dannevirke: *Colenso s.n.* (CHR). Mt. Hauhungatahi: *Moore 540* (CHR). Waimarino: *Matthews 37* (FH). Ohau-iti R.: *Zotov s.n.* (CHR). Tararua Ra., Waitatapia R.: *Mason s.n.* (CHR). Wellington: *Buchanan s.n.* (H). Port Nicholson: *Sinclair s.n.* (BM). Orongorongo R.: *Zotov s.n.* (CHR). — South Island. Golden Bay: *Boor s.n.* (CANTY). Kaituna R. (Nelson): *Given 69903* (CHR). Nelson: *Grant s.n.* (CANTY); *Hochstetter 284* (W); *Jelinek 47* (BM); *Oldham 345* (BM); *Travers s.n.* (K). Westport: *Martin 312.11* (BO, CHR). Wairau Valley: *unknown coll. s.n.* (JE). Marlborough: *McMahon 92* (FH). Paparoa Ra.: *Helms s.n. p.p.* (BM). Runanga: *Martin s.n.* (CHR). Greymouth: *Helms 8 p.p.* and *s.n. p.p.* (BM, FH, H, JE, NY, PC, S-PA, W); *Martin s.n. p.p.* (CHR). Kotuku: *Barker 68239* (CANTY). Lake Brunner: *Barker 69142 p.p.* (CANTY), *69159* (CANTY); *Beckett 920* (BM, CANTY, K, NICH, S-PA); *MacMillan 65/59* (CHR). Mt. Te Kinga: *Barker 6776 p.p.* (CANTY). Lake Swan near Rotomanu: *Barker 6781* (CANTY). Kumara: *Brownlie 119* (CANTY). Taramakau R.: *Beckett 123* (CANTY), *522* (BO). Inchbonnie: *Beckett 920B* (CANTY, FH, NY, S-PA). Between Arahura and Blake: *Berggren 1692* (S-PA). Lake Kanieri: *Veale 87* (Allison). Otira: *Martin s.n.* (CHR). Waiho: *Martin 312.17* (BO, CHR). Franz Jozef Glacier: *Horning NZ-61* (CHR); *Jack s.n.* (Allison); *Martin s.n.* (CHR). Fox Glacier: *Martin s.n.* (CHR). Jackson's Bay: *Lyall 43* (BM, NY). Canterbury: *Sinclair & Haast s.n.* (H). Avoca Valley: *McVean s.n.* (L). Christchurch: *Beckett 2624* (FH). Otago: *Hector 36* (K); *Hutton 36* (K), *37 p.p.* (K). Southland: *Bell s.n.* (H). Bligh Sound: *Lyall 179* (BM). Dusky Sound: *Andrews s.n.* (BM); *Lyall 53b* (BM, H, NY); *Menzies 5* (S-PA), *80 p.p.* (BM, K), *91* (BM), *s.n.* (K). Preservation Inlet: *Allan s.n.* (CHR); *Lyall 61* (BM, FH). Lake Hauroko: *Henry s.n.* (Allison). Longwood Ra.: *Martin s.n.* (CHR). Bluff—Invercargill—Winton: *Berggren 1690 p.p.* (H, S-PA). Invercargill: *Brown s.n.* (CANTY); *Dawson 2233* (H); *Martin 312.8* (BO, CHR). Mikawa: *Eaves & Sinnott s.n.* (FH). — Stewart Island. Port William: *Lyall 76* (BM). Garden Mound: *Martin 312.2* (CHR), *312.3* (CHR). Oban: *Martin 312.13 p.p.* (CHR). Halfmoon Bay: *Bell 758* (CANTY, H). Pine Hill: *Bell 281* (H), *Petrie 522* (BM, CANTY, FH, H, W). Kaipipi: *Barker 6988* (CANTY). Ulva I.: *Martin s.n.* (CHR). Paterson's Inlet: *Martin 312.5* (BO, CHR), *312.9* (CHR). Ryan's Creek: *Sinclair s.n.* (CHR). Cedric Creek: *Martin 312.4 p.p.* (CHR).

Ecology: On moist soil, decaying logs, and occasionally on soil covered rocks; in rain forests; from sea level up to 1750 m.

Notes: 1. The differences between the present species and *H. colensoi* have been indicated under the latter.

2. Tiered plants often have smaller fronds than plants lacking distal innovations. Further, they usually have more strongly tomentose stipes, and branches that are often simple or weakly pinnate.

3. The holotype formed part of Samuel Mossman's collection of New Zealand plants which was divided into sets and offered for sale by a merchant in London. Mueller described the species from a Berlin set which was unfortunately destroyed during the second world war. Though the New York isotype consists of a mixture of two species (fruiting *H. comatum* and sterile *H. colensoi*) I have chosen that collection as lectotype, as the other available isotypes only contained sterile plants of *H. comatum*.

4. All specimens cited by Reichardt (1870) under *Mniodendron comatum* belong in fact to *H. colensoi*; the syntypes of his new species *M. brevisetum* are *H. comatum*. I have not seen any material of *Isothecium tomentosum* Col., but from Colenso's very detailed diagnosis I infer that he described nothing but a form of *H. comatum*. This conclusion had already been reached by Dixon (1929).

5. See note 2 under the section.

22. Hypnodendron comosum (Labill.) Mitt. — **Fig. 33, 35, 36.**

For synonyms, literature, and type specimens see under the varieties.

Plants medium-sized to tall, loosely to densely tufted, pale green to sordid green,

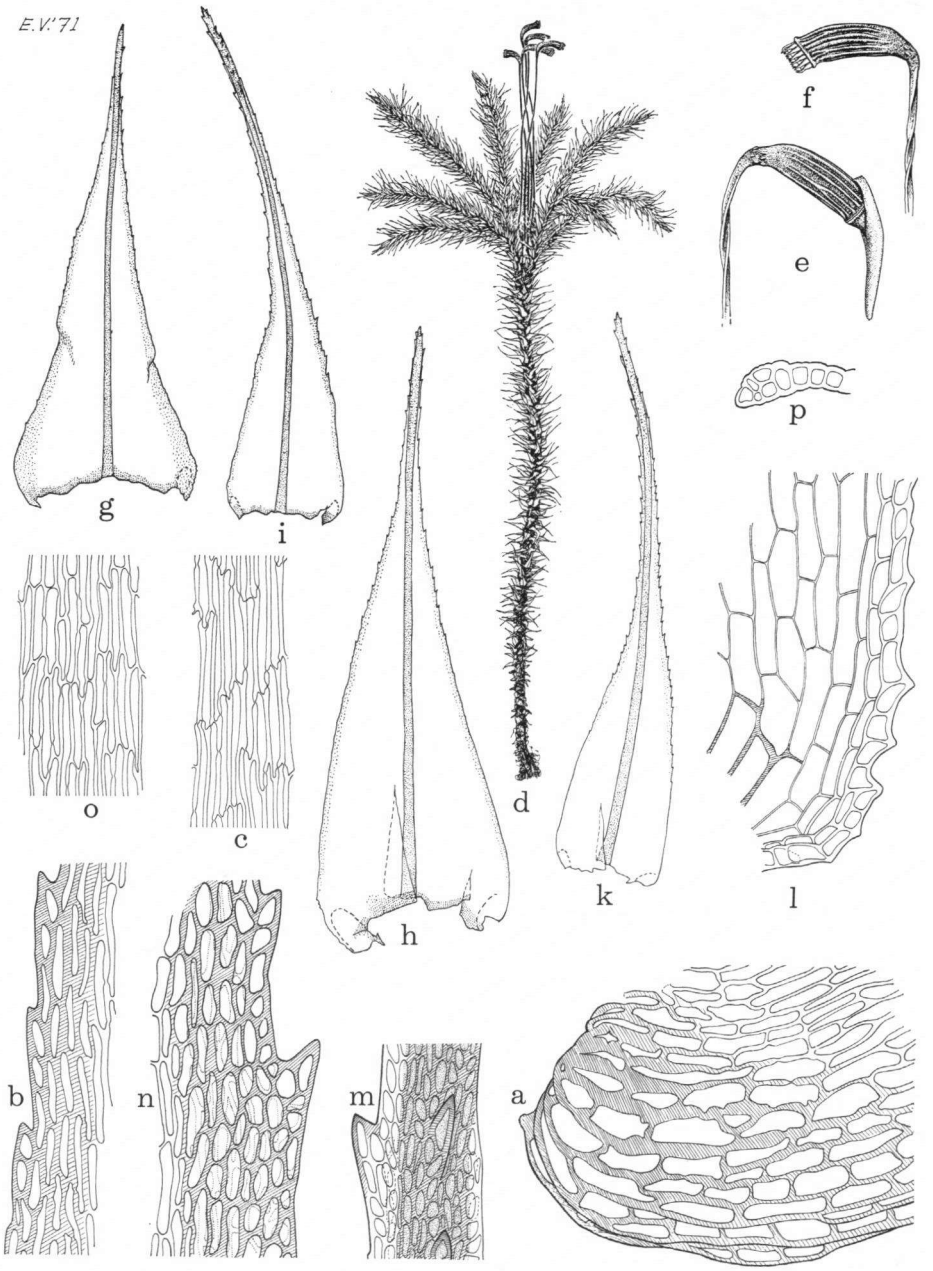

Fig. 36. *Hypnodendron comosum*. a—c: var. *comosum;* d—p: var. *sieberi*. — a, l: Alar cells of stipe leaves, × 260; b, n: margins of branch leaves, × 260; c, o: areolation of branch leaves, × 260; d: habit, × 1; e, f: capsules, × 4; g, h: stipe leaves × 17; i, k: branch leaves, × 17; m: detail of subula of branch leaf, × 260; p: cross section of margin of branch leaf, × 260. (a: *Milligan 778;* b, c: *Lucas s.n.;* d—f: *von Mueller s.n.;* g, k—m, o: *Sieber 4;* h: *Lyall 59;* i: *Weindorfer CE 2800;* n: *Bastow s.n.;* p: *Davis 1209A*).

often becoming orange brown with age, somewhat glossy. *Stipe* erect, up to 9 cm long. *Frond* very variable, simple to many-tiered, up to *c.* 5 cm across, open to dense, indistinctly palmate or umbellate to pinnate; branches simple to sparsely branched, fastigiate to almost horizontal, straight to flexuose or decurved, hardly or not at all attenuate. *Stipe leaves* longitudinally plicate to striate, narrowly triangular-ovate to triangular-ovate-lanceolate; base broadly rounded to cordate, basal leaf angles mostly less wide than in *H. comatum* and *H. colensoi*; apex gradually acuminate; margin near base almost entire, upwards entire to serrate and distinctly dark bordered; costa very strong, mostly brown, excurrent in a short thick arista, dorsally smooth to finely serrate near apex; lamina cells 30—120 by 3—6 μ, L/W ratio *c.* 6—30, walls strongly to extremely incrassate, rarely weakly papillate; marginal cells up to 40 μ long, often wider and having more strongly incrassate walls than the inner lamina cells; alar cells forming a rather small group. *Branch leaves* erecto-patent to falcate-secund, more or less longitudinally striate when dry, long-subulate or aristate from a narrowly triangular-ovate basal part; base rounded to cordate; apex concave; margin near base almost entire, upwards almost entire to coarsely serrate by multicellular simple teeth, dark bordered; costa very strong, greenish or brownish, dorsally smooth to weakly serrate, arista long, usually narrowly bordered basally; lamina cells 25—130 by 3—6 μ, L/W ratio *c.* 5—30, walls strongly to extremely incrassate, rarely weakly papillate; marginal cells irregularly rounded to elongate or rhomboid to linear, often wider and with more strongly incrassate walls than the inner lamina cells, often bistratose in places; alar cells somewhat inflated, walls incrassate, often orange.

Up to 12 (—35) *sporophytes* on each frond. *Setae* (1.5—) 2.0—4.0 cm long, straight or nearly so, orange to dark red or dark reddish brown, sometimes entwined. *Theca* horizontal to cernuous, weakly to rather strongly curved, obconical to cylindrical, 2—5.5 mm long, orange to dark red or dark reddish brown, deeply sulcate, weakly or not at all constricted below the orifice. *Cilia* 2—3 (—4). *Operculum c.* 2—3 mm long. *Calyptra c.* 3.5—5 mm long.

Distribution: Australia (New South Wales, Victoria), Tasmania, New Zealand (South I., Stewart I.), Auckland Is., Campbell I. In the South I. of New Zealand confined to Fiordland and the Arthur Pass National Park in the Southern Alps. Both varieties have been reported from all parts of the area, but no definite collecting localities in continental Australia are known for the var. *comosum*; the gatherings of it labelled 'Australia' could just as well have been collected in Tasmania. Var. *comosum* appears to be less common than var. *sieberi* and has been collected most often in New Zealand and the Auckland Islands.

Ecology: Growing on moist humous soil, decaying logs, and wet rocks; in rain forests; up to 1000 m. The ecological data seem to indicate that both varieties occur in the same habitats and on the same substrates, but var. *comosum* has been found growing more often on decaying logs and in boggy places than var. *sieberi*. However, the available data are few in number and often vague.

Notes: 1. The Australasian entities accepted here in sect. *Comosa* mainly agree with those already distinguished by Wilson (1859), one difference being that he distinguished *Isothecium comosum* and *I. sieberi* on the species level. Typical forms of these exhibit so many striking differences that the presence of two easily separable species seems obvious. However, they are connected by a rather large number of intermediates by which they shade off into one another. In my opinion only one plastic species is present here, and I even doubt whether the varieties recognized will stand a more detailed examination than could be executed now. For the time being they have been kept separate as the morphological differences appear to be more or less correlated with distribution and ecology.

Var. *sieberi* is the most robust Australasian representative of sect. *Comosa* and is macroscopically characterized by its long, wide, usually simple, dark green branches and rather short and often dark red setae. It usually forms loose tufts of plants bearing either none or a few weak distal innovations. Var. *comosum* forms compact tufts of smaller plants which are usually strongly tinged with orange or brown and often bear many tiers of innovations which all are of about the same size and strength.

2. See note 2 under the section.

KEY TO THE VARIETIES

1. Branch leaves narrowly subulate, coarsely serrate. Lamina cells 25—75 μ; costa of branch leaves 85—120 μ wide near its base. Tall, loosely tufted plants; distal innovations absent or weak var. **sieberi**
1. Branch leaves aristate, margin serrulate to sparsely serrate by small teeth. Lamina cells 40—130 μ; costa of branch leaves 50—70 μ wide near the base. Medium-sized densely tufted plants; distal innovations strong, often numerous . . . . . var. **comosum**

a. var. **comosum.** — *Hypnum comosum* Labillardière (1807) 107, t. 253 f. 2; Bridel (1812) 143; Schwaegrichen (1816) 265, t. 91, *pro parte*; Bridel (1819) 164, *pro parte*; Wilson et J. D. Hooker in J. D. Hooker (1845) 140; C. Mueller (1851A) 503, *pro parte*. — *Isothecium comosum* Bridel (1827) 374, *pro parte*; Montagne (1845) 326; Wilson in J. D. Hooker (1854) 106, *pro parte, excl. var.* β; Wilson in J. D. Hooker (1859) 206; J. D. Hooker (1867) 466; Bastow (1887) 84. — *Trachyloma comosum* Mitten *ex* Mitten (1859B) 86, '*comosa*'; Mitten *ex* Wilson in J. D. Hooker (1859) 207, *comb. inval. in syn.* — *Hypnodendron comosum* Mitten *ex* Mitten (1882A) 90, *pro parte*; Mitten in Seemann (1873A) 401, *comb. inval.* — *Mniodendron comosum* Lindberg *ex* Paris (1905) 262; Lindberg (1861) 375, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 355; Paris (1896) 822; Brotherus (1909A) 538, (1909C) 1172, excl. f. 825, (1924B) 439, excl. f. 386; Dixon (1929) 345, *pro parte*; Sainsbury (1945) 186, (1955A) 46, *pro parte*, (1955B) 321, *pro parte excl. ill.* — *Bryum dendroides* Bridel (1803) 20, *quod spec. Tasm., excl. type.* — *Mniodendron dendroides* van der Wijk et Margadant (1959) 74, *quod spec. Tasm., excl. type*; van der Wijk et al. (1964) 394, *pro parte, excl. type.* — Type: *J. J. H. de Labillardière s.n.* (FI holo, not seen, B, BM, L, US), Tasmania ('*in capite Van Diemen*').

Hypnum kroneanum C. Mueller in Geheeb (1877) 53. — *Mniodendron kroneanum* Jaeger *ex* Paris (1905) 263; Jaeger in Jaeger et Sauerbeck (1880) 356, *comb. inval.*; Paris (1896) 822; C. Mueller (1898) 170; Brotherus (1909A) 538, (1909C) 1172, (1924B) 439. — *Mniodendron kronei* C. Mueller *ex* Kindberg (1888) 26, *err. pro M. kroneanum* (C. Muell.) Par. — Type: *H. Krone s.n.* (B holo †, BM), Auckland Islands.

Mniodendron sieberi non (C. Muell.) Par.: Rodway (1914) 212.

Plants medium-sized, densely tufted, often orange brown. *Stipe* up to *c.* 2.5 cm long, very strongly tomentose. *Frond* often many-tiered, up to *c.* 3 cm across, dense. *Stipe leaves* 3.0—3.5 by 0.8—1.0 (—1.6) mm, L/W ratio (2.5—) 3.4—4.2; border distinct to absent; costa *c.* 60—120 μ wide near base; lamina cells linear, *c.* 60—120 by *c.* 4 μ, L/W ratio *c.* 15—30, walls smooth to weakly papillate; marginal cells elongate to short-linear; walls of alar cells incrassate. *Branch leaves* aristate, 2.5—3.5 by 0.4—1.0 mm, L/W ratio 2.8—5.5; margin almost entire to sparsely serrate with small teeth; costa brownish, *c.* 50—70 (—85) μ wide near base, arista serrulate to almost smooth; lamina cells linear, 40—130 μ long, L/W ratio *c.* 10—30, walls occasionally weakly papillate; marginal cells elongate to linear, *c.* 15—40 μ long, mostly unistratose.

Up to 5 *sporophytes* on each frond. *Seta c.* 2—2.5 (—3.5) cm long. *Theca c.* 2—3.5 (—4) mm long.

Distribution and ecology: See under the species.

Australia. Exact locality not given: 4 collections.

Tasmania. Cradle Mt. National Park: *McVean 26785* (L). Macquarie Harbour: *Milligan 778* (W); *unknown coll. MEL 34468* (MEL). Mt. Wellington, St Crispin's: *Bastow 301* (CANTY, MEL); *Watts 294 p.p.* (H); *Weymouth 391* (H), *524* (CANTY, H). Catamaran: *Weymouth 2454* (BM). Recherche: *Weymouth 2585* (FH, H, NY). Cheshunt: *Archer 33 p.p.* (K).

New Zealand. South Island. Westland: *Blotam s.n.* (H). Arthur Pass, Avalanche Peak Track: *Martin 312.6* (CHR), *312.10* (CHR), *312.12 p.p.* (CHR). Wilmott Pass—Doubtful Sound: *Martin 312.12 p.p.* (BO, CHR). Freeman R.: *Simpson CHR 36655* (CHR). Lake Manapouri: *Simpson 1512* (CHR). — Stewart Island. Table Hill: *Martin 312.1* (CHR).

Auckland Islands: *Bolton s.n.* (BM, K); *Cockayne 89* (H); *Le Guillou s.n.* (BM); *Hombron s.n.* (BM); *Hooker 75* (BM, K), *494* (H, S-PA); *Krone s.n.* (BM); *Tennant 6* (H, S-PA).

Campbell Island: *Hooker s.n.* (BM, K).

Notes: 1. See note 2 under the species.

2. These plants form high tufts which are densely interwoven by tomentum. The substrate of the living plants is formed by decayed old stipes and fronds from which they have sprouted. In the plants described and illustrated by Labillardière (1807) and Schwaegrichen (1816) the old parts have become prostrate, and give the appearance of a creeping plant.

b. var. sieberi (C. Muell.) Touw, *stat. nov.* — *Hypnum sieberi* C. Mueller (1851A) 504; Hampe (1856) 213. — *Isothecium sieberi* Wilson in J. D. Hooker (1859) 206; J. D. Hooker (1867) 467; Bastow (1887) 84. — *Hypnodendron sieberi* Mitten *ex* Mitten (1882A) 90; Mitten in Seemann (1873A) 401, *comb. inval.* — *Mniodendron sieberi* Paris (1905) 263; Jaeger in Jaeger et Sauerbeck (1880) 355, *comb. inval.*; Paris (1896) 822; Brotherus (1909C) 1172, (1924B) 439; Herzog (1926B) 363, f. 136; Dixon (1929) 345. — Type: *H. Sieber Musci Nov. Holl. 4* (B holo †, BM lecto, FH, JE, L, MEL, S-PA, W), Australia.

Hypnum comosum non Labill.: Mitten (1856) 265. — *Isothecium comosum* Brid. *sensu* Wilson in J. D. Hooker (1854) 106, *pro parte.* — *Hypnodendron comosum* Mitt. *ex* Mitten (1882A) 90, *pro parte.* — *Mniodendron comosum non* Par.: Brotherus (1909C) f. 825; Rodway (1914) 212; Brotherus (1924B) f. 386; Sainsbury (1955A) 46, *pro parte*, (1955B) t. 48 f. 2.

Mniodendron comatum non (C. Muell.) Par.: Rodway (1914) 212.

Plants medium-sized to tall, loosely tufted, usually dark sordid green. *Stipe* up to 9 cm long. *Frond* simple or bearing up to 2 tiers of usually weak distal innovations, up to 5 cm across, mostly open; branches fastigiate to obliquely spreading. *Stipe leaves* 3.5—5.1 by 1.2—1.8 mm, L/W ratio 2.5—3.7; border mostly distinct; costa very strong, *c.* 85—150 μ wide near base; lamina cells elongate to linear, *c.* 30—75 (—120) by 3—6 μ, L/W ratio *c.* 6—15, walls smooth; marginal cells almost isodiametric to elongate, having extremely incrassate walls; alar cells thin-walled or mixed with a few cells having incrassate walls. *Branch leaves* narrowly subulate, (3.4—) 3.9—5.3 (—6.5) by 0.8—1.0 (—1.25) mm, L/W ratio 4.2—5.4 (—6.5); margin mostly coarsely serrate with up to *c.* 45 μ long teeth; costa green to brownish, very strong, *c.* 85—120 μ wide near base, arista serrate, usually bearing short dorsal teeth; lamina cells elongate to linear, 25—75 μ long, L/W ratio *c.* 5—18, walls smooth; marginal cells isodiametric to elongate, usually bistratose in places.

Up to 12 (—35) *sporophytes* on each frond. *Seta c.* (1.5—) 2—4 cm long. *Theca c.* 2—5.5 mm long.

Distribution and ecology: See under the species.

Australia. New South Wales: *Cartwright 943* (BM, K). — Victoria. Warburton: *van Zanten 681738* (GRO, L). Beenak: *Willis MEL 34446* (MEL). Nayook West: *Willis MEL 34482* (MEL). Sources of the Yarra Yarra: *von Mueller s.n.* (H, K, MEL). Wilson's Promontory, Sealer's Cove: *von Mueller 103* (K, MEL). Coast Range S. of Bendoc: *Stirling s.n.* (MEL). Mt. Ellery: *Willis MEL 33995* (MEL). Mt. Juliet: *unknown coll. s.n.* (BM).

TASMANIA. Hampshire Hills: *Milligan 46* (NY). Pieman R. Heads: *Jackson 15* (MEL). Mt. Zeehan: *Weymouth s.n.* (S-PA). Macquarie Harbour: *Milligan 386* (BM, W); *Moore 36* (H, S-PA); *Weymouth 602* (H); *unknown coll. MEL 34467* and *34469* (MEL). Florentine Valley: *Melville et al. 2340* (K); *Willis s.n.* (NY). Mt. Field National Park: *McVean 26760* (L). Styx R.: *Doing M 172* (L), *M 200* (L). Bathurst Harbour: *Bufton s.n.* (MEL). Lake Peddar: *Schuster s.n.* (BM, MEL). Recherche: *Weymouth 2676* (H). Mt. Wellington: 11 collections. Cascades Rivulet: *Bastow 150* (MEL), *151* (MEL), *158* (MEL); *Taylor 85* (H). Millhouse's Falls: *Weymouth 1446* (H), *1447* (BM, FH, NY), *1448* (H). Hobart Rivulet: *Weymouth 285* (CANTY, H, NY), *2169* (H, K), *2187* (H). Guy Fawkes Rivulet: *Weymouth 383 + 384* (H), *2089* (H, W). Tasman Peninsula, Grove Creek: *Weymouth 744A* (H), *744B* (H). Ibid., Willard's Rivulet: *Weymouth 828 p.p.* (H). Ibid., Newman's Creek: *Weymouth 745* (H), *2088* (H). Cheshunt: *Archer 33 p.p.* (K). Mt. Foulton: *Davis 1209A* (MEL). Peppermint Bay: *Weymouth 280* (H). Russell's Falls: *Weymouth 282* (K). Mt. Bischoff: *Weymouth 1005* (H). Bismark: *Weymouth 2558* (BM). Acheron R.: *Gunn 1593* (BM, K).

NEW ZEALAND: *Menzies s.n.* (K); *unknowr coll. 386* (NY). — South Island. Canterbury, Bealey: *Berggren B 464* (FH). Milford Sound: *Lyall 15* (BM). Dusky Sound: *Forster s.n.* (BM); *Lyall 53 p.p.* (BM); *Menzies 86* (BM, K). Chalky Inlet: *Lyall 194* (BM). — Stewart Island: *Bell s.n.* (CANTY, GRO, H, L); *Cockayne 8293* (H). Garden Mound: *Martin 312.14* (CHR). Oban: *Martin 312.13 p.p.* (BO, CHR).

AUCKLAND ISLANDS. Exact locality not given: *Le Guillou s.n.* (H, PC); *Lyall 59* (BM, K); *McGillavray s.n.* (NY); *Tennant 32* (H); *Wilkes s.n.* (US). Webling Bay: *Fineran 1519* (Allison).

CAMPBELL ISLAND: *Hooker s.n.* (NY).

Notes: 1. See note 2 under the species.

2. The bistratose part of the border is most strongly developed near the base of the subula. The border cells often contain a larger number of chloroplasts than the inner lamina cells.

3. In Australian and Tasmanian plants distal innovations have been found less frequently than in plants from elsewhere. The New Zealand plants usually have smaller teeth than those from other areas.

4. The illustrations of *Mniodendron comosum* in Brotherus (1909C, 1924B) and Sainsbury (1955B) represent var. *sieberi*.

23. Hypnodendron dendroides (Brid.) Touw, *comb. nov.* — *Bryum dendroides* [Swartz *ex*] Bridel (1803) 20, *excl. spec. Tasm.*; [Swartz (1781) 34, t. 1 f. 2; Linnaeus *f.* (1783) 196, t. 14 f. 2]. — *Hypnum dendroides* Weber et Mohr (1803) 3, not seen. — *Mnium dendroides* P. Beauvois (1805) 74. — *Mniodendron dendroides* van der Wijk et Margadant (1959A) 74, *excl. spec. Tasm.*; van der Wijk et al. (1964) 394, *excl. syn.* — Type: *C. P. Thunberg s.n.* (UPS holo, H, L?, S-PA?), Java. — **Fig. 37—39.**

Hypnum divaricatum Reinwardt in Reinwardt et Hornschuch (1829) 723, t. 40 f. d; Moritzi (1846) 130; C. Mueller (1851A) 505; Zollinger (1854) 27. — *Hypnodendron divaricatum* Mitten in Seemann (1873A) 401. — *Mniodendron divaricatum* Lindberg *ex* Cardot (1901) 117; Lindberg (1861) 375, *comb. inval.*; Lindberg in Dozy & Molkenboer (1866) 136, t. 234; Reichardt (1870) 189; Bescherelle (1873) 244; Jaeger in Jaeger et Sauerbeck (1880) 356; van der Sande Lacoste in Veth (1884) 41; Paris (1896) 822; Renauld et Cardot (1896) 107; Cardot (1897) 28, (1901) 118; Paris (1905) 263; Usteri (1906) 391, 392, 472; Brotherus (1907) 343, (1908A) 30; Gepp (1908) 336; Brotherus (1909C) 1171, (1910) 162; Giesenhagen (1910) 748, 751, 756, 789; Herzog (1910) 122; Paris (1910) 39; Cardot (1912) 177; Fleischer (1912) 751; Brotherus (1913A) 97; Fleischer (1914) 115, (1917) 35; Brotherus (1918) 222; Juel (1918) 52; Möller (1919) 330; Fleischer (1923) 1617, f. 255; Potier de la Varde (1923) 403; Brotherus (1924B) 439; Seifriz (1924) 311, 312; Brotherus (1926) 284; Dixon (1926) 46; Herzog (1926A) 338; Brotherus (1928) 123; Dixon (1932A) 32; Dixon (1935A) 97, (1935B) 11; Bartram (1936B) 241, (1938) 129, (1939) 156, f. 193, (1942) 264, (1945) 115; Froehlich (1953) 85; Meijer (1954B) 16; Froehlich (1955) 318; Jovet-Ast et Schmid (1958) 198; Pilous (1959) 248; Crum (1960) 189, Bartram (1962) 193; Noguchi (1963) 146; Schultze-Motel (1963) 444; Pòcs (1965) 466; van Zanten

(1968) 138, 144. — Syntypes: *C. G. C. Reinwardt s.n.* (L lecto, GRO, H), Java, G. Gedeh; *C. G. C. Reinwardt s.n.* (L), Celebes, G. Klabat.

Bryum ferrugineum Junghuhn (1840) 293. — Type: *F. W. Junghuhn s.n.* (L holo, H), Java, G. Pangrango, 5000 ft.

Hypnum wallisii C. Mueller (1874B) 571, *'wallisi'*. — *Mniodendron wallisii* Jaeger *ex* Paris (1905) 263; Jaeger in Jaeger et Sauerbeck (1880) 357, *comb. inval.*, *'wallisi'*; Paris (1896) 823; Brotherus (1909C) 1172, (1924B) 439. — *Mniodendron divaricatum* (Reinw.) Card. var. *wallisii* Bartram (1939) 157, *'wallisi'*; van der Wijk et al. (1964) 395. — Type: *G. Wallis s.n.* (B holo †, BM lecto, H, JE, NY, S-PA), Luzon, Mahahai, *c.* 6800 ft.

Hypnodendron palmaeum Mitten (1882B) 103; Paris (1895) 604, (1904) 374. — *Mniodendron palmaeum* Brotherus (1909C) 1172; Fleischer (1917) 34; Brotherus (1924B) 439; Schultze-Motel (1963) 445; van der Wijk et al. (1964) 395. — Type: not indicated. Lectotype: *Strange s.n.* (NY holo, BM, FH), île des Pins.

Mniodendron densirameum Brotherus (1899A) 120, (1909C) 1172; Fleischer (1917) 34; Dixon (1922) 496; Brotherus (1924B) 439; Thériot (1937) 129. — *Mnium densirameum* Brotherus *ex* Paris (1900) 251, *err. pro Mniodendron densirameum* Broth. — Type: *Musgrave s.n.* (H holo, FH, S-PA), New Guinea, Brown River Valley.

Mniodendron micholitzii Brotherus *ex* Paris (1900) 250; Brotherus (1898) 192, *comb. inval.*; Paris (1905) 263; Brotherus (1909C) 1172; Fleischer (1917) 34; Brotherus (1924B) 439; Bartram (1957A) 41; Schultze-Motel (1963) 445; van Zanten (1964) 292; van der Wijk et al. (1964) 395. — Type: *W. Micholitz 131* (H holo, BM, FH, K, S-PA, W), New Guinea, Milne Bay, mountains near Mila ('Mita').

Mniodendron mittenii Salmon *ex* Paris (1900) 250, (1905) 263; Brotherus (1909C) 1172, (1924B) 439; Dixon (1926) 46, (1935A) 97, (1943) 18. — *Mniodendron microloma* Mitten in Mitten et Wright in Stapf (1894) 259, *comb. inval.* — ? *Mniodendron microloma* Mitten *ex* Geheeb *ex* Paris (1905) 263; Mitten *ex* Geheeb (1886) 352, *comb. inval.*; Paris (1896) 822; Brotherus (1909C) 1172, (1924B) 439; Dixon (1935A) 97; van der Wijk et al. (1964) 395. — Type: *F. W. Burbidge s.n.* (NY), Borneo, Mt. Kinabalu, 6000 ft.

Mniodendron hellwigii Brotherus *ex* Brotherus (1901) 102; Brotherus (1892) 29, *comb. inval.*; Paris (1896) 822; Paris (1905) 263; Brotherus (1909C) 1172; Herzog (1910) 122; Brotherus et Watts (1915) 157; Fleischer (1917) 34; Herzog (1919) 293; Dixon (1922) 496, 509; Brotherus (1924B) 439; Herzog (1926A) 339; Schultze-Motel (1963) 444, *pro parte*; van der Wijk et al. (1964) 395. — Type: *F. Hellwig 317 pro parte* (H holo, S-PA), New Guinea, Finisterregebirge, 2000—2300 m.

Mniodendron kowaldii C. Mueller *ex* C. Mueller (1902) 134; C. Mueller *ex* Paris (1900) 250, *nom. nud.*; Brotherus (1909C) 1172; van der Wijk et al. (1964) 395. — Type: *C. Kowald 1297* (B holo †, H lecto, BM, FH), Southeast New Guinea, Mt. Yule, 7000 ft.

Mniodendron humile Lindberg *ex* Paris (1905) 263; Lindberg in Dozy & Molkenboer (1866) 138, t. 235, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 357; Paris (1896) 822; Brotherus (1909C) 1171; Thériot (1922B) 9; Fleischer (1923) 1620; Brotherus (1924B) 439; Herzog (1926A) 338; Dixon (1934A) 28, (1935A) 97, (1943B) 17; Bartram (1957A) 42, (1959) 90, (1960A) 145, (1961) 371, (1962) 193; Schultze-Motel (1963) 445; van der Wijk et al. (1964) 395; Bartram (1965) 52; Pócs (1965) 466. — Type: *unknown collector s.n.* (L holo, BM, BO, FH, GRO, H, K, S-PA), Celebes.

Mniodendron aristinerve Mitten *ex* Paris (1905) 262; Mitten (1873B) 322, *comb. inval.*; Geheeb (1886) 352; Paris (1896) 821; Brotherus (1909C) 1172, (1924B) 439, (1928) 123; Dixon (1935A) 97; Bartram (1936B) 241; van der Wijk et al. (1964) 394. — Type: *H. Low s.n.* (NY holo, H), Borneo, top of Mt. Kinabalu.

Mniodendron deltoideum Thwaites et Mitten *ex* Paris (1905) 262; Thwaites et Mitten in

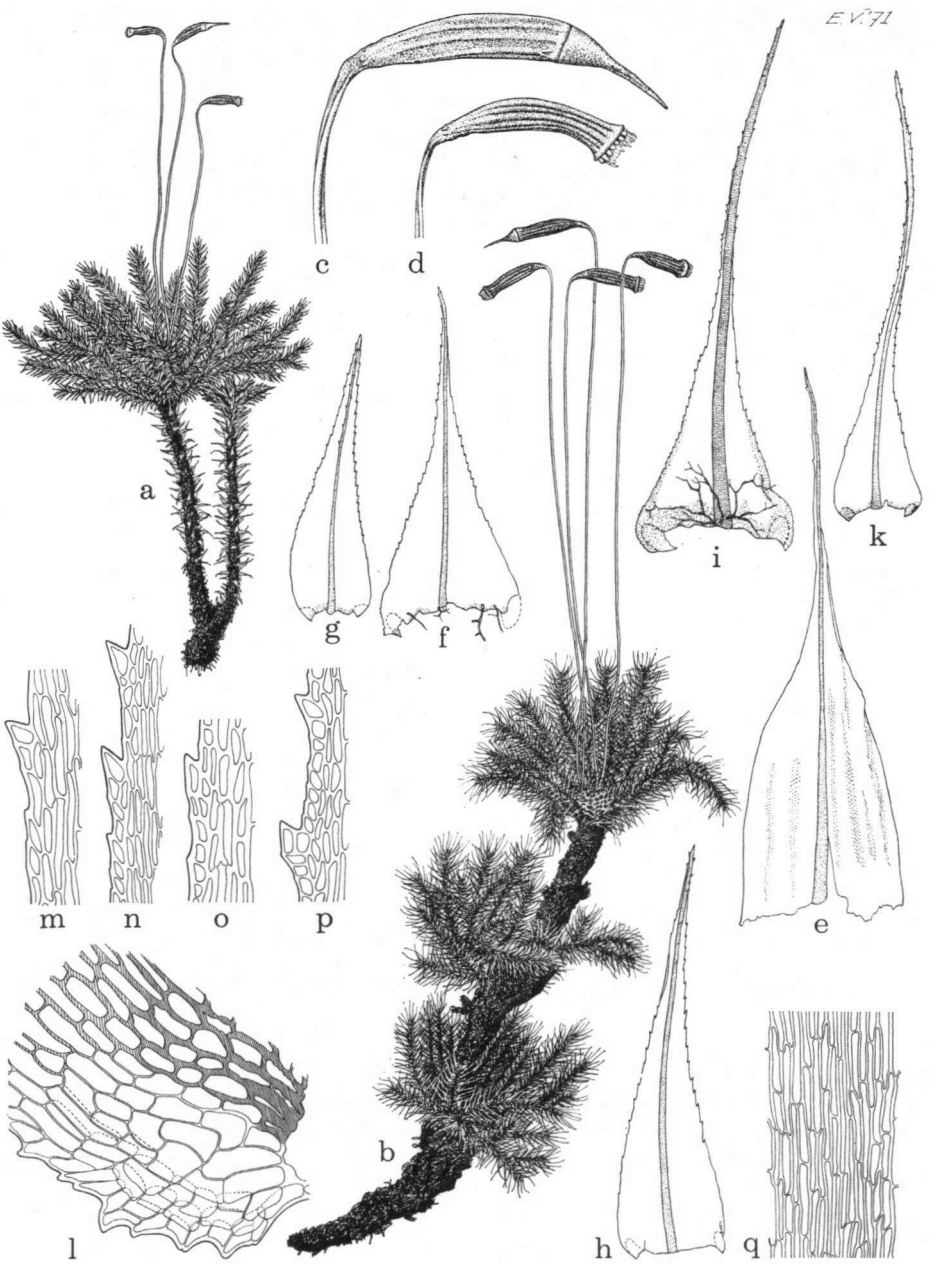

Fig. 37. *Hypnodendron dendroides*. a, c—h, l, m, q; entity 1; b, i, k, o: entity 6; n: entity 2; p: entity 7. — a, b: Habits, × 1; c, d: capsules, × 4; e: perichaetial leaf, × 17; f, i: stipe leaves, × 17; g, h, k: branch leaves, × 17; l: alar cells of stipe leaf, × 260; m—p: margins of branch leaves, × 260; q: areolation of branch leaf, × 260. (a, c: *van Ooststroom 12913;* b, i, k, o: *Burbidge s.n.;* d: *van Ooststroom 14222;* e: *van Ooststroom 13441;* f: *Fleischer MAIP 502;* g: *Wallis s.n.;* h: *Docters van Leeuwen 13207;* l: *Poilane 3519;* m, q: *Reinwardt s.n.;* n: *Darbyshire 477;* p: *Beccari 25*)

Mitten (1873B) 321, *comb. inval.*; Jaeger in Jaeger et Sauerbeck (1880) 357; Paris (1896) 822; Brotherus (1909C) 1171, (1924B) 439; van der Wijk et al. (1964) 394. — Type: *Gardner 20* (NY holo, FH), Ceylon, Adam's Peak.

Mniodendron divaricatum (Reinw.) Card. f. *tabulata* Fleischer (1923) 1619. — Type: *M. Fleischer M.A.I.P. 502* (FH holo, B, BM, BO, GRO, H, L), West Java, G. Gedeh above Tjibodas, 1550 m.

Mniodendron divaricatum (Reinw.) Card. f. *minor* Fleischer in Dixon (1932A) 32, (1934) 28. — Type: *M. Fleischer s.n.* (FH), Sumatra, Mt. Sibajak, 1500—1600 m.

Mniodendron curtisii C. Mueller *ex* Dixon (1926) 46, *nom. nud., in syn.*

Mniodendron longinerve Brotherus *ex* Dixon (1935A) 97, *nom. nud., in syn.*

Mniodendron tahiticum non Besch.: Dixon et Greenwood (1930) 300; Bartram (1936A) 11.

Mniodendron korthalsii non Par.: Dixon (1943B) 18.

Mniodendron fusco-mucronatum non (C. Muell.) Broth.: Bartram (1961) 371, *pro parte.*

Plants small to tall, loosely to densely tufted, pale green to sordid green, sometimes becoming orange brown, almost dull to glossy. *Stipe* up to 8 (—12) cm long. *Frond* simple or bearing up to *c.* 5 tiers of distal innovations, up to 8 (—10) cm across, open to dense, mostly distinctly umbellate, sometimes indistinctly so, or palmate, or pinnate (in poorly developed specimens); branches almost simple to pinnate, mostly horizontal with decurved ends, sometimes more or less fastigiate. *Stipe leaves* widely spreading to squarrose-recurved, exceptionally almost appressed, mostly longitudinally plicate or striate, mostly triangular to narrowly triangular, rarely deltoid or triangular-ovate, 1.4—5.0 by 0.65—1.7 mm, L/W ratio (1.0—) 1.4—3.5 (—4.0); base often much enlarged and auriculate, occasionally cordate or widely rounded; apex mostly narrowly long-acuminate; margin near base entire to coarsely and irregularly serrate, upwards serrate by up to *c.* 35 μ long teeth; costa mostly percurrent to indistinctly excurrent, occasionally excurrent in a brownish arista which may be more than half the length of the leaf, dorsally smooth to remotely and often weakly toothed near apex; lamina cells 50—180 by 2—5.5 μ, L/W ratio *c.* 10—60, walls moderately to strongly incrassate, smooth to weakly papillate; marginal cells shorter; alar cells forming a small to very large group of inflated, thin-walled cells, the inner ones often having incrassate orange coloured walls; occasionally all alar cells thin-walled or all incrassate and orange. *Branch leaves* erecto-patent to falcate-secund, smooth to longitudinally plicate, narrowly to very narrowly triangular to triangular-ovate-lanceolate, (0.9—) 1.4—3.4 (—4.5) by (0.25—) 0.4—0.9 mm, L/W ratio (2.1—) 2.4—4.5 (—5.6); base usually rounded, occasionally cordate; apex acute to gradually or rather abruptly acuminate to subulate, canaliculate to almost flat; margin sharply to rather bluntly serrate by up to 33 μ (mostly up to *c.* 20 μ) long teeth; costa ending in apex to percurrent or indistinctly and very shortly excurrent, occasionally excurrent in a brownish arista as in the stipe leaves, near apex mostly dorsally toothed; lamina cells *c.* (15—) 20—110 by 2—5 μ, L/W ratio *c.* 5—35, walls moderately to strongly incrassate, smooth to papillate; marginal cells quadrate to rhomboid to elongate, sharply defined or gradually passing into the inner lamina cells; alar cells forming a mostly rather ill-defined group of more or less inflated cells having slightly stronger incrassate walls than the lamina cells.

Up to 6(—15) *sporophytes* on each frond. *Seta* 2—7.5 cm long, almost straight to arcuate, yellowish brown to orange, red, or dark brown. *Theca* mostly inclined to horizontal, curved, cylindrical, (2—) 2.5—9 mm long, almost concolourous with the seta or darker, deeply sulcate, not constricted to strongly constricted below the orifice. *Cilia* 3—5. *Operculum c.* 2—4.5 mm long. *Calyptra c.* 3.5—4.5 mm long.

Distribution: Ceylon, Annam, Malesia, Solomon Islands, New Hebrides, Fiji Islands, île des Pins (?).

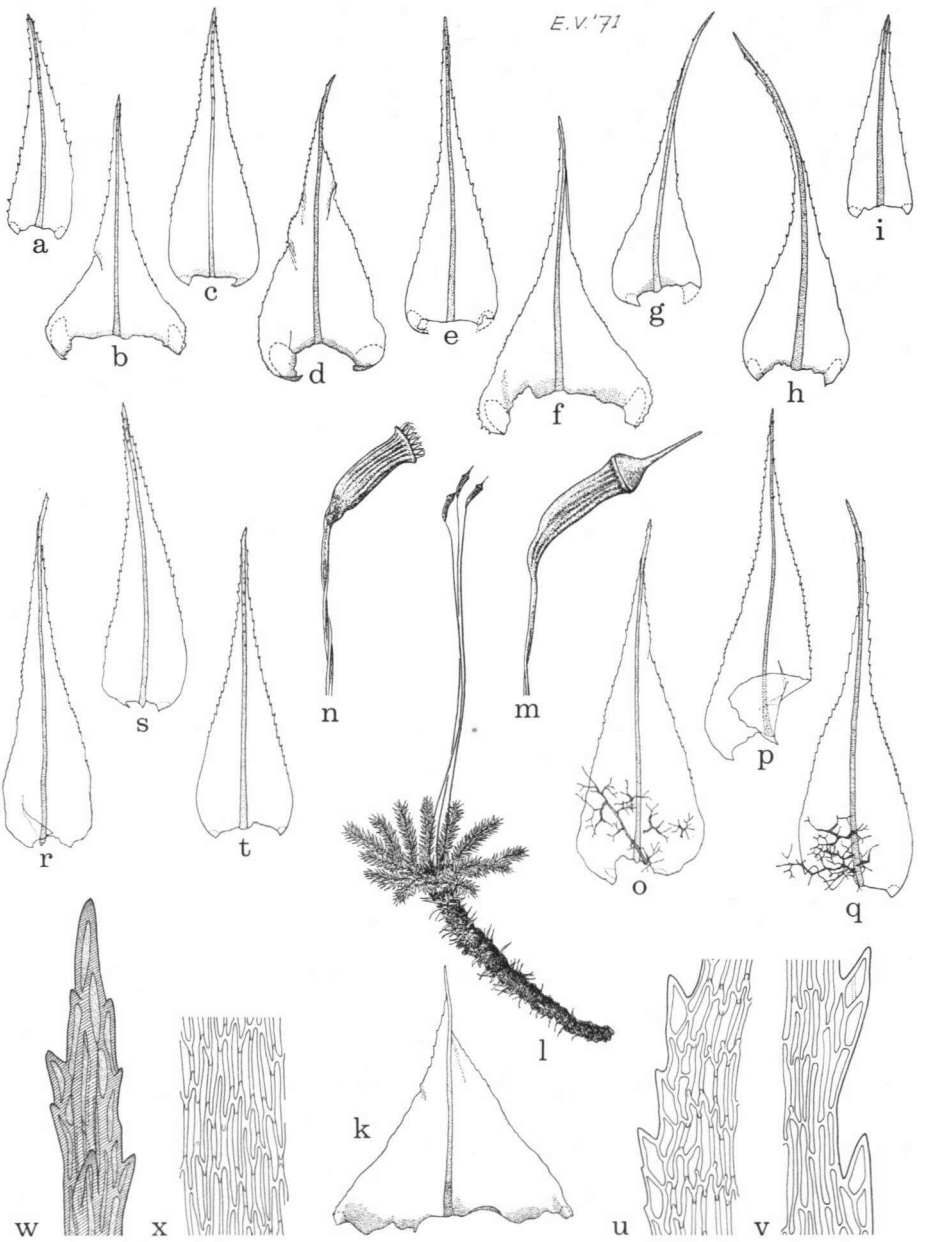

Fig. 38. a—k: *Hypnodendron dendroides* (a, b: entity 2; i: entity 3; k: entity 4; c, d: entity 5; e, f: entity 7; g, h: entity 8); l—x: *H. tahiticum*. — a, c, e, h, i, r—t: Branch leaves, × 17; b, d, f, g. k, o—q: stipe leaves, × 17 (most rhizoids are not attached to the leaves); l: habit, × 1; m, n: capsules, × 4; u, v: margins of stipe leaves, × 260; w: apex of branch leaf, × 260; x: areolation of branch leaf, × 260. (a: *Hellwig s.n.*; b: *Darbyshire 342*; c: *Greenwood 230*; d: *Gibbs 708*; e, f: *Edaño PNH 1155*; g, h: *Burbidge s.n.*; i: *Brass & Collins 31039*; k: *van Royen & Sleumer 7189*; l, m: *Nadeaud s.n.*; n: *Temarii s.n.*; o, r: *Moore 45*; p, s, u, w: *Nadeaud 90*; q, t, v: *Powell 205*; x: *Nadeaud 427*).

Constitutes everywhere *c.* 30—50% of the local collections of *Hypnodendron*, except in the New Hebrides and Fiji where *H. dendroides* is a little less common.

CEYLON. Central Province: *Thwaites CM 167* (BM, H, K, NY, PC, S-PA, W). Adam's Peak: *Gardner 20* (FH, NY); *unknown coll. s.n.* (BM).

PENINSULAR THAILAND. Phuket. Krabi, Phanom Bencha: *Kerr 505* (BM).

ANNAM. Nhatrang: *Poilane 3491 p.p.* (H, PC), *3519* (PC, W); Mt. Honbâ: *Vincens s.n.* (FH, PC).

MALAY PENINSULA. Pulau Penang. Penang Hill: 9 collections. — Kedah. Kedah Peak: 9 collections. — Perak. Exact locality not given: *Ridley SFN 11644* (BM). G. Bujong Malacca: *Ridley 721* (BM, FH, NY, SING). G. Batu Puteh: *Wray 892* (GRO, H, SING). — Kelantan. G. Setong: *Nur SFN 12238* (BM, SING, US). — Trengganu. G. Padang: *Moysey & Kiah SFN 33366* (BM, SING). — Selangor. Bt. Etam: *Ridley 429* (BM, NY, SING). Petating: *Ridley 487* (NY, SING). G. Ulu Kali: *unknown coll. s.n.* (SING). — Pahang. G. Tahan: 9 collections. Fraser's Hill: *Allan 656* (GRO); *Spare 1703* (BM); *Wood 1312* (BM, GRO). G. Benom: *Barnes s.n.* (SING); *unknown coll. SFN 17483* (SING). Pulau Tioman, G. Kajang: *Henderson SFN 12874D* (SING, US). — Johore. G. Ledang = Mt. Ophir: 10 collections.

SUMATRA. Atjeh. G. Setan, Paja: *van Steenis 10110* (BO, GRO, L). Mt. Goh Lembu: *van Steenis 10234* (BO, GRO, L). G. Kemiri: *van Steenis 10240* (BO), *10276* (BM, BO). — East Coast. *Surbeck 487* (L). Dg. Sinabung: *Kausche s.n.* (JE); *Lörzing 8193* (BO, GRO, L). Dg. Sibajak: *Arens 559* (GRO, L); *Fleischer s.n.* (BM, FH); *Lörzing 8408* (BO); *Staal 78* (GRO), *260* (GRO). Dg. Singkut: *van der Wijk 1645* (GRO, L), *1699A* (GRO, L). Berastagi: *Beumée 825* (BM, BO, GRO, L). Dg. Penatapau: *Heusser s.n.* (BM, JE, K). Dg. Sipiutu: *Troll s.n.* (JE). Lake Toba: *Bangham 1228* (FH); *Heusser s.n.* (FH, JE); *Modigliani 243* (FH). Prapat: *van der Wijk 1832* (GRO, L). Asahan R.: *Bartlett & LaRue 247* (H). — Tapanuli. Dairi Lands: *Otto-Surbeck 274* (L), *318* (L). Aek Nalili: *Otto-Surbeck 377C* (L). Dk. Sibuatan: *Lörzing 7148* (BO, GRO, L). Samosir: *Wegner s.n.* (JE). Parbuluan: *Alston 14840B* (BM). Dk. Surungan: *Bartlett 7958* (BM, FH, MO, NY, US). — West Coast. G. Talakmau = Mt. Ophir: *Bünnemeijer 596* (BO, GRO, L), *1177* (BO). Lubuksikaping: *unknown coll. s.n.* (BO, FH). Palupuh: *Bleeker 4247* (FH). G. Sago: *Meijer*, 5 collections (L). G. Singgalang: 40 collections. Above Padang: *Ruttner 250* (JE). Bt. Sipatai: *van Borssum Waalkes 2571* (BO). Alahanpandjang: *Micholitz s.n.* (H); *Teijsmann s.n.* (BO, GRO, L). Tindjulaut: *Micholitz 65* (BM, BO, H, K, PC, S-PA, W), *68* (FH, H). G. Kerintji: 8 collections. G. Talang: *van Borssum Waalkes 2390* (BO). — Benkulen. Bt. Daun: *de Voogd 1390* (BO, GRO, L). Bt. Besar: *Giesenhagen 31* (H). — Palembang. G. Pesagi: *van Steenis 3718* (BM, BO, GRO, L). — Lampong Districts. G. Tanggamus: *Jacobs B 9* (L).

JAVA. West Java. G. Salak: 18 collections. G. Megamendong: *van Bennekom s.n.* (L); *Zippelius s.n.* (L). G. Gedeh and G. Pangrango: 156 collections. G. Masigit: *Noerta & Soekar 2426* (GRO, L, S-PA), *2528* (GRO, L). G. Patuha: *Jacobson 126* (BM, BO, GRO), *127* (BO, GRO, L); *Korthals s.n.* (L). Tjibitu (= Tjikitu ?) above Bandung: *Veldhuis 10078* (BM), *10830* (BM), *10831* (BM). G. Malabar: *Pulle s.n.* (BM); *Wichura 2416B* (BM, H). G. Wajang: *Junghuhn s.n.* (FH, GRO, L, W); *Warburg s.n.* (FH, H). G. Kendang: *Buwalda 3597* (BO, GRO); *Teijsmann s.n.* (FH). G. Tjikurai: *Hasskarl s.n.* (L); *Korthals s.n.* (GRO, L); *Nyman 434* (FH, H, K, NY, S-PA), *464* (FH, H, K). G. Telaga Bodas: *Korthals s.n.* (L). — Central Java. G. Prahu: *Koorders 12* (GRO), *20* (GRO).

LESSER SUNDA ISLANDS. Flores. Ruteng, Rana Mese: *Jaag 1601* (L).

BORNEO. Sabah. Mt. Nungkok: *Collenette 455* (BM), *456D* (BM). Mt. Tambuyokon: *Meijer*, 6 collections (L). Mt. Kinabalu: 53 collections. G. Alab: *Nooteboom s.n.* (L). Mt. Silam: *Iwatsuki 5457* (L, NICH). — Sarawak. Trusan R.: *Haviland b.f. p.p.* (K). Maputi: *Brooke 10210* (GRO, L). Mt. Belinki: *Brooke 10475* (GRO, L). G. Murud: *Paie S 26436 p.p.* (L). Baram R.: *Hose 6* (BM). G. Dulit: *Richards M 1727* (BM, FH, GRO, NICH), *M 2144* (FH, GRO), *M 2181* (GRO). Mt. Poi and G. Rumput: 6 collections. Lundu: *Brooke 10860* (GRO, L). G. Penrissen: *Brooks 44* (BM). — Indonesian Borneo. Songkong Ra. near Sambas: *Schäfer 7* (BM, JE). G. Damus: *Hallier B 544* (BO, FH, GRO, H, L). G. Kenepai: *Hallier B 1802* (BM, BO, FH, GRO, L). Bt. Mulu: *Winkler 3065* (H). Bt. Raja: *Winkler 3156* (H), *3180* (H). G. Amai Ambit: *Hallier B 3184* (BO, FH, GRO, H, L). Bt. Antara: *Amdjah s.n.* (BM, FH). Bt. Batu Lesung: *Amdjah s.n.* (BM, FH). G. Kemul: *Endert 3758* (BM, BO, GRO, L), *4296 p.p.* (BO, GRO), *4542 p.p.* (BO, GRO, L). Mt. Palimasan near Tabang: *Kostermans 12861B* (GRO, L), *12863* (GRO, L). Peak of Balikpapan: *Meijer*, 6 collections (BO, GRO, L).

PALAWAN. Penigisan: *Sandermann Olsen 2167* (L).

LUZON. Apayao. Mt. Duraragan: *Edaño PNH 20102* (L). — Abra: *Ramos BS 7313* (BM, H, K, NY). Mt. Lamunan: *Micholitz s.n.* (FH, GRO, H, JE, L). — Bontoc. Mt. Masapilid: *Ramos & Edaño BS 38245* (BM, FH, H, K, NY, US). — Ifugao. Mt. Polis: *McGregor BS 20328* (GRO, H, K, L, NY, US); *van Royen & Sleumer 5622* (L); *Tixier 1729* (EGER). Mt. Tabayoc: *Jacobs*, 8 collections (L). — Aurora. Baler: *Santos 224* (FH). — Zambales: *Curran & Merritt FB 8164* (BO, H, MO, NY), *FB 8190* (H, NY); *Ramos BS 5142* (H, NY). — Laguna: *Calvin BS 330* (BO). Mt. Banahao = Mahahai: 14 collections. —

Quezon. Lucban: *Elmer 7772* (H), *9289* (BO, GRO, K, L, MO, NY, US, W). — Camarines Sur. Mt. Isarog: *Edaño BS 84211* (FH), *BS 84221* (FH). Mt. Madooy: *Edaño BS 84246* (FH).

Mindoro. Mt. Halcon (incl. Mt. Dulangan): *Edaño PNH 9316* (GRO), *PNH 9340* (GRO); *Merrill BS 6185* (H, NY, US, W); *Whitehead s.n.* (BM).

Panay. Antique: *McGregor BS 32630*(BO, GRO, H, K, MO, NY, US), *BS 32651*(BO, H, K, NY, US). — Capiz. Mt. Bulilao: *Martelino & Edaño BS 35817* (H, NY).

Negros. Occidental. Mt. Canlaon: *Edaño PNH 20150* (L), *PNH 20183* (L). — Oriental: *Brown s.n.* (NICH). Cuernos de Negros: *Elmer 9897* (BM, BO, FH, GRO, H, K, L, MO, NY, PC, US, W); *Magdamo 96* (FH). Mt. Malbug: *Edaño PNH 13078* (GRO). Dumaguete: *Mack 1306a* (FH), *1364* (BM).

Mindanao. Misamis Occidental. Mt. Malindang: *Mearns & Hutchinson FB 4791* (H, K), *FB 4795* (GRO, H, L, NY, S-PA, W). — Bukidnon. Silipan: *Phillips 1* (FH, NY). Impalutao: *Phillips 27* (FH). Mt. Lipa: *Ramos & Edaño BS 37164* (BM, BO, GRO, H, NY, W). — Agusan. Butuan: *Weber 1304* (H, NY, PC). Mt. Hilong-Hilong: *Mendoza & Convocar PNH 10967* (GRO), *PNH 10968* (GRO). — Davao. Mt. Kampalili: *Edaño PNH 12860* (GRO), *PNH 12861* (GRO), *PNH 12866* (GRO), *PNH 12871* (GRO). Mt. McKinley: *Edaño PNH 1155* (GRO), *PNH 1161* (GRO), *PNH 1187* (GRO). Mt. Mayo: *Edaño PNH 12896* (GRO), *PNH 12898* (GRO). Mt. Batangan: *Warburg s.n.* (H, NY). Mt. Apo: *Montano s.n.* (PC); *Robbins 4004* (L). Mt. Talomo: *Robbins 3958* (L).

Celebes: *unknown coll. s.n.* (BM, BO, FH, GRO, H, K, L, S-PA). — North Peninsula. Bojong: *Warburg s.n.* (FH, H, NY, S-PA, W). Manimporok: *Alston 15916* (BM, L). G. Klabat: *Reinwardt s.n.* (L). — East Peninsula. G. Lumut: *Eyma 3651* (GRO). — Southwest Peninsula. Bt. Poka Pindjang: *Kjellberg 22M* (BM, FH, JE, S-PA), *98M* (BM, BO, FH, GRO, S-PA). Todjambu: *Kjellberg 68M* (BO, FH, GRO, L, S-PA). G. Lompobattang = Peak of Bonthain: *Fruhstorfer s.n.* (PC); *Teijsmann s.n.* (FH, L); *Warburg s.n.* (FH). — Southeast Peninsula. Bt. Watuwila: *Kjellberg 3M* (BM, BO, FH, S-PA).

Ceram. Central Ceram: *Stresemann 2* (BM, JE). Between Manusela and Wolu: *Kornassi 710* (BM, BO, GRO, L); *Stresemann 37* (BM, JE), *62* (H, JE), *159a* (BO, GRO, L).

New Guinea. Waigeo Island. Mt. Nok: *Cheesman 114* (BM), *130* (BM). — Japen Island. Serui, Wamiami: *Aet & Idjan 285* (BO). — West New Guinea. Aifat R. Valley, Wamsuf area: *van Royer & Sleumer 7189* (L). Ibid., path from Surirem to Son: *van Royen & Sleumer 7549* (L). Kebar Valley: *Kalkman BW 6387* (L); *Schram BW 7982* (L). Nettoti Ra., Mt. Nettoti: *van Royen & Sleumer 7380 p.p.* (L). Mt. Arfak, Hatam: *Beccari 177 p.p.* (GRO, L). Wandammen Peninsula, Wondiwoi Mts.: *Schram BW 10717* (L). Weijland Mts. (Mt. Jabi): *Janowski s.n.* (BO, L). Mt. Carstensz: 7 collections. Siduarsi Mts.: *Schram 34* (L); *Vink 2019* (L). Mt. Doorman: *Lam 1453* (GRO), *1982* (GRO). Bernhard Camp, Idenburg R.: *Brass 12078* (BO, FH, GRO, L), *12422* (FH), *13038* (BO, FH, GRO, L). Lake Habbema: *Brass 10507* (FH). Bele R.: *Brass 11033* (BO, FH). Hellwig Mts.: *Pulle 525* (BO, FH, GRO, K, L); *von Römer 1028* (BO, FH, GRO, L). Mt. Cyclops: *Koster BW 4287* (L); *McKee 1899* (FH), *1902* (FH); *van Royen & Sleumer 5759* (L), *6091* (L). Mt. Goliath: *de Kock 29* (BO, FH, GRO, L). Orion Mts., Tenmasigin: *Vervoort 312 p.p.* (L). Star Mts., Mt. Antares: *van Zanten 335A* (GRO, L), *336* (GRO, L), *373A* (GRO, L), *385E* (GRO, L). — Territory of New Guinea. Torricelli Mts., Miwaute: *Darbyshire 294* (CANB, FH, L, MEL). Ibid., Mt. Somoro: *Darbyshire 342* (CANB, FH, L, MEL). Ibid., Wigote: *Darbyshire 477* (CANB, FH, L, MEL). Prince Alexander Ra., Mt. Toru: *Pullen 1492* (CANB, FH, L); *Robbins 2351* (CANB, L). Tumandan—Tibinini track: *Robbins 3413* (CANB, FH). Yobobos: *Hoogland & Schodde 7678* (CANB, FH, L, MEL). Sirunki: *Robbins 3135* (CANB, FH). Mt. Sugarloaf: *Robbins 2782* (CANB, FH). Kompiam: *Robbins 2851* (CANB, FH). Yaki R. Valley: *Hoogland & Schodde 6913* (CANB, FH, L). Mt. Hagen: 7 collections. Mt. Hagen Village: *van Zanten*, 5 collections (GRO, L). Wankl: *Hoogland & Pullen 5861* (CANB, FH, L). Nondugl: *van Royen 18289* (CANB, L). Kubor Ra.: *Pullen 5039* (CANB, L), *5258* (CANB, FH, L), *5323* (CANB, L). Mt. Wilhelm: 15 collections. Marafunga: *Sleumer 4570* (L), *4572* (L). Daulo Pass: *van Zanten 68433* (GRO, L). Mombasop: *Robbins 1375* (CANB, FH, L). Mt. Otto: *Brass & Collins 31039* (FH, L). Purosa: *Brass 31668* (FH, L). Kainantu, Waisa: *Eddy 2174* (BM), *2207 p.p.* (BM, L). Arau: *Brass 31978* (FH, L). Mt. Elandora: *Eddy 2077* (BM), *2083* (BM). Finisterre Ra.: 5 collections. Ibid., Daimandi: *Eddy 358* (BM). Ibid., Butemo: *Eddy*, 7 collections (BM, L). Ibid., Moro: *Eddy 1105* (BM). Ibid., Abilala: *Eddy 1261 p.p.* (BM), *1263* (BM, L). Matap: *Clemens 176432* (FH, MO). Menyamya—Kaintiba Road: *Streimann & Kairo NGF 35909* (L). Edie Creek: 6 collections. Mt. Kaindi: *Hewson 487* (L); *Schelpe 7361* (GRO); *van Zanten 68230* (GRO, L), *68271* (GRO, L). Mt. Herzog, Wagau: *Eddy 1705* (BM). *1837* (BM), *1916* (BM). Cromwell Mts., Mannasat: *Hoogland 9548* (CANB, FH). Mt. Rawlinson: *Hoogland 9080* (CANB), *9311* (CANB, L). Pindiu: *Hoogland 8970* (CANB, L). — Territory of Papua. Ibiwara: *Vink 16932 p.p.* (L), *16933 p.p.* (L), *16934C* (L). Mt. Ne: *Kalkman, Vink*, 6 collections (L). Mt. Ambua: *Kalkman 5102* (L), *5103* (L); *Vink 17362* (L). Anga Valley near Ebenda: *Schodde 1541* (CANB, FH, L). Mt. Giluwe: 7 collections. Vakari Ra., Kagua: *Hewson 344* (L). Mt. Yule: *Kowald 1297* (BM, FH, H). Aroa R.: *Weiss s.n. p.p.* (H, JE). Mt. Tafa: *Brass 4027a* (NY), *4955* (L, NY). Murray Pass: *Brass 4627* (NY). Sibium Ra. S. of Ioma: *Pullen 5899* (CANB, L). Mt. Scratchley: *Giulianetti s.n.* (H, K). Owen Stanley Ra., The Gap: *McDonald s.n.*

(BM, H). Efogi: *van Zanten 683792A* (GRO), *683798* (GRO, L), *683799* (GRO, L). Brown R. Valley: *Musgrave s.n.* (FH, H, S-PA). Boridi: *Carr 13021 p.p.* (BM), *13033 p.p.* (L, NY). Mt. Durigolo: *Clark 47* (BM). Mt. Dayman: 6 collections. Mountains near Mila ('Mita'): *Micholitz 131* (BM, FH, H, K, S-PA, W). — Goodenough Island: *Brass 24614* (FH). — Fergusson Island. Mountains between Agamoia and Ailuluai: *Brass 27079* (FH, GRO, L, S-PA, US), *27170* (FH, GRO, L, S-PA, US). — Normanby Island. Mt. Pabinama: *Brass 25740* (FH, GRO, L), *25784* (FH, GRO, L, S-PA, US).

BISMARCK ARCHIPELAGO. New Ireland. Lelet: *Køie 2136* (H, L), *2138* (L).

SOLOMON ISLANDS. Bougainville. Lake Loloru Crater: *Craven & Schodde 320* (CANB, L); *Kajewski 2169* (FH, NICH, NY), *2170B* (FH); *Schodde & Craven 3746* (CANB, L). — Guadalcanal: *Braithwaite 4071* (L). Mt. Gallego: *Dennis BSIP 20.023a* (GRO, L). Mt. Popomanasiu: 11 collections. — San Cristobal. Hinuahaoro: *Brass 3059* (FH).

NEW HEBRIDES AND BANKS ISLANDS. Vanua Lava: *Aubert de la Rue 121* (FH, NICH, S-PA). — Espiritu Santo. Santo Peak: *Robbins 3845* (L). — Aneityum: *Gunn*, 7 collections. Anelhaugat: *unknown coll. s.n.* (BM).

ÎLE DES PINS: *Strange s.n.* (BM, FH, NY).

FIJI ISLANDS. Viti Levu. Mt. Evans: *Greenwood 230* (BM). Nandarivatu: *Gibbs 708* (BM, K); *Greenwood 601* (BM), *758* (BM). Mt. Victoria: *Greenwood 1181* (FH). Suva: *Meade 1323* (FH). — Vanua Levu. Mt. Ndikeva: *Smith 1887a* (FH, K, NY, US).

Ecology: Terrestrial, on decaying logs, humus-covered rocks, and tree-bases in montane and subalpine rain forests and scrubs; also near streams on wet rocks and tree-branches overhanging the water. According to Fleischer (1923) mostly growing in open places in forest. Alt. (300—) 600—3300 (—4000) m.

Notes: 1. See note 2 under the section. The reasons for the substitution of the epithet '*divaricatum*' by '*dendroides*' have been explained there. Lindberg (1861, 1866) had already mentioned the conspecificity of *Bryum dendroides* Swartz *ex* Brid. and *Hypnum divaricatum* Reinw. The illustration given by Swartz (1781) is of poor quality, and his description is also not completely in agreement with Thunberg's specimen.

2. As a rule, young stipes are glabrous or nearly so and become clad with tomentum with age. Sometimes, however, the amount of tomentum may remain very small.

3. In tall plants pseudoparaphyllia are often absent or very scarce.

4. Dwarf plants bearing caducous leaves have been found once (*Edaño PNH 12898*, Mindanao).

Variability: Many species distinguished by previous authors have been united here into a single extremely variable species. Extreme forms of it differ so widely that a distinction at the species level seems self-evident, but these extremes are connected by numerous intermediates by which they gradually shade off into one another. For the sake of convenience the species has been divided into eight entities, which necessarily are vaguely delimited, and into which many intermediates could not be placed. Therefore, no formal names have been given to these entities.

The entities have been united into two groups which are also connected by intermediates. The '*dendroides*' group (entity 1—5) occurs all over the area of the species, whereas the '*aristinerve*' group is restricted to the Philippines and West Malesia (including Borneo). Intermediates between the two groups have not yet been found in Borneo and appear to be rare in the Philippines, but '*aristinerve*' characters are often less pronounced in plants from the Philippines than from Borneo. Most plants from the Malay Peninsula represent intermediates between entities 1 ('*dendroides*' group) and 7 ('*aristinerve*' group); the features of '*aristinerve*' usually predominate there. Most Sumatran specimens belong to entity 1, but intermediates between 1 and 7 have often been collected in the Gajo Lands and the West Coast District; '*dendroides*' features predominate in these plants. In West Java only a few plants have '*aristinerve*' characters in a weak form.

Several entities (3, 4, 6) appear to be restricted to a single mountain complex. Less

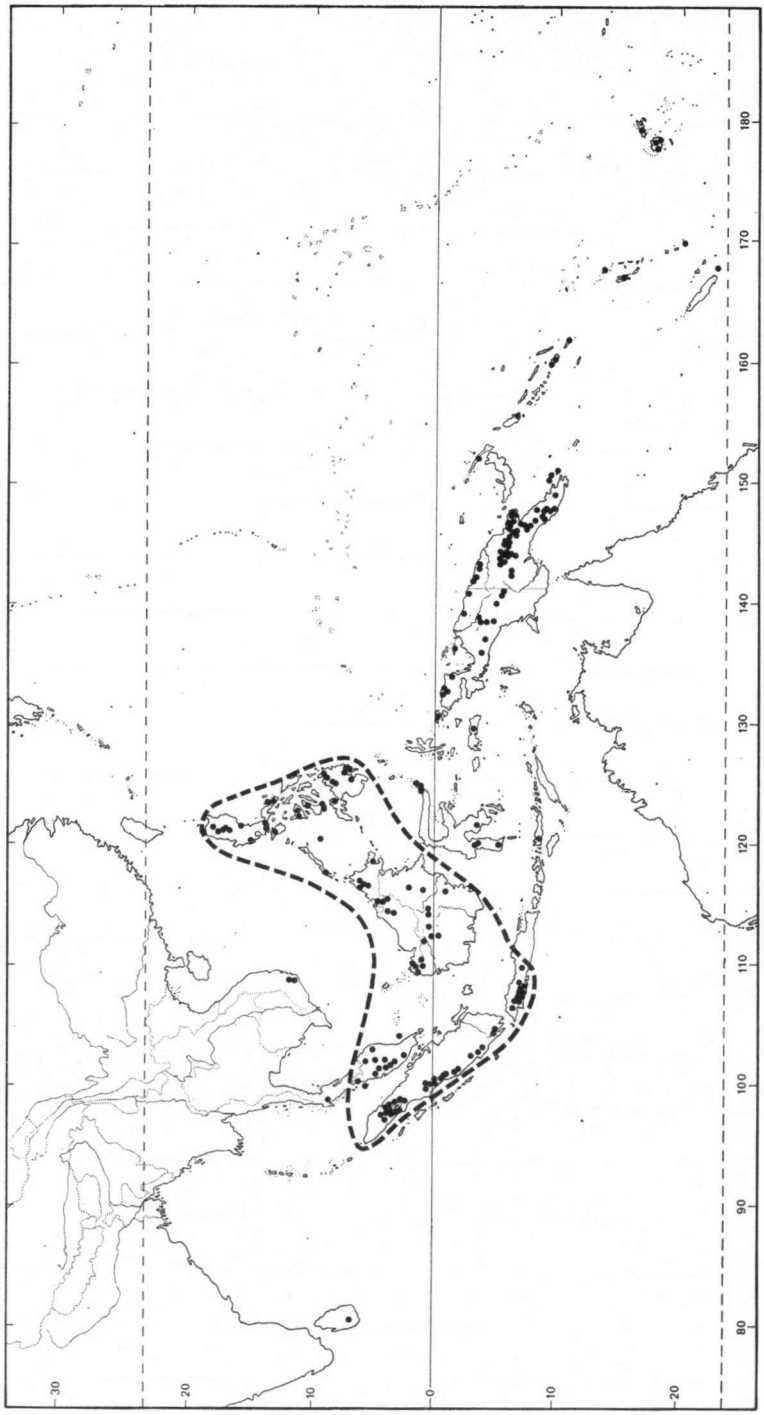

Fig. 39. Distribution of *Hypnodendron dendroides*. The area of specimens having characters of the '*aristinerve*' group has been indicated by a broken line.

conspicuous local segregates have been recognized in other entities as well as in the intermediate forms.

A. 'dendroides' group.

Stipe leaves mostly gradually long-acuminate; costa ending in leaf apex to indistinctly excurrent, never forming a distinct arista. *Branch leaves* straight to weakly secund, smooth to longitudinally plicate, acute to gradually acuminate; costa as in the stipe leaves, but mostly shorter; lamina cells 20—110 by 2—5 μ; marginal cells usually not forming a distinct border, rhomboid to elongate, quadrate cells absent or few.

Entity 1 (including *Bryum dendroides* Brid., *B. ferrugineum* Jungh., *Hypnum divaricatum* Reinw., *H. wallisii* C. Muell., *Mniodendron deltoideum* Par., *M. divaricatum* (Reinw.) Card. f. *tabulata* Fleisch. and f. *minor* Fleisch.).

Plants mostly medium-sized to tall, often tinged with orange or brown. *Stipe leaves* 1.7—3.4 by 1.0—1.65 mm. *Branch leaves* mostly longitudinally plicate, 1.8—3.4 by 0.6—0.9 mm; apex mostly gradually acuminate, occasionally acute, mostly canaliculate; lamina cells 3—5 μ wide; marginal cells mostly elongate, rhomboid cells often few or absent. *Seta* 2.5—5.5 cm. *Theca* (3.5—) 4.5—8.2 mm.

The present entity comprises the tallest plants of *H. dendroides*. It is the most common form in Sumatra and Java, but has also been found in Ceylon, Annam, the Malay Peninsula, South-East Borneo, Luzon, Panay, Mindanao, Celebes, and Flores. The plants from the Malay Peninsula, Sumatra, and Java are often taller than those from elsewhere, and they often have elongate marginal cells only.

The Javan *Bryum dendroides*, *B. ferrugineum*, and *Hypnum divaricatum* were already considered conspecific by Lindberg (1866). Bartram (1939) reduced *Hypnum wallisii* to a variety of *Mniodendron divaricatum*. The type specimen (which he did not examine) perfectly matches typical plants of the present entity. According to Thwaites et Mitten in Mitten (1859A) *Mniodendron deltoideum* differs from *M. divaricatum* in having deltoid and subauriculate stipe leaves. These characters have been found in (usually rather small) specimens of entity 1, in many specimens of entity 2, and occasionally even in plants belonging to entity 7. In my opinion the type specimen represents a small form of entity 1.

Entity 2 (including *Mniodendron humile* Par., *M. hellwigii* Broth., *M. micholitzii* Par., *M. densirameum* Broth., *M. kowaldii* C. Muell.).

Plants usually small and pale green, often with conspicuously red coloured branches, often glossier than plants belonging to entity 1. *Stipe leaves c.* 1.3—2.5 by 0.65—1.3 mm. *Branch leaves* often smooth or nearly so, *c.* (0.9—) 1.4—1.9 by (0.25—) 0.4—0.6 mm; apex acute to weakly acuminate, mostly less strongly canaliculate and often more widely spreading than in entity 1; lamina cells *c.* 2—4 μ wide; rhomboid marginal cells mostly numerous. *Seta* 2—4.5 cm. *Theca* 2.2—4.5 mm.

The present entity is the most common form in Ceram and New Guinea, and has also been collected in Celebes, the Bismarck Archipelago, and the Solomons. In the last mentioned two groups of islands the plants often are unusually tall. As entities 1 and 2 mainly differ in size, these plants could not always be distinguished satisfactorily from entity 1. This also holds true for other tall plants collected in the area of entity 2, and the reverse is true as well. Dixon (1935A) has already stated that he could see no distinctions except in size between *Mniodendron humile* and *M. divaricatum*, and had seen intermediate forms. In a paper on mosses from New Guinea Fleischer (1917) reduced *Mniodendron*

kowaldii to *M. divaricatum*. Brotherus (1892, 1898, 1899A) described three species from New Guinea, which in my opinion are nothing but forms of entity 2. He stated that *M. hellwigii* Broth. differed from *M. divaricatum* in size only, and the same applies in my opinion to *M. micholitzii* Broth. and *M. densirameum* Broth. The latter was compared by its author to *M. fusco-aciculare* (= *H. fusco-mucronatum* ssp. *chalmersii*). I suppose that mistake was caused by the bad condition of the specimen, which has lost nearly all its stipe leaves. Bartram (1957A) published a tentative key to the New Guinea species of *Mniodendron*, which included among others *M. hellwigii*, *M. micholitzii*, and *M. humile*. He apparently misinterpreted *M. hellwigii*, as the characters mentioned in the key and the plants bearing that name in his herbarium all belong to *H. fusco-mucronatum*. The leaf characters he employed to separate *M. humile* and *M. micholitzii* have been found to be of no use, as auriculate and non-auriculate stipe leaves have been found in each entity, except entity 5.

Entity 3.

Closely related to entity 2, but having distinctly attenuate and often fastigiate branches bearing very small (*c.* 1.3—1.7 mm long) leaves, which are less widely spreading to almost appressed and often have an incurved apex; costa very wide and percurrent to shortly excurrent in a thick cuspidate point; walls of alar cells incrassate, strongly coloured.

Plants belonging to this entity have only been found at altitudes above 2500 m on Mt. Wilhelm and nearby Mt. Otto, New Guinea. In the same area plants have been collected combining characters of entities 2 and 3.

Entity 4.

Stipe leaves deltoid, exceptionally wide (1.5—1.9 mm), appressed to somewhat spreading. *Frond* open, rather wide; branches long, pinnate. *Branch leaves* very wide. Otherwise agreeing with entity 2.

This peculiar form has been collected only once (New Guinea, Tamrau Mts., *van Royen & Sleumer 7189*).

Entity 5 (including *Hypnodendron palmaeum* Mitt.).

Plants of the same size as entity 2 and showing almost the same branch leaf characters. *Stipe leaves* triangular-ovate; base strongly cordate; apex acute to slightly acuminate. Very few sporophytes have been collected; those available agree with entity 2.

This form has been collected in the New Hebrides, Fiji, and île des Pins (?). As appears from the description it is very close to entity 2. Some plants of the latter from New Guinea and the Solomons approach it in having only slightly widened and strongly rounded stipe leaf bases.

Mitten did not cite a specimen for his new species *Hypnodendron palmaeum*, nor did he indicate its distribution. Brotherus (1909C, 1924B) and Fleischer (1917) apparently assumed that the type came from New Guinea, and *H. palmaeum* is reported as a species from Australia and New Guinea by Schultze-Motel (1963). The paper in which the species was described mainly concerns collections from New Guinea (leg. Chalmers), Aneityum (leg. Milne), and île des Pins (leg. Strange). Mitten's herbarium contains only one specimen of *H. palmaeum*, which Strange collected in île des Pins. I feel rather safe in assuming this specimen to be the type. Unfortunately, several problems have remained unsolved. The occurrence of *H. dendroides* in île des Pins seems rather unlikely; as in New Caledonia *H. dendroides* is replaced by *H. camptotheca*, one would expect the same in the nearby île des Pins. Mitten (1873A) reported *Mniodendron divaricatum* from the same island, where it

was supposed to have been collected by Milne (who visited île des Pins in 1853 during his voyage in the 'Herald'). However, Strange's collection is the sole collection from île des Pins belonging to the *Hypnodendron dendroides* complex in Mitten's herbarium. Is only one collection involved here, and by whom and where was it collected? If the plants were gathered by Milne, he could just as well have collected them in Aneityum, a much more likely locality where he had collected extensively during the same voyage of the 'Herald'.

B. 'aristinerve' group.

Stipe leaves often abruptly narrowed, more or less subulate, costa percurrent to long-aristate. *Branch leaves* mostly secund to falcate-secund, longitudinally plicate, more or less abruptly narrowed to a canaliculate subula or a long arista which measures at least one third of the length of the leaf; costa percurrent to long-excurrent; lamina cells 15—90 by 3—5 μ; marginal cells mostly forming a distinct border, rounded to quadrate or rhomboid, quadrate and rhomboid cells mostly numerous, elongate cells few or absent.

The present group consists of two forms which are connected by a large number of intermediates. For practical reasons the latter have been treated separately; they have already received much attention before and have long been known as *Mniodendron microloma.*

Brotherus (1909C, 1924B) erroneously inserted the 'species' belonging to this group in *Mniodendron* sect. *Comatulina*, the species of which should have a bistratose leaf margin. Like Dixon (1935A) I have never observed specimens with such a margin.

Entity 6 (including *Mniodendron aristinerve* Par.).

Plants medium-sized, robust, often reddish or brownish. *Stipe leaves c.* 3.0—5.0 by 1.1—1.4 mm; base deltoid to triangular; costa of stipe leaves and branch leaves very strong, excurrent in an often brownish, weak to strong toothed arista, which is at least half of the length of the leaf. *Branch leaves c.* 2.5—4.5 by 0.6—0.8 mm; costa at the leaf base *c.* 55—75 μ wide; lamina cells *c.* 15—60 μ long, very incrassate. *Seta c.* 4.0—6.5 cm long. *Theca c.* 5.0—7.5 mm long.

Typical specimens have only been found at altitudes above 1500 m on Mt. Kinabalu and the nearby Mt. Tambuyokon, North Borneo. In the same mountain complex many specimens have been collected which connect entities 6 and 8.

Entity 7 (including *Mniodendron curtisii* Dix.).

Plants mostly small to medium-sized, pale green to sordid green, mostly dull to slightly glossy. *Stipe leaves c.* 1.7—2.3 by 0.7—1.1 (—1.5) mm; base mostly triangular; costa mostly percurrent to very shortly excurrent, leaves rarely shortly aristate. *Branch leaves c.* (1.6—) 1.9—2.6 by 0.5—0.75 mm; apex more or less distinctly narrowed to a canaliculate subula; costa at the leaf base *c.* 25—45 μ wide, percurrent to very shortly excurrent; lamina cells 20—90 μ long. *Seta c.* 3—4.5 cm long. *Theca c.* 3.5—5.0 mm long.

This is the most common form of the *Hypnodendron dendroides* complex in Borneo. It has also been collected frequently in the Philippines (Palawan, Luzon, Mindoro, Negros, Mindanao), and occurs in one locality at least in the Malay Peninsula (Pulau Penang). A number of Phillippine collections placed in this entity have branch leaves more gradually narrowed and less strongly curved than is usual. Although the type specimen of *Mniodendron mittenii* Salm. *ex* Par. belongs to entity 8 many herbarium specimens bearing that name belong to the present entity.

Entity 8 (including *Mniodendron microloma* Mitt. in Stapf = *M. mittenii* Par., *M. microloma* Mitt. *ex* Par. ?, *M. longinerve* Broth.).

Intermediate between entities 6 and 7. Stipe leaves and branch leaves subulate or ending in a narrowly bordered arista.

North Borneo, Luzon, Panay, Negros, Mindanao.

Mniodendron microloma Mitt. *ex* Geh. (1886) was based on a specimen which, according to Geheeb, was most likely given that name by Mitten. Geheeb did not mention any specimen for this new species, but the diagnosis appeared in a paper on mosses collected by Burbidge in the Sulu Archipelago. Eight years afterwards Mitten (1894) himself published *M. microloma* as a new species, based on a Burbidge specimen from Mt. Kinabalu, Borneo. Paris (1905) considered *M. microloma* Mitt. in Stapf a later homonym of *M. microloma* Mitt. *ex* Geh. and replaced it by *M. mittenii* Par. Dixon (1935A) apparently held the opinion that the types of Geheeb's and Mitten's species could not be identical, as they had been collected in different localities. However, this may not be true, as Geheeb (in an introduction to his paper) also gave Mt. Kinabalu as the collecting locality of nearly all plants treated. Various herbaria contain duplicate sets of Burbidge's Kinabalu collection, which apparently have been named by Mitten. If Geheeb's plants also consisted of such a duplicate set, both diagnoses of *M. microloma* were based on the same collection. Unfortunately, this problem cannot be solved as Geheeb's herbarium no longer exists.

The notes under the diagnosis of *M. microloma* Mitt. in Stapf clearly refer to *M. brevifolium* published on the same page, and those under the latter apparently belong to the former.

The characters Dixon (1935A) attributed to *M. mittenii* refer to entity 7, and many herbarium specimens from Borneo and the Malay Peninsula bearing the name *M. mittenii* belong there.

Only one collection is known to exist of *M. longinerve* Broth. (Luzon, *Micholitz s.n.*). Surprisingly, only the duplicates bear that name, whereas Brotherus termed his own specimen *M. aristinerve*.

24. Hypnodendron tahiticum (Besch.) Touw, *comb. nov.* — *Mniodendron tahiticum* Bescherelle *ex* Bescherelle (1901) 12; Bescherelle (1894) 55, *comb. inval.*; Paris (1896) 822; Bescherelle (1898) 126; Paris (1905) 263; Brotherus (1909C) 1172, (1924B) 439; Bartram (1931) 8, (1933B) 13, *pro parte*, (1950) 269; van der Wijk et al. (1964) 395. — Syntypes: *J. Nadeaud 90* (BM lecto, NY, PC), Tahiti, Téoa, Arue Valley and clayey summit of Mt. Marau, *c.* 1100 m; *J. Lépine 11* (BM), Tahiti; *C. Wilkes s.n.* (US), mountains of Tahiti. — **Fig. 38.**

Hypnum comosum non Labill.: Nadeaud (1873) 16.

Plants small to medium-sized, densely tufted, pale green to sordid green or pale brownish green, slightly glossy. *Stipe* up to 5(—6.5) cm long. *Frond* simple or tiered, up to 3.5(—4.5) cm across, mostly dense, umbellate, fasciculate, palmate, or pinnate; branches mostly simple, straight or decurved (sometimes strongly so in male plants). *Stipe leaves* mostly longitudinally striate, triangular-ovate-lanceolate, 2.1—3.1 by 0.6—1.0 (—1.1) mm, L/W ratio 2.6—3.7 (—4.0); base rounded to strongly cordate; apex gradually long-acuminate; margin near base crenulate to serrulate, upwards serrulate to serrate with up to *c.* 25 μ long teeth; costa excurrent in a short to rather long and sharp arista, dorsally smooth or bearing a few small teeth; lamina cells 35—100 by 2—5 μ, L/W ratio *c.* 12—30, walls mostly moderately incrassate, smooth to papillate; marginal cells rhomboid to linear; alar cells forming a small to rather large group of enlarged to somewhat inflated cells having incrassate and occasionally orange coloured walls. *Branch leaves* patent,

erect to secund, triangular-ovate-lanceolate, mostly smooth, 1.8—2.5 (—2.9) by 0.5—0.8 mm, L/W ratio 3.0—4.1 (—4.9); base rounded to cordate; apex gradually acuminate, weakly canaliculate; margin serrate with up to *c.* 27 μ long teeth; costa percurrent to excurrent in a short arista, bearing many small dorsal teeth; lamina cells 30—75 by 2—4 μ, L/W ratio *c.* (5—) 10—25, walls mostly moderately incrassate, smooth to weakly papillate; marginal cells as in the stipe leaves, sometimes not differentiated; alar cells forming a small and ill-defined group of inflated cells having slightly stronger incrassate walls than the lamina cells.

Up to 3 *sporophytes* on each frond. *Seta* (3.7—) 4.0—5.5 cm long, often only 0.13—0.18 mm across, mostly straight and reddish or reddish brown, its distal part paler. *Theca* inclined to horizontal, curved, cylindrical, *c.* 3—4.5 (—5.5) mm long, pale brown to dark brown, shallowly to deeply sulcate, mostly distinctly constricted below the orifice. *Cilia* 2—4. *Operculum c.* 2—4 mm long, abruptly narrowed to a very thin rostrum. *Calyptra c.* 3.5—5 mm.

Distribution: Samoa group, Society group, Marquesas (?).

Samoa group. Exact locality not given: *Powell 205* (BM, NY).

Society group. Raiatea. Temehani Ra.: *Moore 45* (FH), *46a* (FH). Faaroa Bay: *Moore 61* (FH), *62* (FH). Averaiti Valley: *Moore 57* (FH), *76a* (FH), *77* (FH). — Tahiti. Road to Vahiria: *Eriksson 75* (FH, GRO, H, S-PA). Mt. Orohena: *St. John & Fosberg 17056* (FH), *17151* (FH). Rereahu: *Nadeaud s.n.* (CHR, S-PA). Puaa Valley: *Nadeaud 427* (BM, FH, S-PA), *429* (H, PC), *430* (FH). Arue Valley and Mt. Marau: *Nadeaud 90* (BM, NY, PC). Tuairi: *Nadeaud s.n.* (CHR). Miaa: *Temarii s.n.* (FH, S-PA). Taravao: *Temarii s.n.* (L, NICH, PC, S-PA, US). Paparatea: *Temarii s.n.* (CHR). Pirae-Aroai trail: *Whitney 697i* (FH).

Marquesas. Ua Pu: *Jones 1210* (FH).

Ecology: The plants from Tahiti were found growing terrestrially and on tree trunks in rain forest between 600 and 1500 m; those from Raiatea were all found growing on branches of trees and shrubs between 300 and 800 m; no ecological data are known from elsewhere.

Notes: 1. Very closely related to *H. dendroides* (especially its West Pacific entity 5), but deviating so much from that species that I have preferred to keep *H. tahiticum* as a species. The principal differences between these two species have been given in the key. Additional characters by which *H. tahiticum* differs from *H. camptotheca* are the on an average shorter leaf cells, the reddish seta, and the theca which is usually strongly constricted below the orifice.

2. Plants from Tahiti are rather stiff, pale green to sordid green, the cordate leaf angles are small, and the lamina cells are mostly distinctly papillate. The threadlike seta measures only 0.13—0.18 mm across, and the theca is up to 4.5 mm long. The Raiatean plants are more flaccid, often yellowish or brownish, and have less strongly serrate leaves, larger cordate leaf angles, and weakly papillate to smooth cells. The seta measures *c.* 0.20—0.35 mm across (which is normal in sect. *Comosa*), and the theca is longer. The only collection from Samoa consists of two plants having longer leaves than the plants from the Society group. The leaves differ also in having stronger marginal teeth, a rounded and little narrowed leaf base, a stronger, further excurrent costa, and few alar cells which have strongly incrassate, dark coloured walls. Unfortunately, this collection comprises only one sporophyte, consisting of a seta measuring 5.5 by 0.14 mm and a theca only 2.3 mm long. Thus, *H. tahiticum* appears to be rather variable and to consist of a number of local forms. However, much more additional material is needed to give a good picture of its variability.

3. With considerable hesitation the specimen from the Marquesas has been placed here. It consists of a very poor, juvenile, and incomplete male plant, which not clearly has the differential charactes of *H. tahiticum*.

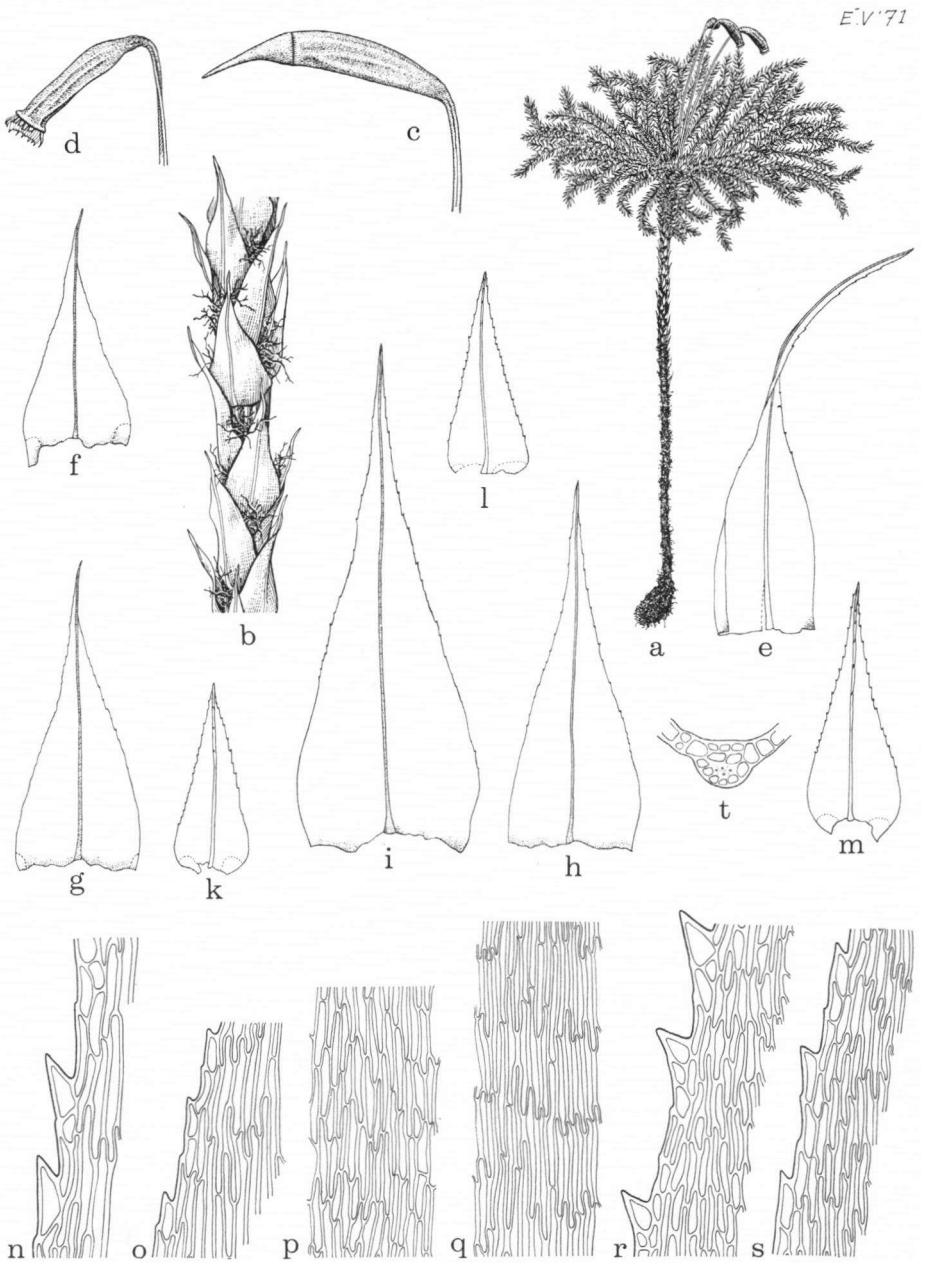

Fig. 40. *Hypnodendron fusco-mucronatum*. a—d, f, g, k, o, q, s, t: ssp. *fusco-mucronatum;* e, h, i, l—n, p, r: ssp. *chalmersii*. — a: Habit, × 1; b: stipe, × 8; c, d: capsules, × 4; e: perichaetial leaf, × 17; f—i: stipe leaves, × 17; k—m: branch leaves, × 17; n, o: margins of stipe leaves, × 260; p, q: areolation of branch leaves, × 260; r, s: margins of branch leaves, × 260; t: cross section of costa of branch leaf, × 260. (a, b, g: *Elmer 14191;* c, d: *Elmer 7399:* e, i, m, n, r: *van Zanten 682753;* f, k, o, q, s, t; *Nooteboom 1401;* h, l, p: *Hoogland 4016*).

Sect. Pseudomniodendron, *sect. nov.*

Stipes tomentosus. Frons umbellata, plerumque non-nitida. Folia caulina adpressa, tenuiter serrata. Theca sulcata. Spori 13—17 μ diam. Operculum acute rostratum.

Type species: *Hypnum fusco-mucronatum* C. Muell.

Plants usually small to medium-sized, erect. *Distal innovations* absent. *Stipe* more or less tomentose. *Pseudoparaphyllia* inconspicuous, appressed, often sparse or absent. *Frond* umbellate; branches not or weakly complanate. *Stipe leaves* ± appressed, triangular to narrowly triangular; insertion line straight or nearly so; base slightly narrowed, often shortly decurrent; apex usually weakly acuminate; margin shortly serrate with simple teeth; costa thin, ending in apex to shortly excurrent, smooth; cells smooth, basal cells enlarged, walls green to pale orange; alar cells indistinct or differentiated. *Branch leaves* isomorphous to weakly anisomorphous, symmetrical or nearly so, mostly triangular-ovate-oblong; apex acute to weakly acuminate; margin and costa as in stipe leaves; basal cells much enlarged, walls green; alar cells often forming a large group.

Male gametoecia scattered. *Perichaetial leaves* strongly plicate. *Theca* more or less sulcate, horizontal to cernuous. *Spores* 13—17 μ. *Operculum* sharply rostrate.

Distribution: See under the species.

25. Hypnodendron fusco-mucronatum (C. Muell.) Jaeg. — Fig. 40, 41.

For synonyms, literature, and type specimens see under the subspecies.

Plants small to medium-sized, rarely tall, erect, loosely to densely tufted, pale green to dark sordid green or brownish, mostly dull, occasionally more or less glossy. *Stipe* up to 9 cm long, erect, tomentose at base only when young, mostly becoming sparsely to densely tomentose along its entire length with age. *Frond* mostly dense and distinctly umbellate, less often palmate or pinnate in poorly developed plants, up to 6.5 cm across; branches sparsely branched to densely pinnate, strongly decurved when dry. *Stipe leaves* appressed (apex often weakly spreading when moist), triangular to narrowly triangular, 1.7—4.5 by 0.8—1.5 mm, L/W ratio 2.1—3.0, mostly longitudinally plicate near base, pale green to whitish or brownish, very thin and fragile; base slightly narrowed, often shortly decurrent; apex gradually narrowed to a sharp and often brownish point, weakly canaliculate to flat; margin flat or nearly so, serrate with up to *c.* 20 μ long simple teeth mixed with smaller crenulations formed by protruding cell apices; costa usually ill-defined; lamina cells 65—185 by 3.5—6 (—7) μ, L/W ratio *c.* 15—40 (—50), walls smooth, often porate; alar cells and cells of the decurrent bands forming an ill-defined group of inflated and often collapsed thin-walled cells, usually not differentiated in leaves without decurrent bands. *Branch leaves* mostly triangular-ovate-oblong, occasionally ovate, 1.2—2.2 by 0.5—0.9 (—1.2) mm, L/W ratio (1.8—) 2.2—3.1, longitudinally plicate to striate and strongly incurved and twisted at apex when dry; base broadly rounded, often shortly decurrent; margin serrate with up to 15 μ long simple teeth; costa thin, bearing up to 5 dorsal teeth; lamina cells 15—85 by 3—6.5 μ, L/W ratio *c.* 5—20, walls smooth or nearly so, sometimes porate; alar cells quadrate to rectangular or hexagonal, walls thin to incrassate and often sinuose.

Up to 13 *sporophytes* per frond. *Seta* 1.5—2.5 (—4) cm long, straight or nearly so, yellowish brown to orange, reddish brown, or dark brown. *Theca* curved, cylindrical, 3—7 mm long, dark brown, sulcate to angular in its distal part, occasionally almost smooth or entirely sulcate. *Cilia* 2—3 (—4). *Operculum* 2.5—3.5 mm long, dark brown. *Calyptra c.* 3.5—4.5 mm long.

Distribution: Philippines, Borneo, Ceram, New Guinea, Bismarck Archipelago, Solomon Islands, New Hebrides.

Ecology: Terrestrial, on moist rocks, decaying logs, and trunk-bases; in rain forests, often growing along streams; 300—2400 (—2700?) m.

Note: The tomentose stipe, dull green umbellate frond, and short simple teeth already distinguish *H. fusco-mucronatum* macroscopically from the other species of the genus. However, the amount of tomentum is very variable. Some gatherings contained only plants with almost naked stipes, whereas others had the stipes just as thickly clad with tomentum as in the species of sect. *Comosa*.

KEY TO THE SUBSPECIES

1. Cells of branch leaves linear, 35—85 μ long. Stipe leaves mostly distinctly decurrent and with clearly differentiated alar cells . . . . . ssp. **fusco-mucronatum**
1. Cells of branch leaves elongate to linear, 15—55 μ long. Stipe leaves very shortly or not decurrent, alar cells not differentiated . . . . . ssp. **chalmersii**

a. ssp. fusco-mucronatum. — *Hypnum fusco-mucronatum* C. Mueller (1862) 393. — *Hypnodendron fusco-mucronatum* Jaeger in Jaeger et Sauerbeck (1880) 360; Paris (1895) 604, (1904) 373. — *Mniodendron fusco-mucronatum* Brotherus (1905) 12, (1908A) 30, (1909C) 1172, (1913A) 97; Williams (1914) 376; Brotherus (1918) 222, (1924B) 439; Bartram (1939) 157, f. 194; van der Wijk et al. (1964) 395. — Syntypes: *C. G. Semper s.n.* (B †, BM lecto, GRO, H, L), Luzon, Mariveles; *H. Cuming 2205 pro parte* (B†, BM, FH, GRO, H, L, NY, S-PA, W), Philippines.

Hypnodendron brevifolium Mitten in Mitten et Wright in Stapf (1894) 259; Paris (1900) 191, (1904) 372. — *Mniodendron brevifolium* Geheeb *ex* Brotherus (1909C) 1172; Mitten *ex* Geheeb (1886) 353, *comb. inval.*; Paris (1896) 823; Brotherus (1924B) 439; Dixon (1935A) 97; van der Wijk et al. (1964) 394, (1969) 774. — Type: *F. W. Burbidge s.n.* (NY holo, BM, FH, GRO, H), Borneo, Mt. Kinabalu.

Frond up to 4.5 cm across, mostly densely branched. *Stipe leaves* 1.7—2.5 (—2.7) by 0.8—1.1 mm, L/W ratio 2.1—2.6; base mostly decurrent and with distinct alar cells; marginal teeth *c.* 5—15 μ long; costa mostly percurrent to shortly excurrent. *Branch leaves* 1.2—1.8 by 0.5—0.7 mm; marginal teeth *c.* 5—10 μ long; cells *c.* 35—85 by 3—5.5 μ, L/W ratio *c.* 10—20. Up to 5 *sporophytes* per frond. *Seta* 1.5—2.5 cm long. *Theca* 3.5—5.5 mm long.

Distribution: Philippines (Luzon, Biliran, Negros, Mindanao), North Borneo.

LUZON. Pampanga. Mt. Pinatubo: *Elmer 22314* (BM, FH, H, MO, NICH, NY, PNH), *22369* (BM, BO, FH, L, MO, NICH, NY). — Batan. *Medina 22042* (H, K, NY, US). Mariveles: *Semper s.n.* (BM, GRO, H, L). Mt. Mariveles: *Whitford 281* (BO, FH, GRO, H, L, MEL, NY, W). — Rizal. Mt. Irid: *Ramos BS 42001* (BM, FH). — Laguna. Mt. Maquiling: *Baker 2661* (BM, BO, GRO, H, L, MO, NY, S-PA, US); *Robinson BS 9730* (BM, H, K, NY, PC, US). Malbiga: *Barba 26* (GRO). Mt. Banahao (= Mahahai): 9 collections. — Quezon. Lucban: *Elmer 7399* (BO, GRO, H, K, L, MO, NY, US, W).

BILIRAN: *McGregor BS 18458* (FH, GRO, H, K, NY, US).

NEGROS. Occidental. Kinabkaban R.: *Edaño PNH 20196* (L). — Oriental. Cuernos de Negros: *Edaño PNH 13017* (GRO); *Elmer 10172* (BM, BO, FH, GRO, H, JE, K, L, MO, NY, PC, US, W). Lake Davao: *Edaño PNH 13112* (GRO). Dumaguete: *Mack 1306* (FH).

MINDANAO. Zamboanga: *Copeland D* and *s.n.* (BO, GRO, H, K, L, S-PA, W). — Agusan. Mt. Urdaneta: *Elmer 14191 p.p.* (BO, FH, GRO, H, K, L, MO, PC, US, W). — Davao. Mt. Apo: *Copeland 976* (FH, H, NY, W); *Elmer 11542* (BM, BO, GRO, H, JE, K, L, MO, NY, US, W); *Williams 2658a* (FH, H, NY, US).

BORNEO: *Burbidge s.n.* (NY). — Sabah. Mt. Kinabalu: 11 collections. G. Trus Madi: *Nooteboom 1401 p.p.* (L), *1413 p.p.* (L), *1477 p.p.* (L).

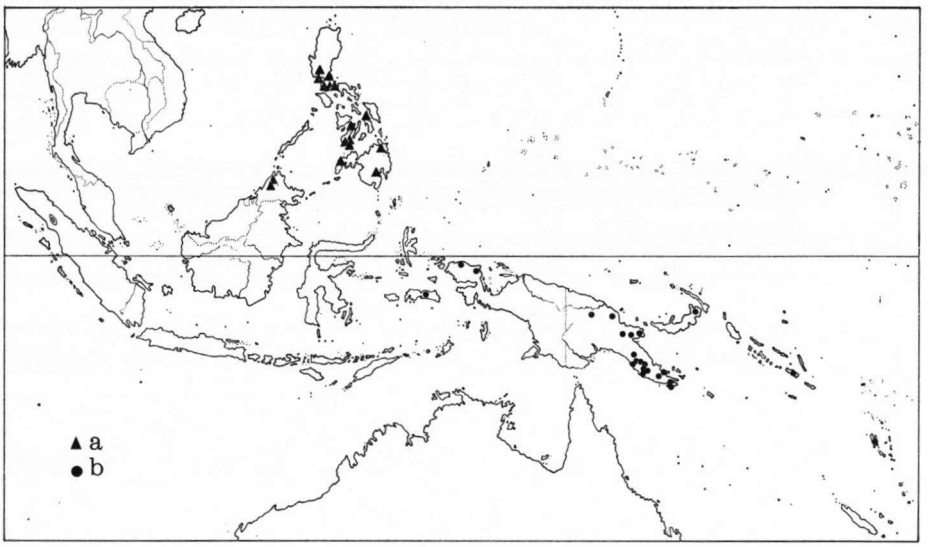

Fig. 41. Distribution of *Hypnodendron fusco-mucronatum* ssp. *fusco-mucronatum* (a) and ssp. *chalmersii* (b).

Notes: 1. I have selected Semper's gathering as lectotype because it contains sporophytes and the collecting locality is given. Cuming's collection consists of female plants without sporophytes and is of uncertain origin; as collecting locality only 'Insulae Philippinae' is given, and even that might be incorrect as the same label has been used for extra-Philippine collections (Merrill, 1915). Moreover, no. 2205 was used several times and for different bryophytes.

2. Judging from their contents the notes under the diagnoses of *Mniodendron brevifolium* and *M. microloma* (Mitten et Wright in Stapf, 1894) have been exchanged with each other.

b. ssp. **chalmersii** (Mitt.) Touw, *stat. nov.* — *Hypnodendron chalmersii* Mitten (1882B) 103; Paris (1895) 604, (1904) 372; Brotherus (1909C) 1169; Fleischer (1917) 34; Brotherus (1924B) 438; Schultze-Motel (1963) 442; van der Wijk et al. (1964) 532. — Type: *J. Chalmers s.n.* (NY holo, H, JE), New Guinea, spur of the Owen Stanley Range.

Hypnodendron fusco-aciculare C. Mueller in Geheeb (1889) 10; Paris (1895) 604; Geheeb (1898) 25; Paris (1904) 373. — *Mniodendron fusco-aciculare* Brotherus (1899B) 123, (1909C) 1172; Fleischer (1917) 34; Brotherus (1924B) 439. — Type: *J. Chalmers & C. A. G. Bridge s.n.* (B holo†), New Guinea, Cloudy Mountains near South Cape.

Hypnodendron brassii Bartram (1965) 52. — Type: *L. J. Brass 32042* (FH holo, L), New Guinea, Eastern Highlands, Arau, on ground in Castanopsis-oak forest, 1400 m.

Hypnodendron pugionatulum C. Mueller *ex* Geheeb (1898) 25, *nom. nud., in syn.* — *Mniodendron pugionatulum* (C. Muell.) Fleischer (1917) 34, *nom. nud.*

Mniodendron fusco-mucronatum (C. Muell.) Jaeg. *sensu*: Bartram (1945) 112; Schultze-Motel (1963) 371.

Mniodendron hellwigii non Broth.: Dixon (1943A) 34; Bartram (1957A) 41, (1959) 90.

Frond up to 6.5 cm across, densely to loosely branched. *Stipe leaves* 2.3—4.5 by 0.9—1.5 mm, L/W ratio 2.4—3.0; base usually not or hardly decurrent; alar cells not or weakly

differentiated; marginal teeth *c.* 12—20 μ long; costa usually ending in apex to percurrent, occasionally excurrent. *Branch leaves* 1.5—2.2 by 0.6—0.9 (—1.2) mm; marginal teeth *c.* 5—15 μ long; cells *c.* 15—55 by 3—6.5μ, L/W ratio *c.* 5—17. Up to 11(—13) *sporophytes* per frond. *Seta* 2—4 cm long. *Theca* 3—7 mm long.

Distribution: Ceram, New Guinea, Bismarck Archipelago (New Britain), Solomon Islands (Guadalcanal), New Hebrides (Espiritu Santo).

CERAM: *Eyma s.n.* (BO).

NEW GUINEA. West New Guinea. Vogelkop Peninsula, Tamrau Ra., Mt. Kusemun: *van Royen & Sleumer 7703* (L). Ibid., Arfak Mts., Hatam: *Beccari 177 p.p.* (FH, GRO, H, L). — Territory of New Guinea. Sepik-Wagi Divide, near Gubb's plantation: *Vink 16796* (L). Mombasop: *Robbins 1372* (CANB, FH, L). Arau: *Brass 32042* (FH, L). Boana: *Clemens 41867* (FH). Mt. Rawlinson: *Hoogland 9213* (CANB, L). — Territory of Papua: *McGregor 633* and *s.n.* (FH, H, S-PA, W); *Musgrave s.n.* (BM, H, NY). Mt. Yule: *Kowald 1298 p.p.* (BM, FH, GRO, H, NY, S-PA). Aroa R.: *Weiss s.n. p.p.* (GRO, H, JE). Mt. Tafa: *Brass 4164* (FH). Mt. Scratchley: *Giulianetti s.n.* (GRO, H, K). Isurava S. of Kokoda: *Hoogland 4016* (CANB, FH, L, MEL). Efogi: *van Zanten 683679* (GRO), *683771* (GRO, L). Spurs of the Owen Stanley Ra.: *Chalmers s.n.* (H, JE, NY). The Gap: *McDonald s.n. p.p.* (H). Boridi: *Carr 13021 p.p.* (BM, GRO, L, NY), *13417b* (GRO, L). Astrolabe Ra.: *Clark 82* (BM), *101* (BM, JE), *112* (BM, NICH). Mt. Dayman: *Armit s.n.* (GRO, L); *Brass 22335 p.p.* (FH), *22783* (FH). Bonenau: *Cruttwell M 48* (GRO). Sagarai R.: *Micholitz 132* (BM, FH, H, K, S-PA). Cloudy Mts.: *Chalmers 624* and *s.n.* (GRO, H, PC).

BISMARCK ARCHIPELAGO. New Britain. Baining Mts.: *Parkinson 5305* (CANTY, FH, H).

SOLOMON ISLANDS. Guadalcanal. Mt. Popomanasiu: *Braithwaite 4762* (L); *van Zanten 682564* (GRO, L), *682753* (GRO, L).

NEW HEBRIDES. Espiritu Santo. Santo Peak: *Robbins 3861* (L).

Notes: 1. The present subspecies shows a wider range of variation than ssp. *fusco-mucronatum*. The plants are usually taller, have longer and wider leaves, and bear a larger number of sporophytes, but their leaf cells are shorter than in ssp. *fusco-mucronatum*. The stipe leaves are mostly longer in relation to their width than in that subspecies.

2. The type (and only) specimen of *H. brassii* consists of very tall plants having highly tomentose stipes. It is aberrant as it has ovate and only weakly incurved branch leaves which are more densely serrate than usual. As such broad-leaved forms have also been found in other species of *Hypnodendron* (*H. milnei*, *H. dendroides*, *H. diversifolium*) separation from *H. fusco-mucronatum* appears unjustified.

3. The holotype specimen of *H. fusco-aciculare* was destroyed but I have been able to examine several Chalmers collections from other herbaria bearing that name and collected in the Cloudy Mountains. Unfortunately, I am not sure that these are isotypes, because the type specimen appears to have been neither numbered nor dated and because Bridge's name does not appear on the labels of the specimens examined. These plants, however, agree with Mueller's description.

4. Though I share Dixon's (1922) opinion concerning the conspecificity of *H. chalmersii* and *H. fusco-aciculare* I do not agree with his statement that 'it is very probable that both Mitten's and C. Mueller's species were described from the same gathering, as both are founded on specimens gathered by Dr. Chalmers'. Judging from the labels and the data given by van Steenis-Kruseman (1950) this is most unlikely, as these types were collected in different parts of New Guinea and in different years.

2. BRAITHWAITEA

Lindberg (1872) 250; Jaeger in Jaeger et Sauerbeck (1877) 299; Kindberg (1899) 393; Brotherus (1906B) 776; Fleischer (1906) 670, 721; Brotherus (1909C) 1167; Fleischer (1923) 1600; Brotherus (1924B) 433; Herzog (1926B) 127, 361, 362, 366, 368. — *Pterobryon* Hornsch. (sect.) *Braithwaitea* Mitten (1882A) 82.

Type species: *Leskea sulcata* Hook.

Plants rigid. *Stipe* black, tomentose at base only, erect or ascending from a very short creeping basal part. Peripheral and outer cortical stipe cells in many layers extremely incrassate, reddish to blackish, gradually becoming less strongly incrassate towards the centre of the stipe; inner cortical cells wide, walls yellow, strongly incrassate to thin; central strand distinct, measuring up to *c.* 10 cells across, mostly completely filled up, yellow to brownish. Rhachis bearing many dormant buds surrounded by small spreading *pseudoparaphyllia*. *Frond* pinnate to bipinnate; branches often bearing clusters of *gemmae* sprouting from branched rhizoids. *Stipe leaves* loosely appressed, triangular-ovate-oblong; insertion line straight or nearly so; apex acute to gradually long-acuminate; margin flat, almost entire, remotely and minutely crenulate to serrulate; costa thin, percurrent to shortly excurrent, near apex occasionally bearing minute dorsal teeth, costa cells not clearly differentiated into different types; lamina cells linear, smooth to weakly papillate; basal and alar cells weakly differentiated. *Branch leaves* isomorphous, concave, ovate to ovate-oblong; apex cymbiform with recurved margin, more or less obtuse; margin as in the stipe leaves, but near apex closely serrate to dentate with small teeth; costa strong, upwards slightly widened, excurrent in a short, often recurved mucro, strongly protruding at the dorsal face of the leaf and almost smooth to strongly scabrous with many small teeth; areolation as in the stipe leaves, but cells shorter, bearing small and narrow, often indistinct papillae.

Gametoecia situated along the distal part of the rhachis and the distal main branches. Full-grown *female gametoecia* tubular, yellowish green; *inner perichaetial leaves* smooth, more or less abruptly narrowed to a long erect acumen. *Theca* more or less sulcate, erect or suberect, almost straight; exothecial cells thin-walled. *Exostome* teeth not bordered, yellowish to colourless, papillose throughout, ventral lamellae very low. *Endostome* processes linear, unequal in size, the longest ones reaching almost as far as the exostome teeth, sometimes appendiculate; *cilia* absent; basal membrane very low. *Spores c.* 15—25 μ across, minutely pustulose. *Operculum* conical, gradually narrowed to a blunt apex. *Calyptra* pale yellowish to pale brownish, smooth.

Distribution: One species in New Caledonia, E. Australia, Lord Howe Island (?), and New Zealand.

1. **Braithwaitea sulcata** (Hook.) Jaeger in Jaeger et Sauerbeck (1877) 299; Brotherus (1906B) 777, f. 582; Fleischer (1923) 1601; Brotherus (1924B) 435, f. 382; Herzog (1926B) f. 134; Dixon (1929) 339; Allison (1931) 36; Burges (1935) 84; Burges et Johnston (1953) 75; Sainsbury (1955B) 315, t. 47 f. 1; Martin (1958) 107, 108, 114; van der Wijk et al. (1959B) 231, (1969) 358. — *Leskea sulcata* W. J. Hooker (1819) t. 164; Schwaegrichen (1829) t. 270. — *Hypnum sulcatum* Arnott (1825) 59. — *Climacium sulcatum* Bridel (1827) 274; Bruch, Schimper et Guembel (1842) 29; Mitten (1856) 264; C. Mueller (1872) 157; Paris (1894) 277, (1900) 103, (1904) 349. — *Neckera sulcata* C. Mueller (1850) 122. — *Isothecium sulcatum* Wilson in J. D. Hooker (1854) 104; J. D. Hooker (1867) 464. — *Dendro-Leskea sulcata* Hampe in F. von Mueller (1880) 80. — *Pterobryon sulcatum* Mitten (1882A) 82. — Type: *R. Brown s.n.* (BM), Australia, Port Jackson. — **Fig. 42, 43.**

Pilotrichum nematosum C. Mueller (1864) 373, (1868) 614. — *Braithwaitea nematosa* Jaeger in Jaeger et Sauerbeck (1877) 299. — Type: *H. Scott s.n.* (B holo †, NY lecto), Australia, Ash Island.

Pterobryella spininervis Brotherus et Paris in Brotherus (1911) 25. — Type: *L. Le Rat s.n.* (H holo, PC), New Caledonia, Mt. Dogny ridge, 1050 m.

Pterobryopsis filigera Brotherus et Watts (1918) 558; van der Wijk et al. (1967) 233. —

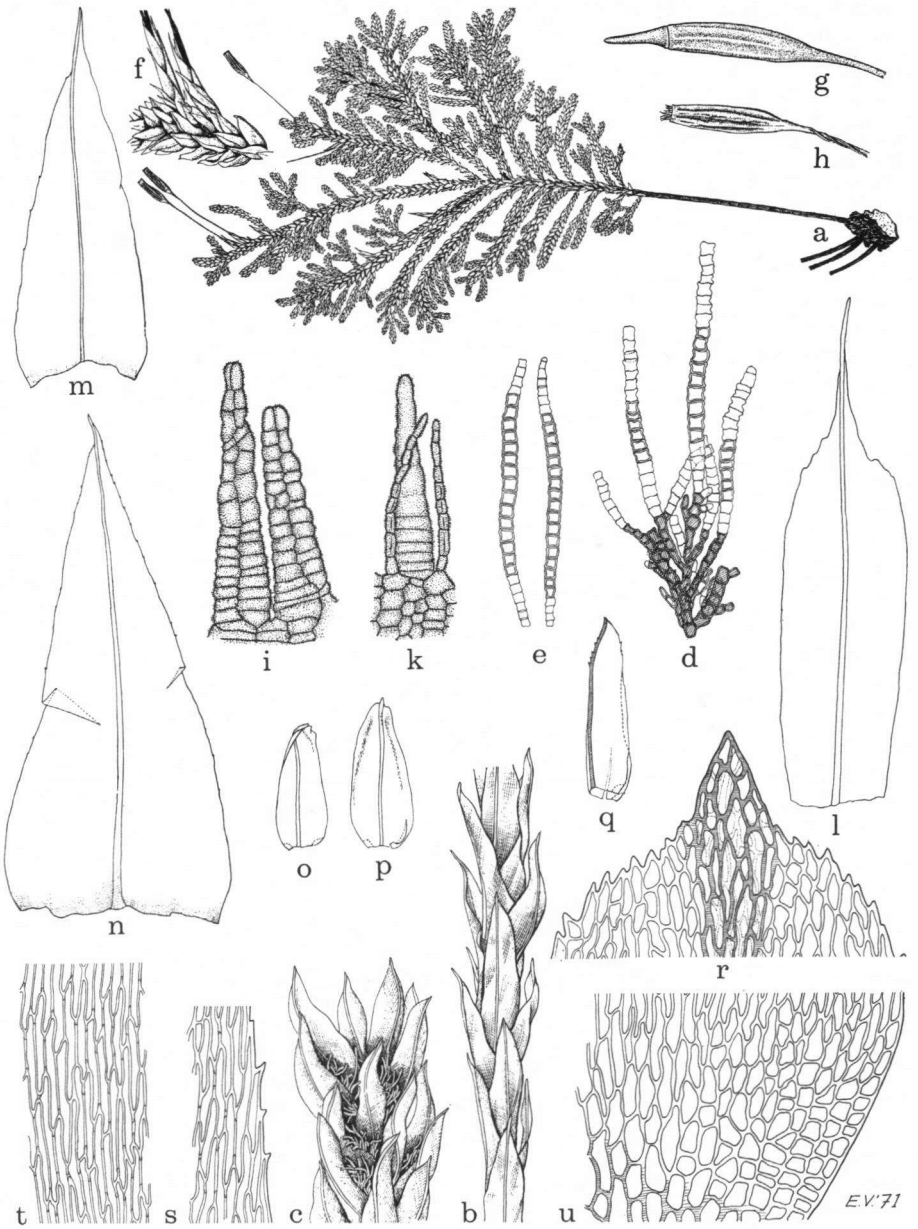

Fig. 42. *Braithwaitea sulcata*. — a. Habit, × 1; b: stipe, × 8; c: branchlet bearing gemmae, × 17; d, e: gemmae, × 95; f: branchlet bearing 2 perichaetia, × 4; g, h: capsules, × 4; i: exostome, × 95; k: endostome, × 95; l: perichaetial leaf, × 17; m, n: stipe leaves, × 17; o—q: branch leaves, × 17; r: apex of branch leaf, × 260; s: margin of branch leaf, × 260; t: areolation of branch leaf, × 260; u: alar cells of branch leaf, × 260. (a, b, f, o, p: *Watts 1770;* c—e: *Hartmann s.n.;* g: *Whitelegge 399;* h—k: *Watts s.n.;* l, n: *unknown coll. 6;* m, q: *Sainsbury s.n.;* r—u: *Travers s.n.*).

Syntypes: *W. W. Watts 549* (H lecto), Australia, North Queensland, Malanda, on trunks of trees; *W. W. Watts 605a* (not seen), North Queensland, Ravenshoe, on trunks of trees.

Plants medium-sized to tall, up to 12 (—17.5) cm long, projecting horizontally from the substrate, pale green to sordid green, often becoming reddish, brownish, or yellowish, glossy. *Stipe* up to 6.5 (—8) cm long, defoliate below. *Frond* ± ovate-oblong, up to 8 (—11) cm long, loosely to very densely pinnate to bipinnate, often irregular or bushy; apex of branches rounded. *Gemmae* filiform, up to 0.6 mm long, green to reddish, trabeculate, consisting of a single row of quadrate cells having moderately incrassate walls; basal and distal cells thin-walled. *Stipe leaves* 2.5—4.5 by 1.0—1.8 mm, L/W ratio 2.0—3.5, pale greenish; base weakly narrowed; apex acute to gradually long-acuminate; margin remotely and minutely crenulate to serrulate, near apex bearing somewhat stronger serratures; costa distinct to very faint; lamina cells 45—115 by 3.5—6 μ, L/W ratio *c.* 10—20; walls of basal cells mostly more strongly incrassate, porate, orange; alar cells quadrate to rectangular, usually thin-walled, forming a small elongate group. *Branch leaves* imbricate and often irregularly longitudinally undulate when dry, erecto-patent when moist, often clearly arranged in 8 rows, 1.5—2.0 by 0.6—0.9 mm, L/W ratio 2.0—2.5 (—2.8); base rounded; apex somewhat obtuse to truncate or emarginate; lamina cells 25—80 by 4.5—5 μ, L/W ratio *c.* 5—17.

Up to 12 (—20) *sporophytes* on each frond. Full-grown *female gametoecia* up to *c.* 4.5 mm long. *Vaginula* normal, covered by paraphyses and decrepit archegonia, not tomentose. *Seta* (0.7—) 1.0—1.5 (—1.8) cm long, straight or nearly so, orange to pale brownish, reddish, or dark brown. *Theca* cylindrical, (3.0—) 3.5—5.0 (—5.5) mm long, striate to angular or deeply sulcate, occasionally almost smooth, usually not constricted below the orifice, orange to brown. *Operculum c.* 0.9—2.0 mm long. *Calyptra c.* 3—4 mm long.

Distribution: New Caledonia, E. Australia, Lord Howe Island (?), New Zealand. Most frequently collected in S. Queensland and New South Wales. In New Zealand widespread but uncommon in the North Island, in the South Island very rare and confined to its northernmost part.

NEW CALEDONIA. Mt. Dogny: *Le Rat s.n.* (H, PC).

AUSTRALIA. Queensland. Malanda: *Watts 549* (H). Rockhampton: *Dietrich s.n.* (JE). Ranges between Burnett R. and Brisbane R.: *von Mueller s.n.* (NY). Condamine: *Hartmann 186* (MEL). Kingaroa SW. of Gympie: *unknown coll. 49.1* (CHR). Imbil: *Mitchell A 16* (Allison). Blackall Ra.: *Whitteron 37* (H), *188* (H). d'Aguilar Ra.: *unknown coll. 15* (BM). Ash Island: *Dietrich 458* (MEL); *Scott s.n.* (NY). Brisbane R.: *Dietrich s.n.* (BM, H, JE, MEL, NY, S-PA); *von Mueller s.n.* (BM, NY). Toowoomba: *Hartmann s.n.* (NY). Brisbane: *Bailey 21* (H, L, NY); *Shelton 239* (NICH). Enoggera: *unknown coll. MEL 34504* (MEL). Pimpama: *Wild s.n.* (CANTY, FH, MEL). Upper Logan R.: *unknown coll. MEL 34494* (MEL). Cunningham's Gap: *Hartmann 11* (MEL). Killarney, Brown's Falls: *Whitteron s.n.* (CANTY, FH, H, MEL, S-PA). Lamington Plateau: *Lyndon s.n.* (MEL). — New South Wales. Tweed R.: *Goldschmid 586* (H), *unknown coll. s.n.* (MEL). Mt. Warning: *Guilfoyle s.n.* (MEL). Brunswick R., Myocum: *Watts s.n.* (CANTY). Cape Byron: *Anderson s.n.* (NY). Whian Whian State Forest: *Doing M 123* (L). Richmond R.: 16 collections. Tintenbar: *Watts 354* (H, S-PA), *1770* (JE, W). Pierce's Creek: *Watts 288* (H), *950* (CANTY, FH, H). Clarence R.: *Beckler s.n.* (MEL); *Rudder s.n.* (NY); *Young 150* (BM). Blicks R.: *Perrot s.n.* (MEL, NY); *unknown coll. MEL 34500* (MEL). Bellinger R.: *Rudder s.n. p.p.* (MEL). Dorrigo: *Mitchell A 216* (Allison). McLeay R.: *Fitzgerald s.n.* (BM); *Rudder s.n. p.p.* (MEL); *Tozer s.n.* (BM, MEL). Manning R.: *Cross s.n.* (MEL). Paterson R., Lorryburn: *Lamont 51 p.p.* (BM). Williams R.: *Filson 11187* (MEL); *Lamont 51 p.p.* (BM). Hunter R.: *Carter s.n.* (W); *Rudder s.n.* (MEL). Port Jackson: *Brown s.n.* (BM). Cordeaux Dam: *Constable M 11040* (K, US). Mt. Cambewarra: *Forsyth 1082* (H, NY); *Thorpe 175* (MEL); *Whitelegge s.n.* (S-PA). Lilyvale: *Forsyth 886* (H); *Whitelegge 399* (H). — Victoria: *von Mueller s.n.* (BM). Dandenong Ra.: *unknown coll. s.n.* (W). Tarwin: *Manton s.n.* (MEL). Upper Ovens R.: *McCann s.n.* (NY).

LORD HOWE ISLAND: *unknown coll. MEL 34493* (MEL).

NEW ZEALAND. North Island: *Sinclair s.n.* (BM). North Auckland: *Matthews 243* (BM). Mangonui: *Matthews 18* (FH). Herekino: *Petrie 786 p.p.* (CANTY), *s.n.* (H). Waipoua: *Martin s.n.* (CHR). Great

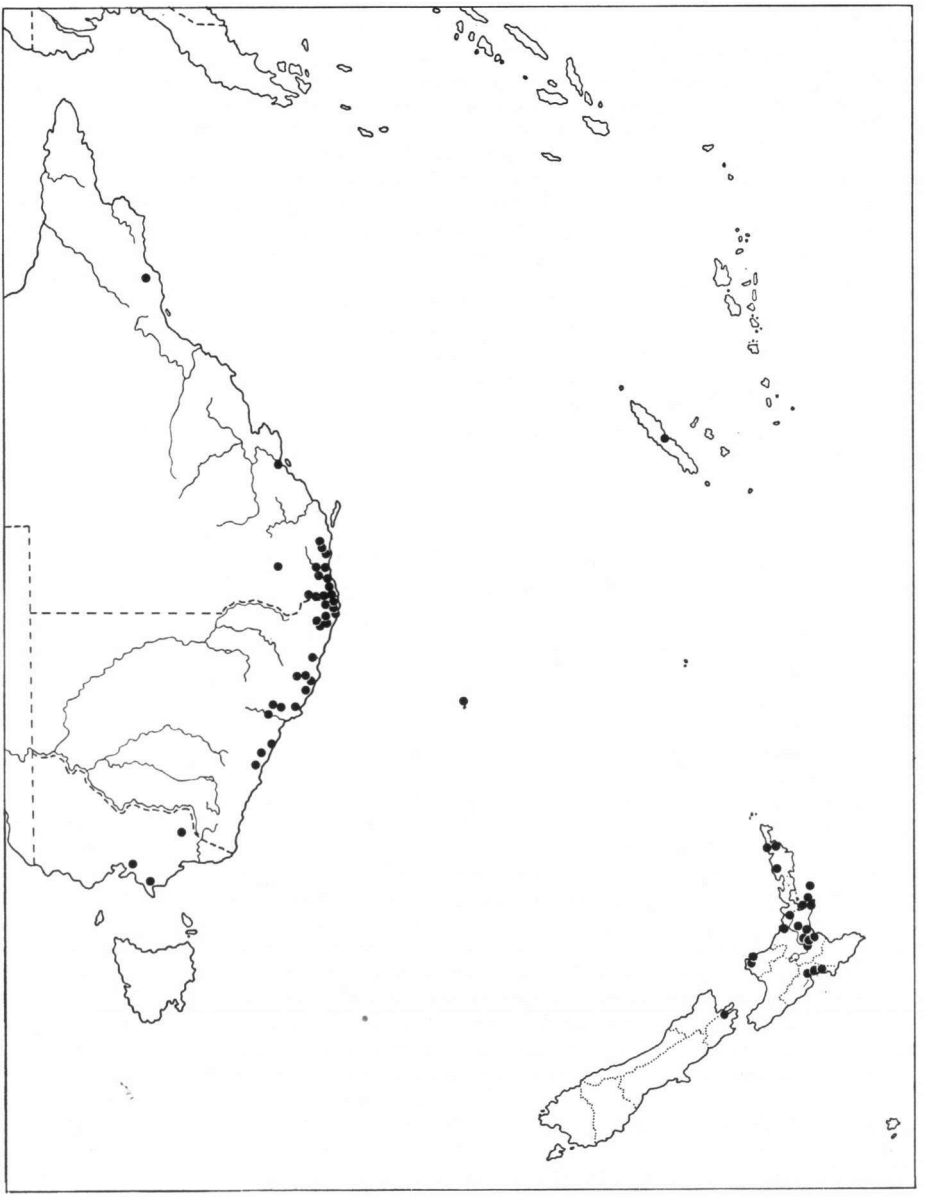

Fig. 43. Distribution of *Braithwaitea sulcata*.

Barrier I.: *Knight s.n.* (PC). Lower Waikato R.: *Hochstetter s.n.* (BM); *Petrie 786 p.p.* (CANTY); *unknown coll. 262* (NY), *s.n.* (S-PA). Coromandel: *Cheeseman 121* (CANTY); *Matthews 149* (Allison). Tokatea: *Zürm s.n.* (JE). Hunua: *Moore s.n.* (CHR); *Ashcroft s.n.* (Allison). Taotaoroa near Cambridge: *Sainsbury s.n.* (BM, L, NY, US, W). Maungatautari: *Moore 416* (CHR). Matamata: *Sainsbury s.n.* (PC). Tauranga: *Berggren 1588* (H, S-PA), *1591* (H, S-PA, W). Mt. Ngongotoha: *Allison 3370* (Allison). Lake Rotorua: *Berggren 1589* (S-PA), *1590* (H); *Heywood 52a* (BM). Puaiti Bush S. of Rotorua: *Allison 81* (Allison). Rotoehu Bush between Lake Rotoehu and Bay of Plenty: *Allison 2367* (Allison), *9764* (Allison). Taranaki: *Heywood 54* (BM), *86a* (BM). New Plymouth: *Gupp s.n.* (NY). Hawke's Bay, Wairoa, Makaretu Falls: *Hodgson 290* (NY). Tangoio: *Meebold 7* (JE), *8* (JE). Petane: *Hamilton s.n.* (CANTY). — South Island. Marlborough, Pelorus Valley: *Rutland 9* (CANTY).

Ecology: On tree-trunks and branches, occasionally on rocks; usually in rain forests, but apparently able to stand drier conditions than plants of *Hypnodendron*. The altitude of the collecting locality has been given on the labels of only 2 collections from Australia and 4 from New Zealand. They indicate that *Braithwaitea sulcata* is not restricted to altitudes below 300 m (as Martin, 1958, stated), but occurs in New Zealand up to 500 m at least. The sole specimen from New Caledonia was collected at 1050 m alt.

Notes: 1. The combination *Braithwaitea sulcata* has been erroneously attributed to Lindberg who created the genus but did not make the combination.

2. Several published illustrations appear to contain errors, or might otherwise lead to a misleading picture of the species. The plants illustrated by Hooker (1818) are more loosely branched than is normal, the perichaetial leaves are more strongly dentate than is usual, and the exostome teeth are shown as red instead of yellowish or colourless. Schwaegrichen's (1829) illustration based on the same collection gives a better picture, but here the capsule and the peristome are of a much darker colour than is usual. Brotherus' (1906B, 1924B) plate shows a very densely branched plant of which the brood filaments and the papillae on the leaf cells have been illustrated miserably. The so-called stipe leaf happens to be a leaf of the rhachis, and not a branch leaf, as Sainsbury (1955B) assumed. Sainsbury (1955B) has given a very rough and incorrect sketch of the leaf papillae.

3. Jaeger (1877) reported *Braithwaitea* from Tasmania. I have not seen any material from that island, nor did I find any other reports from Tasmania in the literature.

4. Plants bearing sporophytes are very common among the Australian collections, but are represented from only five New Zealand localities: Mangonui, Lower Waikato R., Coromandel, Hunua, and Rotoehu Bush. In New Zealand reproduction by spores appears to be largely replaced by vegetative reproduction, as most plants produced gemmae in abundance. The latter are usually absent or very scarce in Australian plants. Male plants are everywhere very rare.

5. The fronds of plants from Australia and New Zealand are of equal size, but the New Zealand plants often have slightly longer stipes.

INSUFFICIENTLY KNOWN SPECIES

Hypnodendron subarborescens C. Mueller (1889) 10; Paris (1895) 605, (1904) 375; Brotherus (1909C) 1169; Fleischer (1917) 34; Brotherus (1924B) 438. — *Hypnodendron arborescens* (Mitt.) Mitt. var. *minus* Thériot (1910) 7; Fleischer (1923) 1607; Schultze-Motel (1963) 442; van der Wijk et al. (1962) 532, (1969) 699. — Type: *W. Bäuerlen 354* (B holo †), New Guinea, Fly River (branch).

I have not been able to examine the type specimen of *H. subarborescens*, which was destroyed in Berlin, nor did I see the specimen mentioned by Geheeb (1898). Judging from the description it is just a small form of *H. subspininervium* ssp. *arborescens*, but the only collection bearing the name (*Kowald 1298*, New Guinea, det. C. Mueller) consists

of a mixture of dwarf plants of *H. fusco-mucronatum* ssp. *chalmersii*, *H. diversifolium*, *H. milnei* ssp. *parvum*, and *H. vitiense* ssp. *vitiense*.

Mniodendron nanum C. Mueller *ex* C. Mueller (1902) 133; C. Muell. *ex* Paris (1900) 250, *nom. nud.*; Brotherus (1909C) 1172. — *Hypnodendron nanum* C. Muell. *ex* Paris (1900) 192, *nom. nud.*; Fleischer (1917) 34. — Type: *L. Loria s.n.* (B holo †), New Guinea, Port Moresby, Moroko ('Mo-roka'), 1100 m.

Judging from the description near to or identical with *H. fusco-mucronatum*, though the leaf margin is described as being incrassate. Five Loria collections identified by Mueller bear this name, but none of these contains *H. fusco-mucronatum*: *Loria 747* consists of *H. milnei* ssp. *parvum*, *Loria 1599* is *H. subspininervium* ssp. *arborescens*, and *Loria 730*, *730B*, and *1600* are mixtures of poor specimens of *H. auricomum* ssp. *auricomum*, *H. dendroides*, *H. diversifolium*, *H. brevipes*, and *H. subspininervium* ssp. *arborescens*. The type might have been a mixture of *H. fusco-mucronatum* ssp. *chalmersii* and *H. milnei* ssp. *parvum*

EXCLUDED TAXA

Limbella (Broth.) Bartram (1933A) 131; Mueller (1896A) 466, *nom. nud*; Brotherus (1927) 23. — *Hypnodendron* Mitt. subg. *Limbella* Broth. (1909C) 1170, *pro parte*, (1924B) 438, *pro parte (Hypnum* Hedw. sect. *Limbella* C. Mueller (1889) 37, *pro parte, typo excluso)*. — Type species (for *Hypnodendron* subg. *Limbella:* lectotype species): *Neckera tricostata* Sull.

The name *Limbella* was introduced but not validly published by Mueller (1885) in the combination *Hypnum (Limbella) confluens n. sp.* He later validated and circumscribed *Hypnum* sect. *Limbella* in 1889. Among the species included at that date was *Hypnum conspissatum*, which was later chosen as a lectotype of *Sciaromium* Mitt. 1869. These two species and most other species Mueller included in sect. *Limbella* have been transferred by subsequent authors to *Sciaromium (Amblystegiaceae)*. However, some authors placed the Hawaiian species in the *Hypnodendraceae*, either under *Hypnodendron* (Brotherus 1909C, 1924B), or in a separate genus *Limbella* (Bartram 1933A). Presumably, only one variable species, *L. tricostata* (Sull.) Bartr., is involved here; it does not belong to the *Hypnodendraceae* but seems to be very close to *Pterobryella (Pterobryaceae)* and especially *P. rigida* (Mitt.) Touw (= *P. vagapensis* C. Muell.)

Hypnodendron intralimbatum Brotherus (1925) 531 ≡ *Limbella intralimbata* Cardot (1912) 176, *comb. inval.* = **Limbella tricostata** (Sull.) Bartr.

Hypnodendron leptolomaceum Brotherus (1909C) 1170 ≡ *Limbella leptolomacea* C. Mueller (1896A) 467, *comb. inval.* = **Limbella tricostata** (Sull.) Bartr., *fide* Bartram (1933A) 132.

Hypnodendron limbatulum Brotherus (1909C) 1170 ≡ *Limbella limbatula* C. Mueller (1896A) 466, *comb. inval.* = **Limbella tricostata** (Sull.) Bartr., *fide* Bartram (1933A) 132.

Hypnodendron naumannii (C. Muell.) Kindberg (1891) 99 ≡ *Hypnum naumannii* C. Mueller (1883) 83 = **Porothamnium arbusculans** (C. Muell.) Fleisch., *fide* Reimers (1926) 65 (type lost).

Hypnodendron obscurum (Col.) Gepp in Paris (1900) 192 ≡ *Isothecium obscurum* Colenso (1888) 241 = **Camptochaete angustata** (Mitt.) Reichdt, *fide* Dixon (1927) 274 (type not seen).

Hypnodendron praenitens (C. Muell.) Mitt. (1882A) 90 ≡ *Hypnum* (*Dendro-Hypnum*) *praenitens* Hampe (1874) 671, *nom. inval.* ≡ **Pterobryella praenitens** C. Mueller in Bescherelle (1878) 65.

Hypnodendron rigidum Mitten in Seemann (1873A) 401 ≡ **Pterobryella rigida** (Mitt.) Touw, *comb. nov.* Type: *G. Milne 366* (NY holo, PC), New Hebrides, Aneityum; abundant on trees. *Pterobryella vagapensis* C. Mueller in Bescherelle (1878) from New Caledonia is identical and has to be reduced to a synonym of *P. rigida.*

Hypnodendron savatieri Schimper in Bescherelle (1893) 370, *nom. nud. in syn.* = **Pleuroziopsis ruthenica** (Weinm.) Britt.

Hypnodendron speciosissimum (Sull.) Mitten in Seeman (1873A) 401 ≡ *Hypnum speciosissimum* Sullivant (1854) 75 ≡ **Pterobryella speciosissima** (Sull.) C. Mueller in Bescherelle (1878) 65.

Hypnodendron stipitatum (Mitt.) Jaeger in Jaeger et Sauerbeck (1880) 360 ≡ *Trachyloma stipitatum* Mitten (1864) 156 = **Porothamnium spec.**

Hypnodendron tricostatum (Sull.) Jaeger in Jaeger et Sauerbeck (1880) 360 ≡ *Neckera tricostata* Sullivant (1854) 81 ≡ **Limbella tricostata** (Sull.) Bartram (1933A) 132.

BIBLIOGRAPHY

ALLISON, K. W. 1931. Mosses and their habitats in the Atiamuri District, New Zealand. The Bryologist 34: 29—37.
ARNOTT, G. A. W. 1825. Disposition méthodique des espèces de mousses.
BARTRAM, E. B. 1931. Mosses of Raiatea. B. P. Bishop Mus. Occ. Pap. 9, 16: 1—14.
—— 1933A. Manual of Hawaiian mosses. B. P. Bishop Mus. Bull. 101: 1—275.
—— 1933B. Polynesian mosses. B. P. Bishop Mus. Occ. Pap. 10, 10: 1—28.
—— 1936A. Contributions to the mosses of Fiji. Ibid. 11, 20: 1—30.
—— 1936B. Bornean mosses, principally from Mount Kinabalu. Philip. J. Sc. 61: 235—251.
—— 1938. Mosses of the Solomon Islands. The Bryologist 41: 127—132.
—— 1939. Mosses of the Philippines. Philip. J. Sc. 68: 1—437.
—— 1942. Third Archbold Expedition mosses from the Snow Mountains, Netherlands New Guinea. Lloydia 5: 245—292.
—— 1945. Mosses of the Morobe District, Northeast New Guinea. The Bryologist 48: 110—126.
—— 1950. Mosses collected by Dr. John Eriksson during the Swedish 'Albatross Expedition 1947—48. Acta Horti Goteb. 18: 267—273.
—— 1953. Additional mosses from northeastern New Guinea. Svensk Bot. Tidskr. 47: 397—401.
—— 1956. Additional Fijian mosses. III. J. Wash. Acad. Sc. 46: 392—396.
—— 1957A. Mosses of eastern Papua, New Guinea. Brittonia 9: 32—56.
—— 1957B. Mosses of Upolu, western Samoa. B. P. Bishop Mus. Occ. Pap. 22: 15—30.
—— 1957C. Mosses collected during Dr. and Mrs. C. Skottsberg's second expedition to the Juan Fernandez Islands, December 1954 to March 1955. Ark. f. Bot. Ser. 2, 4, 3: 29—43.
—— 1959. Contribution to the mosses of the Highlands of eastern New Guinea. Brittonia 11: 86—98.
—— 1960A. Mosses of d'Entrecasteaux Group & Louisiade Archipelago, Papua, New Guinea. Blumea 12: 142—150.
—— 1960B. Additions to the moss flora of Netherlands New Guinea. Svensk Bot. Tidskr. 54: 483—487.
—— 1961. Low altitude mosses from northeastern New Guinea. Brittonia 13: 368—380.
—— 1962. Mosses of the Western Highlands of eastern New Guinea. Rev. Bryol. Lichénol. N.S. 30: 185—207.
—— 1965. Mosses of the Eastern Highlands, New Guinea, from the 6th Archbold Expedition, 1959. Contr. U.S. Nat. Herb. 37: 43—67.
BASTOW, R. A. 1887. Tasmanian mosses. Pap. Proc. Roy. Soc. Tasm. 1886: 38—102.
BESCHERELLE, E. 1873. Florule bryologique de la Nouvelle-Calédonie. Ann. Sc. Nat. Bot. Sér. 5, 18: 184—245.
—— 1878. Note sur trois nouvelles espèces de mousses de la Nouvelle-Calédonie appartenant au genre Pterobryella C. Müll. Bull. Soc. Bot. Fr. 25: 64—68.
—— 1893. Nouveaux documents pour la flore bryologique du Japon. Ann. Sc. Nat. Bot. Sér. 7, 17: 327—393.
—— 1894. Florule bryologique de Tahiti et des îles de Nukahiva et Mangareva. Ann. Sc. Nat. Bot. Sér 7, 20: 1—62.
—— 1898. Florule bryologique de Tahiti (supplément). Bull. Soc. Bot. Fr. 45: 52—67, 110—128.
—— 1901. Deuxième supplément à la flore bryologique de Tahiti. Ibid. 48: 11—17.
BRIDEL, S. E. 1803. Muscologia recentiorum, 2 (3).
—— 1812. Muscologia recentiorum supplementum, 2.
—— 1819. Id., 4 (Mantissa Muscorum).
—— 1827. Bryologia universa, 2.
BROTHERUS, V. F. 1892. Musci in: O. WARBURG, Bergpflanzen aus Kaiser Wilhelms-Land, gesammelt auf der Zöller'schen Expedition im Finisterregebirge von F. Hellwig. Engl. Bot. Jahrb. 16: 1—32.
—— 1898. Some new species of Australian mosses. IV. Oefv. Finsk. Vet. Soc. Foerh. 40: 159—193.
—— 1899A. Id. V. Ibid. 42: 91—128.
—— 1899B. in: ANONYMUS, Flora of British New Guinea. Bull. Misc. Inf. Kew 1899: 95—126.
—— 1901. Musci in: K. SCHUMANN & K. LAUTERBACH, Die Flora der Deutschen Schutzgebiete in der Südsee: 79—104.
—— 1905. Contributions to the bryological flora of the Philippines. Oefv. Finsk. Vet.-Soc. Foerh. 47, 14: 1—12.
—— 1906A. Contributions à la flore bryologique de la Nouvelle Calédonie. I. Ibid. 48, 15: 1—20.
—— 1906B. Bryales in: A. ENGLER & K. PRANTL, Die natürlichen Pflanzenfamilien. Ed. 1, T. 1, Abt. 3, H. 1, II: 776—777.
—— 1907. Musci Halconenses. Philip. J. Sc. 2, Sect. C, Bot.: 339—343.

—— 1908A. Contributions to the bryological flora of the Philippines. II. Ibid. 3: 11—30.
—— 1908B. Musci in: K. RECHINGER, Botanische und Zoologische Ergebnisse einer wissenschaftlichen Forschungsreise nach den Samoa-Inseln, dem Neuguinea-Archipel und den Salomonsinseln. Denkschr. Math.-Nat. Kl. Kais. Akad. Wiss. Wien 84: 387—400.
—— 1909A. Musci in: C. CHILTON, The subantarctic islands of New Zealand. 2: 535—538.
—— 1909B. Contribution à la flore bryologique de la Nouvelle Calédonie. (II). Oefv. Finsk. Vet.-Soc. Foerh. 51, A, 17: 1—31.
—— 1909C. Bryales in: A. ENGLER & K. PRANTL, Die natürlichen Pflanzenfamilien. Ed. 1, T. 1, Abt. 3, H. 1, II: 1166—1172, 1224.
—— 1910. Contributions to the bryological flora of the Philippines. III. Philip. J. Sc. 5, Sect. C., Bot.: 137—162.
—— 1911. Contribution à la flore bryologique de la Nouvelle Calédonie. III. Oefv. Finsk. Vet.-Soc. Foerh. 53, A, 11: 1—42.
—— 1913A. Contributions to the bryological flora of the Philippines. IV. Philip. J. Sc. 8, Sect. C, Bot.: 65—98.
—— 1913B. Musci novi Philippinenses. II. Leafl. Philip. Bot. 6: 1973—1979.
—— 1918. Contributions to the bryological flora of the Philippines. (V). Philip. J. Sc. 13, Sect. C, Bot.: 201—222.
—— 1924A. The Musci of the Juan Fernandez Islands, in: C. SKOTTSBERG, The Natural History of Juan Fernandez and Easter Island. 2: 409—448.
—— 1924B. Bryales in: A. ENGLER & K. PRANTL, Die natürlichen Pflanzenfamilien. Ed. 2, Bd. 10.
—— 1925. Ibid., Bd. 11.
—— 1926. Contributions to the bryological flora of the Philippines. VI. Philip. J. Sc. 31: 277—300.
—— 1927. Hawaiian mosses. B. P. Bishop Mus. Bull. 40: 1—37.
—— 1928. Musci in: E. IRMSCHER, Beiträge zur Kenntnis der Flora von Borneo. Mitt. Inst. Allg. Bot. Hamburg 7: 115—140.
—— & W. W. WATTS. 1915. The mosses of the New Hebrides. J. Proc. Roy. Soc. New South Wales 49: 127—157.
—— & —— 1918. The mosses of North Queensland. Proc. Linn. Soc. New South Wales 43: 544—567.
BRUCH, PH., W. PH. SCHIMPER & TH. GUEMBEL. 1842. Bryologia Europaea 5, fasc. 16: 25—30.
BUCHANAN, J. 1874. Notes on the flora of the province of Wellington, with a list of plants collected therein. Trans. Proc. New Zeal. Inst. 6: 210—235.
BURGES, A. 1935. Notes on the mosses of New South Wales. II. Additional records. Proc. Linn. Soc. New South Wales 60: 83—93.
—— & R. D. JOHNSTON. 1953. The structure of a New South Wales subtropical rain forest. J. of Ecol. 41: 72—83.
CARDOT, J. 1897. Contribution à la flore bryologique de Java. Mousses récoltées par M. J. Massart. Ann. Jard. Bot. Buitenzorg, Suppl. 1: 1—31.
—— 1901. Note sur deux collections de Mousses de l'Archipel Indien. Rev. Bryol. 28: 112—118.
—— 1906. Mousses de l'île Formose. Beih. Bot. Centralbl. 19, 2: 85—148.
—— 1912. Musci in: B. P. G. HOCHREUTINER, Plantae Hochreutineranae. Ann. Cons. Jard. Bot. Genève 15—16: 157—177.
COCKAYNE, L. 1921. The vegetation of New Zealand. Die Vegetation der Erde, XIV.
COLENSO, W. 1888. On new indigenous cryptogams, of the orders Lycopodiaceae, Musci, and Hepaticae. Trans. Proc. New Zeal. Inst. 20: 234—254.
CRUM, H. 1960. A small collection of West Javanese mosses. The Bryologist 62: 188—190.
DIXON, H. N. 1912. On some mosses of New Zealand. J. Linn. Soc. Bot. 40: 433—459.
—— 1922. The mosses of the Wollaston Expedition to Dutch New Guinea, 1912—13; with some additional mosses from British New Guinea. Ibid. 45: 477—510.
—— 1926. A list of mosses of the Malay Peninsula. Gard. Bull. Straits Settl. 4: 1—46.
—— 1927. Studies in the Bryology of New Zealand, with special reference to the herbarium of Robert Brown. V. New Zeal. Inst. Bull. 3: 239—298.
—— 1929. Id. VI. Ibid. 3: 299—372.
—— 1932A. Contributions to the moss flora of Sumatra. Ann. Bryol. 5: 17—50.
—— 1932B. Classification of mosses, in: F. VERDOORN, Manual of Bryology: 397—412.
—— 1933. On the moss flora of Siam. J. Siam. Soc. Nat. Hist. Suppl. 9: 1—51.
—— 1934A. Mosses of Celebes. Ann. Bryol. 7: 19—36.
—— 1934B. Musci in: C. G. G. J. VAN STEENIS, On the origin of the Malaysian mountain flora. 1. Bull. Jard. Bot. Buitenzorg Ser. 3, 13: 135—262.
—— 1935A. A contribution to the moss flora of Borneo. J. Linn. Soc. Bot. 50: 57—140.
—— 1935B. Further contributions to the moss flora of Siam. J. Siam Soc. Nat. Hist. Suppl. 10: 1—30.

—— 1938. On a small collection of mosses from New Guinea, with a revision of the genus Spiridens by W. R. Sherrin. Ann. Bryol. 10: 16—19.
—— 1939. High alpine mosses from Sumatra. Ann. Bryol. 12: 48—56.
—— 1941. New and rare Bornean mosses. J. of Bot. 79: 57—62.
—— 1942A. Papuan mosses. Ibid. 80: 1—11.
—— 1942B. Additions to the mosses of North Queensland. Proc. Roy. Soc. Queensland 53: 23—40.
—— 1943A. Alpine mosses from New Guinea. Farlowia 1: 25—40.
—— 1943B. War zone mosses. The Bryologist 46: 14—22.
—— 1944. A note on the phytogeographical relations of Sumatran and other alpine mosses. Proc. Linn. Soc. London 156: 91—94.
—— & E. B. Bartram. 1937. S. Berggren's New Zealand mosses. Bot. Not. 1937: 63—84.
—— & W. Greenwood. 1930. The mosses of Fiji. Proc. Linn. Soc. New South Wales 55: 261—302.
Dusén, P. 1903A. The vegetation of western Patagonia. Rep. Princeton Univ. Exp. Patag. 1896—1899. 8, 1: 1—33.
—— 1903B. Patagonian and Fuegian mosses. Ibid.: 63—125.
Erdtman, G. 1965. An introduction to Palynology. III. Pollen and spore morphology/plant taxonomy. Gymnospermae, Bryophyta.
Fleischer, M. 1906. Die Musci der Flora von Buitenzorg (zugleich Laubmoosflora von Java). Flore de Buitenzorg. V, 3.
—— 1912. Laubmoose in: Résultats de l'expédition scientifique néerlandaise à la Nouvelle-Guinée en 1907 et 1909. Nova Guinea 8, Bot.: 735—753.
—— 1914. Laubmoose in: Résultats de l'expédition scientifique néerlandaise à la Nouvelle-Guinée. Ibid. 12, Bot.: 109—128.
—— 1917. Die Laubmoose Papuasiens. I. Engl. Bot. Jahrb. 55: 19—37.
—— 1920. Natürliches System der Laubmoose. Hedwigia 61: 390—400.
—— 1923. Die Musci der Flora von Buitenzorg (zugleich Laubmoosflora von Java). Flore de Buitenzorg. V, 4.
Froehlich, J. 1953. Die von Prof. Dr. Viktor Schiffner in den Jahren 1893/94 in Ceylon, Penang, Singapore, Sumatra und Java gesammelten Laub- und Torfmoose. Ann. Naturh. Mus. Wien 59: 66—116.
—— 1955. Die von Prof. F. Ruttner 1928/29 auf Bali, Java und Sumatra gesammelten Musci. Arch. f. Hydrobiol. Suppl. 21: 299—342.
Geheeb, A. 1876. Sur une petite collection de mousses d'Australie récoltées par un amateur. Rev. Bryol. 3: 2—4.
—— 1877. Sur quelques nouvelles espèces de mousses antarctiques. Rev. Bryol. 4: 52—53.
—— 1886. Bryologische Fragmente. III. Flora 69: 339—353.
—— 1889. Neue Beiträge zur Moosflora von Neu-Guinea. Bibl. Bot. 13: 1—13.
—— 1894. Musci frondosi in monte Pangerango insulae Javae a Dr. O. Beccari annis 1872 et 1874 lecti. Rev. Bryol. 21: 81—85.
—— 1898. Weitere Beiträge zur Moosflora von Neu-Guinea. Bibl. Bot. 44: 1—29.
Gepp, A. 1908. Bryophyta in: H. N. Ridley, On a collection of plants made by H. C. Robinson and L. Wray from Gunong Tahan, Pahang. J. Linn. Soc. Bot. 38: 335—336.
—— 1917. Bryophyta in: L. S. Gibbs, A contribution to the phytogeography and flora of the Arfak Mountains, etc.: 65—67.
Giesenhagen, K. 1910. Die Moostypen der Regenwälder. Ann. Jard. Bot. Buitenzorg, Suppl. 3, 2: 711—789.
Hampe, E. 1852. Sendschreiben an den Herrn Dr. Karl Müller, Verfasser der Synopsis muscorum frondosorum. Bot. Zeit. 10: 65—73.
—— 1856. Musci frondosi in Australasia felici lecti. (Continuatio). Linnaea 28: 203—215.
—— 1867. Bryologische Mitteilungen aus dem Herbarium. Flora 50: 65—80.
—— 1871. Das Moosbild. Verh. K. K. Zool.-Bot. Ges. Wien 21: 375—398.
—— 1872. Musci frondosi in insulis Ceylon et Borneo a Dr. Od. Beccari lecti. Nov. Giorn. Bot. Ital. 4: 273—291.
—— 1874. Species muscorum novas ex Herbario Melbourneo Australiae. Linnaea 38: 661—672.
—— 1880. Musci frondosi australiae continentalis, praesertim e baronis de Mueller collectionibus, in: F. von Mueller, Fragm. Phyt. Austr. 11, Suppl. 3: 45—52.
—— & A. Geheeb. 1881. Musci frondosi in Tasmania et Nova-Seelandia a Dr. O. Beccari, anno 1878, lecti. Rev. Bryol. 8: 25—28.
Hedwig, J. 1801. Species muscorum.
Herzog, Th. 1910. Laubmoose aus Deutsch-Neu-Guinea und Buru. Hedwigia 49: 119—127.
—— 1916. Neue Laubmoose aus Ostasien und Südamerika. Ibid. 57: 233—250.
—— 1919. Die Laubmoose der II. Freiburger Molukkenexpedition. Ibid. 61: 286—299.

—— 1923. Beiträge zur Bryophytenflora Chiles. Hedwigia 64: 1—18.
—— 1926A. Bryophyten der weiteren Indomalaya. Hedwigia 66: 337—357.
—— 1926B. Geographie der Moose.
—— 1938. Contribucion al conocimiento de la flora Briofita del Sur de Chile. Parte Sistematico. Arch. Esc. Farmac. Fac. Cienc. Med. Córdoba (R.A.), secc. cient. 7: 1—56.
—— 1939. Zur Bryophytenflora Südchiles. I. Verzeichnis der gesammelten Bryophyten. Beih. Bot. Centralbl. Abt. B, 60: 1—35.
—— 1954. Zur Bryophytenflora Chiles. Rev. Bryol. Lichénol. N.S. 23: 27—99.
—— 1960. Weitere Beiträge zur Bryophytenflora von Chile. Ibid. 29: 183—206.
HOLTTUM, R. E. 1927. A list of mosses collected in the Botanic Gardens, Singapore. Gard. Bull. Straits Settl. 4: 88—92.
HOOKER, J. D. 1867. Handbook of the New Zealand Flora.
—— & W. WILSON. 1844. Musci antarctici. Hook. Lond. J. Bot. 3: 533—556.
HOOKER, W. J. 1818—1820. Musci Exotici.
HORIKAWA, Y. 1939. Contributions to the bryological flora of Eastern Asia. J. Jap. Bot. 15: 359—368.
JAEGER, A., & F. SAUERBECK. 1876. Genera et species muscorum systematice disposita seu adumbratio florae muscorum. VI. Ber. Thät. St. Gall. Naturw. Ges. 1874/75: 85—188.
—— 1877. Id. VIII. Ibid. 1876/77: 211—454.
—— 1880. Id. IX. Ibid. 1877/78: 257—514.
JOVET-AST, S., & M. SCHMID. 1958. Bryophytes du Haut-Donnaï et du Darlac (Viet-nam). Rev. Bryol. Lichénol. N.S. 27: 195—200.
JUEL, H. O. 1918. Plantae Thunbergianae.
JUNGHUHN, F. 1840. Nova genera et species plantarum florae Javanicae. Tijdschr. Nat. Gesch. Phys. 7: 285—317.
KINDBERG, N. C. 1888. Enumeratio Bryinarum exoticarum quam alphabetice disposuit.
—— 1898. Studien über die Systematik der pleurokarpischen Laubmoose. Bot. Centralbl. 76: 83—87.
—— 1899. Ibid. 77: 385—395.
KOPONEN, T. 1968. Generic revision of Mniaceae Mitt. (Bryophyta). Ann. Bot. Fenn. 5: 117—151.
KREULEN, D. J. W. (in print). Spore output of moss capsules in relation to ontogeny of archesporial tissue. Trans. Brit. Bryol. Soc.
LABILLARDIÈRE, J.-J. H. 1807. Novae Hollandiae plantarum specimen. 2.
LESLIE, J. R. 1925. Mosses of Wilson's Promontory. Vict. Nat. 42: 116—117.
LINDBERG, S. O. 1861. Om en ny art af slägtet Hypnum. Oefv. K. Vet. Akad. Foerh. 18: 371—375.
—— 1866. Hypnodendron, Mniodendron in: F. DOZY & J. H. MOLKENBOER, Bryologia Javanica. 2: 132—140.
—— 1872. Contributio ad floram cryptogamam Asiae Boreali-Orientalis Acta Soc. Sc. Fenn. 10: 221—280.
LINDSAY, W. L. 1866. On new and rare cryptogams from Otago, New Zealand. Trans. Bot. Soc. Edinburgh 8: 280—284.
LINNAEUS, C. VON. 1783. Methodus muscorum illustrata. Acta Med. Suec. 1: 153—204.
LÖVE, A. 1967. IOPB Chromosome number reports. XIV. Taxon 16: 552—571.
MARGADANT, W. D. 1968. Early bryological literature.
MARTIN, W. 1946A. The moss flora of the Arthur Pass National Park. Trans. Roy. Soc. New Zeal. 76: 37—57.
—— 1946B. Geographic range and internal distribution of the mosses indigenous in New Zealand. Ibid. 76: 162—184.
—— 1950. The bryophytes of Stewart Island. Part 2. Ibid. 78: 485—501.
—— 1952. Distribution of the mosses indigenous to New Zealand. Suppl. 2. Ibid. 80: 197—205.
—— 1958. Survey of moss distribution in New Zealand. The Bryologist 61: 105—115.
MEIJER, W. 1954A. Collecting bryophytes in Borneo. The Bryologist 57: 261—272.
—— 1954B. Bryologische brieven uit Indonesië. III. Buxbaumia 8: 10—20.
MERRILL, E. D. 1915. Genera and species erroneously credited to the Philippine flora. Philip. J. Sc. 10, Sect. C, Bot.: 171—194.
MEUSEL, H. 1935. Wuchsformen und Wuchstypen der europäischen Laubmoose. Nova Acta Leop. N.S. 3: 123—277.
MITTEN, W. 1856. A list of the Musci and Hepaticae collected in Victoria, Australia, by Dr. F. Mueller. Hook. J. Bot. 8: 257—266.
—— 1859A. Musci Indiae Orientalis. J. Proc. Linn. Soc. Bot. Suppl. 1: 1—171.
—— 1859B. Description of some new species of Musci from New Zealand and other parts of the Southern Hemisphere, together with an enumeration of the species collected in Tasmania by William Archer, Esq. J. Proc. Linn. Soc. Lond. 4: 64—100.
—— 1861. Musci et Hepaticae Vitienses. Bonplandia 9: 365—367.

—— 1864. On the Musci and Hepaticae from the Cameroons Mountain and from the River Niger. J. Proc. Linn. Soc. Bot. 7: 147—169.
—— 1868. A list of the Musci collected by the Rev. Thomas Powell in the Samoa or Navigator's Islands. J. Linn. Soc. Bot. 10: 166—195.
—— 1869. Musci Austro-Americani. Ibid. 12: 1—659.
—— 1873A. Musci in: B. SEEMANN, Flora Vitiensis: 378—404.
—— 1873B. New species of Musci collected in Ceylon by Dr. Thwaites. J. Linn. Soc. Bot. 13: 293—326.
—— 1882A. Australian mosses. Trans. Proc. Roy. Soc. Victoria 19: 49—96.
—— 1882B. Record of new localities of Polynesian mosses, with descriptions of some hitherto undefined species. Proc. Linn. Soc. New South Wales 7: 98—104.
—— 1891. An enumeration of all the species of Musci and Hepaticae recorded from Japan. Trans. Linn. Soc. Lond. Ser. 2, 3, Bot.: 153—206.
—— & C. H. WRIGHT. 1894. Muscineae in: O STAPF, On the flora of Mount Kinabalu in North Borneo. Ibid. 4: 255—261.
MÖLLER, H. 1919. Beiträge zur Moosflora Javas, Straits Settlements und Birmas. Hedwigia 60: 313—330.
MONTAGNE, C. 1845. Plantes cellulaires in: J. DUMONT D'URVILLE, Voyage au Pôle Sud et dans l'Océanie sur les corvettes l'Astrolabe et la Zelée, Bot. 1.
—— 1848. Sixième centurie de plantes cellulaires exotiques nouvelles. Ann. Sc. Nat. Bot. Ser. 3, 10: 106—136.
MORITZI, A. 1846. Systematisches Verzeichniss der von H. Zollinger in den Jahren 1842—44 auf Java gesammelten Pflanzen.
MUELLER, C. 1847. De muscis nonnullis novis vel minus cognitis exoticis. Bot. Zeit. 5: 801—806.
—— 1850/1851A. Synopsis Muscorum Frondosorum. 2.
—— 1851B. Die von Samuel Mossman im Jahre 1850 in Van Diemen's Land, Neuseeland und Neuholland gemachte Laubmoossammlung. Bot. Zeit. 9: 545—552, 561—567.
—— 1857. Decas Muscorum Oceani Pacifici. Ibid. 15: 777—782.
—— 1862. Additamenta ad Synopsis Muscorum nova. Ibid. 20: 392—393.
—— 1864. Manipulus muscorum novorum. Ibid. 22: 373.
—— 1868. Beitrag zur ostaustralischen Moosflora. Linnaea 35: 613—626.
—— 1872. Musci Australici praesertim Brisbanici novi. Ibid. 37: 143—160.
—— 1874A. Musci polynesiaci praesertim Vitiani et Samoani Graeffeani. J. Mus. Godeffroy 3, 6: 51—90.
—— 1874B. Novitates Bryothecae Müllerianae. Linnaea 38: 545—620.
—— 1883. Die auf der Expedition S.M.S. „Gazelle" von Dr. Naumann gesammelten Laubmoose. Engl. Bot. Jahrb. 5: 76—88.
—— 1885. Bryologia Fuegiana. Flora 68: 391—429.
—— 1896A. Bryologia Hawaiica adjectis muscis novis oceanicis. Ibid. 82: 434—479.
—— 1896B. Musci in: F. REINECKE, Die Flora der Samoa-Inseln. Engl. Bot. Jahrb. 23: 317—332.
—— 1897. Prodromus Bryologiae Argentinicae atque regionum vicinarum. III. Hedwigia 36: 84—144.
—— 1898. Symbolae ad Bryologiam Australiae. II. Hedwigia 37: 76—171.
—— 1902. Id. III. Ibid. 41: 119—134.
—— & V. F. BROTHERUS. 1900. Musci Schauinslandiani. Abh. Nat. Ver. Bremen 16: 493—512.
—— & E. HAMPE. 1855. Musci frondosi Australasiae ab Dre. Ferd. Müller lecti. Linnaea 26: 489—505.
MURRAY, J. 1963. Vegetation studies on Secretary Island, Fiordland. Part 7. Bryophytes and Lichens. New Zeal. J. Bot. 1: 221—235.
NADEAUD, J. 1873. Énumération des plantes indigènes de l'île de Tahiti recueillies et classées par le Docteur J. Nadeaud, ancien chirurgien de la Marine.
NELMES, E., & W. CUTHBERTON. 1931. Curtis's Botanical Magazine Dedications 1827—1927.
NOGUCHI, A. 1953. Mosses of Mt. Sarawaket, New Guinea. J. Hattori Bot. Lab. 10: 1—23.
—— 1963. A collection of mosses from the Philippines. Sc. Rep. Tôhoku Univ. Ser. 4, Biol. 29: 145—151.
PALISOT DE BEAUVOIS, A. M. F. J. 1805. Prodrome des cinquième et sixième familles de l'Aethiogamie. Les Mousses. Les Lycopodes.
PARIS, E. G. 1894—1898. Index Bryologicus.
—— 1900. Id., Supplementum primum.
—— 1903—1905. Id., Ed. 2.
—— 1909. Collatio nominum Brotherianorum et Indicis Bryologici.
—— 1910. Florule bryologique et hépaticologique de l'île des Pins (Kunié). Rev. Bryol. 37: 34—42.
PILOUS, Z. 1959. Contribution to the mosses of the Philippines. Preslia 31: 247—250.
Pócs, T. 1965. Prodrome de la bryoflore du Vietnam. Egri Tanárk. Föisk. Füz. 371: 453—495.
POTIER DE LA VARDE, R. 1923. Muscinées annamites récoltées par M. Poilane. Bull. Mus. Nat. Hist. Nat. 29: 397—404.

REICHARDT, H. W. 1870. Fungi, Hepaticae et Musci frondosi in: E. FENZL, Reise der Österreichischen Fregatte Novara um die Erde. Bot. Theil. 1: 131—196.
REIMERS, H. 1926. Beiträge zur Bryophytenflora Südamerikas. I. Hedwigia 66: 27—75.
REINWARDT, C. G. C. & C. F. HORNSCHUCH. 1829. Musci frondosi Javanici. Nova Acta Phys. Med. Acad. Caes. Leop.-Carol. 14, 2: 697—732.
RENAULD, F., & J. CARDOT. 1896. Mousses récoltées à Java par M. J. Massart. Rev. Bryol. 23: 96—108.
RICHARD, A. 1832. Essai d'une flore de la Nouvelle-Zélande, in: J. DUMONT D'URVILLE, Voyage de découvertes de l'Astrolabe, 2. Bot.: 1—155.
ROBINSON, C. B. 1914. The geographic distribution of Philippine mosses. Philip. J. Sc. Ser. C, Bot. 9: 199—218.
RODWAY, L. 1914. Tasmanian Bryophyta. III. Ann. Rep. Roy. Soc. Tasmania 1913: 177—263.
SAINSBURY, G. O. K. 1945. New and critical species of New Zealand mosses. Trans. Roy. Soc. New Zeal. 75: 169—186.
—— 1955A. Notes on Tasmanian mosses from Rodway's herbarium. VI. Pap. Proc. Roy. Soc. Tasmania 89: 45—53.
—— 1955B. A Handbook of the New Zealand mosses. Roy. Soc. New Zeal. Bull. 5: 1—490.
—— & K. W. ALLISON. 1962. Mosses from the Auckland Islands and Campbell Island. Rec. Dom. Mus. 4: 133—142.
ST. JOHN, H. 1940. Itinerary of Hugh Cuming in Polynesia. B. P. Bishop Mus. Occ. Pap. 16: 81—90.
SANDE LACOSTE, C. M. VAN DER, 1867. Musci frondosi in: F. A. W. MIQUEL, Prolusio florae Japonicae. Ann. Mus. Bot. Lugd.-Bat. 2: 292—300.
—— 1884. Musci frondosi in: P. J. VETH, Midden Sumatra, IV, II, 13: 40—42.
SCHULTZE-MOTEL, W. 1963. Vorläufiges Verzeichnis der Laubmoose von Neuguinea. Willdenowia 3: 399—549.
SCHUMANN, K., & K. LAUTERBACH. 1905. Nachträge zur Flora der Deutschen Schutzgebiete in der Südsee.
SCHWABE, G. H. & E. 1939. Zur Bryophytenflora Südchiles. II. Zur Ökologie südchilenischer Moose. Beih. Bot. Centralbl. Abt. B, 60: 36—51.
SCHWAEGRICHEN, C. F. 1816. Species muscorum supplementum 1, 2.
—— 1828. Ibid. 3, 1.
—— 1829. Ibid. 3, 2.
SCOTT, G. A. M. 1970. Vegetation studies on Secretary Island, Fiordland. Part 11. Epiphytic and ground cryptogamic vegetation on the northern slopes. New Zeal. J. Bot. 8: 30—50.
SEIFRIZ, W. 1924. The altitudinal distribution of lichens and mosses on Mt Gedeh, Java. J. of Ecol. 12: 307—313.
SHIN, T. 1965. A small collection of mosses from Isl. Batan, the Philippines. Hikobia 4: 263—271.
STEENIS-KRUSEMAN, M. J. VAN, 1950. Malaysian plant collectors and collections. Flora Malesiana I, 1.
SULLIVANT, W. S. 1854. Notices on some new species of mosses. I. Proc. Amer. Acad. Arts Sc. 3: 73—81.
—— 1855. II. Ibid. 3: 181—185.
SWARTZ, O. 1781. Methodus muscorum illustrata.
TADGELL, A. J. 1924. Mount Bogong and its flora. Vict. Nat. 41: 56—80.
THÉRIOT, I. 1922A. Musci in: A. B. RENDLE et al., A systematic account of the plants collected in New Caledonia and in the Isle of Pines by Prof. R. H. Compton. II. J. Linn. Soc. Bot. 45: 462—466.
—— 1922B. Mousses de l'Annam. 2e contribution. Rev. Bryol. 49: 6—9.
—— 1931. Id. 4e contribution. Ibid. N.S. 4: 135—137.
—— 1937. Sur une collection de mousses des Nouvelles-Hébrides. Ibid. N.S. 10: 128—135.
TIXIER, P. 1969A. Bryophytae Indosinicae. Rev. Bryol. Lichénol. N.S. 36: 292—296.
—— 1969B. Bryophytae Neocaledonicae a M. Schmid lectae. Ibid. 36: 297—299.
USTERI, A. 1906. Beiträge zur Kenntnis der Philippinen und ihrer Vegetation, mit Ausblicken auf Nachbargebiete. Viert. Nat. Ges. Zürich 50: 321—488.
WANG, C. K. 1960. An enumeration of all the species of Musci recorded from Taiwan, with some species recently known from this area. Biol. Bull. Tunghai Univ. 3: 1—38.
—— 1967. Mosses recently found in Formosa. Ibid. 28: 1—30.
WEBER, F., & D. M. H. MOHR. 1803. Index musei plantarum cryptogamarum.
WIJK, R. VAN DER, & W. D. MARGADANT. 1959A. New combinations in mosses. II. Taxon 8: 70—75.
——, —— & P. A. FLORSCHÜTZ. 1959B—1969. Index Muscorum. Regnum Vegetabile 17 (A—C), 26 (D—Hypno), 33 (Hypnum—O), 48 (P—S), 65 (T—Z, Appendix).
WILLIAMS, R. S. 1914. Philippine mosses. Bull. New York Bot. Gard. 8, 31: 331—378.
WILSON, W. 1854. Musci in: J. D. HOOKER, The botany of the antarctic voyage. II. Flora Nova-Zelandiae: 57—125.
—— 1859. Id. III. Flora Tasmaniae: 160—221.

—— & J. D. HOOKER. 1845. Musci in: J. D. HOOKER, The botany of the antarctic voyage. I. Flora Antarctica: 117—143.
ZANTEN, B. O. VAN, 1964. Mosses of the Star Mountains Expedition. Nova Guinea Bot. 16: 263—368.
—— 1968. Mosses of the Danish Noona Dan Expedition to the Philippines, Bismarck Archipelago and the British Solomon Islands. J. Hattori Bot. Lab. 31: 135—151.
ZOLLINGER, H. 1854. Systematisches Verzeichnis.

INDEX TO SPECIES AND INFRASPECIFIC TAXA

Accepted names are in plain type, synonyms, misinterpretations, and misidentifications in *italics*, new names and combinations in **bold type.** Numbers refer to the number of the accepted genus, species, and subspecies or variety. Insuff. = Insufficiently known species. Excl. = Excluded species.