

A Taxonomic Revision of the
Moss Families Hookeriaceae and
Hypopterygiaceae in Malaya

Haji Mohamed and Harold Robinson



SMITHSONIAN INSTITUTION PRESS

Washington, D.C.

1991

ABSTRACT

Mohamed, Haji, and Harold Robinson. A Taxonomic Revision of the Moss Families Hookeriaceae and Hypopterygiaceae in Malaya. *Smithsonian Contributions to Botany*, number 80, 44 pages, 168 figures, 1 map, 1991.—Keys, descriptions, and some figures are provided for the 9 genera and 28 species of Hookeriaceae (including *Chaetomitriopsis* and *Chaetomitrium*) and the 3 genera and 7 species of Hypopterygiaceae recognised in Malaya. Eight species are reported as new to Malaya: *Actinodontium raphidostegum*, *Daltonia angustifolia*, *D. armata*, *Distichophyllum brevicuspes*, *D. jungermannioides*, *D. maibarae*, *Cyathophorella hookeriana*, and *C. spinosa*. *Chaetomitrium perakense* Brotherus ex Dixon and *Distichophyllum ulukaliense* Damanhuri & Mohamed are reduced to the synonymy of *C. orthorrhynchum* and *D. jungermannioides* respectively.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SERIES COVER DESIGN: Leaf clearing from the katsura tree *Cercidiphyllum japonicum* Siebold and Zuccarini.

Library of Congress Cataloging-in-Publication Data

Mohamed, Haji

A taxonomic revision of the moss families Hookeriaceae and Hypopterygiaceae in Malaya / Haji Mohamed and Harold Robinson.

p. cm. — (Smithsonian contributions to botany ; no. 80)

Includes bibliographic references and index.

1. Hookeriaceae—Malaysia—Malaya—Classification.

2. Hypopterygiaceae—Malaysia—Malaya—Classification.

I. Robinson, Harold Ernest, 1932- . II. Title. III. Series.

QK1.S2747 no. 80 [QK539.H64] 581 s-dc20 [588'.2] 91-4223

© The paper used in this publication meets the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials Z39.48—1984.

Contents

	<i>Page</i>
Introduction	1
Abbreviations	1
Acknowledgments	3
Family HOOKERIACEAE	3
Key to the Genera of Malayan Hookeriaceae	3
Genus <i>Actinodontium</i>	4
Key to the Malayan Species of <i>Actinodontium</i>	4
<i>Actinodontium ascendens</i>	4
<i>Actinodontium raphidostegum</i>	4
Genus <i>Callicostella</i>	4
Key to the Malayan Species of <i>Callicostella</i>	6
<i>Callicostella papillata</i>	6
<i>Callicostella prabaktiana</i>	6
Excluded Species	6
Genus <i>Calyptrochaeta</i>	9
<i>Calyptrochaeta remotifolia</i>	9
Genus <i>Chaetomitriopsis</i>	9
<i>Chaetomitriopsis glaucocarpa</i>	9
Genus <i>Chaetomitrium</i>	9
Key to the Malayan Species of <i>Chaetomitrium</i>	10
<i>Chaetomitrium borneense</i>	10
<i>Chaetomitrium leptopoma</i>	10
<i>Chaetomitrium orthorrhynchum</i>	11
<i>Chaetomitrium papillifolium</i>	11
<i>Chaetomitrium setosum</i>	11
Excluded Species	11
Genus <i>Cyclodictyon</i>	12
<i>Cyclodictyon blumeianum</i>	12
Genus <i>Daltonia</i>	12
Key to the Malayan Species of <i>Daltonia</i>	12
<i>Daltonia angustifolia</i>	13
<i>Daltonia armata</i>	13
<i>Daltonia contorta</i>	13
Excluded Species	13
Genus <i>Distichophyllidium</i>	17
<i>Distichophyllidium nymanianum</i>	17
Genus <i>Distichophyllum</i>	17
Key to the Malayan Species of <i>Distichophyllum</i>	17
<i>Distichophyllum brevicuspes</i>	19
<i>Distichophyllum cirratum</i>	19
<i>Distichophyllum cuspidatum</i>	19
<i>Distichophyllum jungermannioides</i>	22
<i>Distichophyllum maibarae</i>	22
<i>Distichophyllum malayense</i>	25
<i>Distichophyllum mittenii</i>	25
<i>Distichophyllum nigricaulis</i>	25

<i>Distichophyllum osterwaldii</i>	26
<i>Distichophyllum schmidtii</i>	26
<i>Distichophyllum spathulatum</i>	29
<i>Distichophyllum tortile</i>	29
Excluded Species	29
Family HYOPTERYGIACEAE	29
Key to the Genera of Malayan Hypopterygiaceae	32
Genus <i>Cyathophorella</i>	32
Key to the Malayan Species of <i>Cyathophorella</i>	32
<i>Cyathophorella burkillii</i>	32
<i>Cyathophorella hookeriana</i>	32
<i>Cyathophorella spinosa</i>	35
Excluded Species	35
Genus <i>Hypopterygium</i>	35
Key to the Malayan Species of <i>Hypopterygium</i>	35
<i>Hypopterygium aristatum</i>	37
<i>Hypopterygium tenellum</i>	37
Genus <i>Lopidium</i>	37
Key to the Malayan Species of <i>Lopidium</i>	37
<i>Lopidium struthiopteris</i>	40
<i>Lopidium trichocladon</i>	40
Literature Cited	43
Index	44

A Taxonomic Revision of the Moss Families Hookeriaceae and Hypopterygiaceae in Malaya

Haji Mohamed and Harold Robinson

Introduction

The present study revises taxonomically the species of the families Hookeriaceae and Hypopterygiaceae known in Malaya (Map 1). The circumscription of these two families has been a matter of controversy (Miller, 1971; Crosby, 1974; Buck, 1987; Robinson, 1971, 1986, and Tan & Robinson, 1990). In this study, we have followed the concept of Fleischer (1908) and Bartram (1939) in circumscribing the two families. However, we believe that *Chaetomitriopsis* and *Chaetomitrium*, though treated here, in the Hookeriaceae, do not really belong to that family but occupy a position closer to the Hypnaceae. Not included here is *Sclerohypnum riparium* Dixon which has been known only from the type specimen from Malaya. It has been reexamined by Harrington and Miller (1979). They have suggested that if peristome structure is used as the determining factor, it should provisionally be assigned to the Hookeriaceae. Although we have seen no material of the species, the scanning electron micrographs of the exostome shown by Harrington and Miller do not show the wide median furrow similar to that which is seen on many of the Hookeriaceae. Although a region of depression is present in the middle, it is quite different from the wide furrow usually found in the Hookeriaceae. In addition, the presence of somewhat inflated, subquadrate alar cells on the leaves suggest that it would be more appropriate to place *Sclerohypnum* in the Hypnaceae.

A total of 28 species in 9 genera (including 1 species in *Chaetomitriopsis* and five in *Chaetomitrium*) are recognized in the Hookeriaceae while 7 species in 3 genera are recognized in the Hypopterygiaceae. Eight species: *Actinodontium raphidostegum*, *Daltonia angustifolia*, *D. armata*, *Distichophyllum brevicuspis*, *D. jungermannioides*, *D. maibarae*, *Cyathophorella hookeriana*, and *C. spinosa* are recorded as

Haji Mohamed, Botany Department, University of Malaya, 59100, Kuala Lumpur, Malaysia. Harold Robinson, Department of Botany, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

new to Malaya. *Chaetomitrium perakense* Brotherus ex Dixon and *Distichophyllum ulukaliense* Damanhuri & Mohamed are reduced to synonymy of *C. orthorrhynchum* and *D. jungermannioides* respectively. Previous claims of *Callicostella beccariana*, *Chaetomitrium ciliatum*, *C. elongatum*, *C. lanceolatum*, *C. muricatum*, *C. nematosum*, *C. torquescens*, *Cyathophorella tenera*, *Daltonia aristifolia*, and *Distichophyllum undulatum* in Malaya have been found to be based on misidentified specimens. *Distichophyllum malayense* is the only endemic species of the Hookeriaceae in Malaya.

The specimens cited in the text are limited to types studied and representative specimens which show the distribution of the species within Malaya. All the specimens cited are from the Herbarium of the Botany Department, University Malaya, Kuala Lumpur, Malaysia (KLU), unless denoted otherwise.

ABBREVIATIONS.—The following abbreviations are used to indicate the herbaria in which the specimens studied are located.

B	Botanisches Museum, Berlin-Dahlem, Germany
BM	British Museum (Natural History) London, England
BO	Herbarium Bogoriense, Bogor, Indonesia
FH	Farlow Herbarium at Harvard University, Cambridge, Massachusetts (includes the Bartram and Fleischer Herbaria)
G	Conservatoire de Jardin botaniques, Geneva, Switzerland
H	Botanical Museum, University of Helsinki, Finland
H-BR	Helsinki: Brotherus Herbarium (part of the Botanical Museum, University of Helsinki, Finland)
L	Rijksherbarium, Leiden, Netherlands
NY	New York Botanical Garden, Bronx, New York



MAP 1.—Map of peninsular Malaysia (Malaya) showing the divisions of states and three well collected mountains.

- PC Laboratoire de Cryptogamie, Muséum d'His-
toire Naturelle, Paris, France
- SING Singapore Botanic Gardens, Singapore
- UKMB Herbarium of the Botany Department,
Universiti Kebangsaan Malaysia, Bangi, Ma-
laysia
- U Botanical Museum and Herbarium, Utrecht,
Netherlands
- US United States National Herbarium, Smith-
sonian Institution, Washington D.C.

Ranges given for the species in text are mostly from the literature. Literature on the mosses of Malaya used in the study in addition to that cited in text includes Damanhuri and Mohamed (1986), Dixon (1924, 1931), Johnson (1980), Mohamed (1985), and Mohamed and Mohamed (1986). Further references used covering other areas include Bartram (1939), Dozy and Molkenboer (1845-1854), Gangulee (1977), and Townsend (1982).

ACKNOWLEDGMENTS.—The first author would like to acknowledge the research fellowship grant awarded by the Smithsonian Institution which enabled him to carry out research at the National Herbarium (US) at Washington D.C. Together, we thank Halimatul Sadiyah Abdullah (KLU), Ahmad Damanhuri Mohamed (UKMB), B.C. Tan and D. Pfister (FH), P. Isoviita (H), A. Harrington (BM), H. Bischler (PC), W. Buck

(NY), M. Shah (SING), P. Tixier, and C.C. Townsend for the loan of specimens. We thank A. Damanhuri Mohamed for drawing the figures of *Cyathophorella*. We also thank Sherry Pittam, R.M. King, and other members of the Botany Department of the Smithsonian Institution who helped in one way or another in the completion of the research and the preparation of the manuscript. Special thanks are offered to B.C. Tan and Bruce Allen for their detailed reviews of the manuscript.

Family HOOKERIAACEAE

HOOKERIAACEAE Schimper, Corollarium Bryologiae Europeae, 101, 1855.

Plants small to robust, frequently complanate; primary stems usually branched and prostrate; secondary stems prostrate, suberect, or pendent; leaves variable in shape, with or without border, the dorsal leaves erect-spreading to spreading; costa single, double, or absent; cells smooth or papillose; alar cells not differentiated. Synoicous, autoicous, or dioicous. Calyptra generally mitriform, smooth, scabrous, or pilose, the base usually lobed or fringed-ciliate. Seta short or elongate, smooth, papillose, or ciliate; capsule inclined or horizontal, occasionally erect; peristome double, exostome teeth papillose or striate, often with a wide median furrow; cilia lacking, rarely rudimentary.

Key to the Genera of Malayan Hookeriaceae

1. Costa single 2
 Costa double or none 3
2. Stems not complanate-foliate; leaves isomorphous, oblong-lanceolate to lanceolate-linear; exostome without a median furrow, papillose *Daltonia*
 Stems complanate-foliate; leaves dimorphous, ovate-oblong to spatulate; exostome deeply furrowed, striolate *Distichophyllum*
3. Costae strong, reaching at least midleaf 4
 Costae weak, short or none 6
4. Leaves distinctly bordered; leaf cells lax, more than 30 µm wide
 *Cyclodictyon*
 Leaves not or only weakly bordered; leaf cells firm, less than 30 µm wide 5
5. Exostome outer surface papillose, without median furrow; stems ascending; leaf cells more than twice as long as wide; costae not protruding abaxially
 *Actinodontium*
 Exostome outer surface striolate, with median furrow; stems prostrate; leaf cells mostly isodiametric; costae protruding abaxially *Callicostella*
6. Leaves bordered; leaf cells smooth 7
 Leaves not bordered; leaf cells often prurlose 8
7. Leaves large, more than 2 mm long; margin distinctly toothed above; seta densely spinuliferous *Calyptrochaeta*
 Leaves small, less than 2 mm long; margin entire; seta smooth
 *Distichophyllidium*
8. Leaves strongly divergent or deflexed; operculum conic *Chaetomitriopsis*
 Leaves imbricate to erect-spreading; operculum rostrate *Chaetomitrium*

Genus *Actinodontium*

Actinodontium Schwaegrichen, Spec. Musc. Suppl., 2:75, 1826. [Type: *A. ascendens* Schwaegrichen.]

Plants small, green, growing in tufts; stems ascending, radiculose below, simple, densely radially foliate; leaves ovate-lanceolate, acuminate; costae double, extending beyond

midleaf; cells elongate, smooth. Heteroicous. Calyptra naked, lacinate at base. Capsule erect, subcylindric; operculum rostrate; exostome teeth papillose with zig-zag median line.

The plants of this genus are mainly epiphytic, in Malaya often occurring on tea plants. The leaves are bicostate as in *Callicostella* but the costae do not protrude abaxially.

Key to the Malayan Species of *Actinodontium*

- Leaves ovate to oblong-elliptic; apices acute to short-acuminate; capsules up to 2.5 mm long *A. ascendens*
 Leaves oblong-lanceolate; apices long-acuminate; capsules up to 3 mm long
 *A. raphidostegum*

Actinodontium ascendens

FIGURES 5-8

Actinodontium ascendens Schwaegrichen, Spec. Musc. Suppl., 2(2):75, 1826. [Type: Java, sine loco, Reinwardt s.n. (G?), not seen.]

Plants to 1 cm high, in tufts; stems simple, rarely branched; leaves crowded, erect and slightly shrunken or crisped when dry, erect-spreading when moist, ovate to oblong-elliptic, 2.1-2.8 mm long, 0.6-0.9 mm wide, widest at midleaf or below, apices acute to short-acuminate; margin entire above, plane or slightly recurved below; border scarcely differentiated, consisting of one row of weakly differentiated cells near apex; costae unequal, extending to $\frac{3}{4}$ of leaf; median cells thin-walled, rhomboid to elongate-hexagonal, 60-120 μ m long, 15-20 μ m wide; basal cells 90-150 μ m long, 12-17 μ m wide, elongate-hexagonal to somewhat linear; basal cells at attachment quadrate to short-rectangular. Calyptra often stuck on operculum even after capsule matures, mitrate, lacinate and whitish below, smooth and brownish above. Seta smooth, to 7 mm long; capsule including operculum 2.5 mm long, suberect; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Ringlet, Boh Tea plantation estate, on twigs of tea plants, 1540 m, *Abdullah & Zamzuri 1127*; Cameron Highlands, Tanah Rata, Parit Waterfalls, 1100 m, *Tixier 5219* (PC).

WORLD DISTRIBUTION.—Sri Lanka, Thailand, Java, and Malaya.

FERTILITY.—Both packets examined have sporophytes.

REMARKS.—*Actinodontium ascendens* is distinguished from *A. raphidostegum* on the basis of leaf shape, leaf size, and capsule length. *Actinodontium ascendens* has elliptic to ovate leaves with acute to short-acuminate apices and capsules rarely exceeding 2.5 mm in length, while *A. raphidostegum* has oblong-lanceolate leaves with long-acuminate apices and capsules measuring up to 3 mm long. The leaves of *A. ascendens* are smaller, measuring 2.1-2.8 mm long 0.6-0.9 mm wide, while *A. raphidostegum* has leaves measuring 3.5-4.5 mm long, 0.8-1.2 mm wide. Despite the differences,

there are specimens in which the characters intergrade. In Malaya, these two species are found in the same habitats and localities.

Actinodontium raphidostegum

FIGURES 1-4

Actinodontium raphidostegum (C. Müller) Bosch & Lacoste, Bryol. Jav., 2:37, 1862.

Hookeria raphidostega C. Müller, Syn., 2:677, 1857. [Type: Java, Blume s.n. (B, destroyed).]

Plants to 1.5 cm high; leaves crowded, slightly shrunken and flexuose when dry, erect-spreading when moist, oblong-lanceolate, gradually long-acuminate, 3.5-4.5 mm long, 0.8-1.2 mm wide; margins entire above, involute for $\frac{2}{3}$ of length below; costae unequal, parallel, extending beyond midleaf; leaf cells smooth, thin-walled, elongate-rhomboid to elongate-hexagonal, 80-130 μ m long, 16-20 μ m wide. Calyptra mitrate, lacinate at base, covering only top of capsule. Seta smooth, erect, to 6 mm long; capsule erect or slightly inclined, ovate-cylindrical with a short apophysis, to 3 mm long (including operculum); operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Tanah Rata, MARDI Research Station, 1440 m, on tea plants, *H. Mohamed & Zamzuri 1052a*; *Baki Bakar 258*.

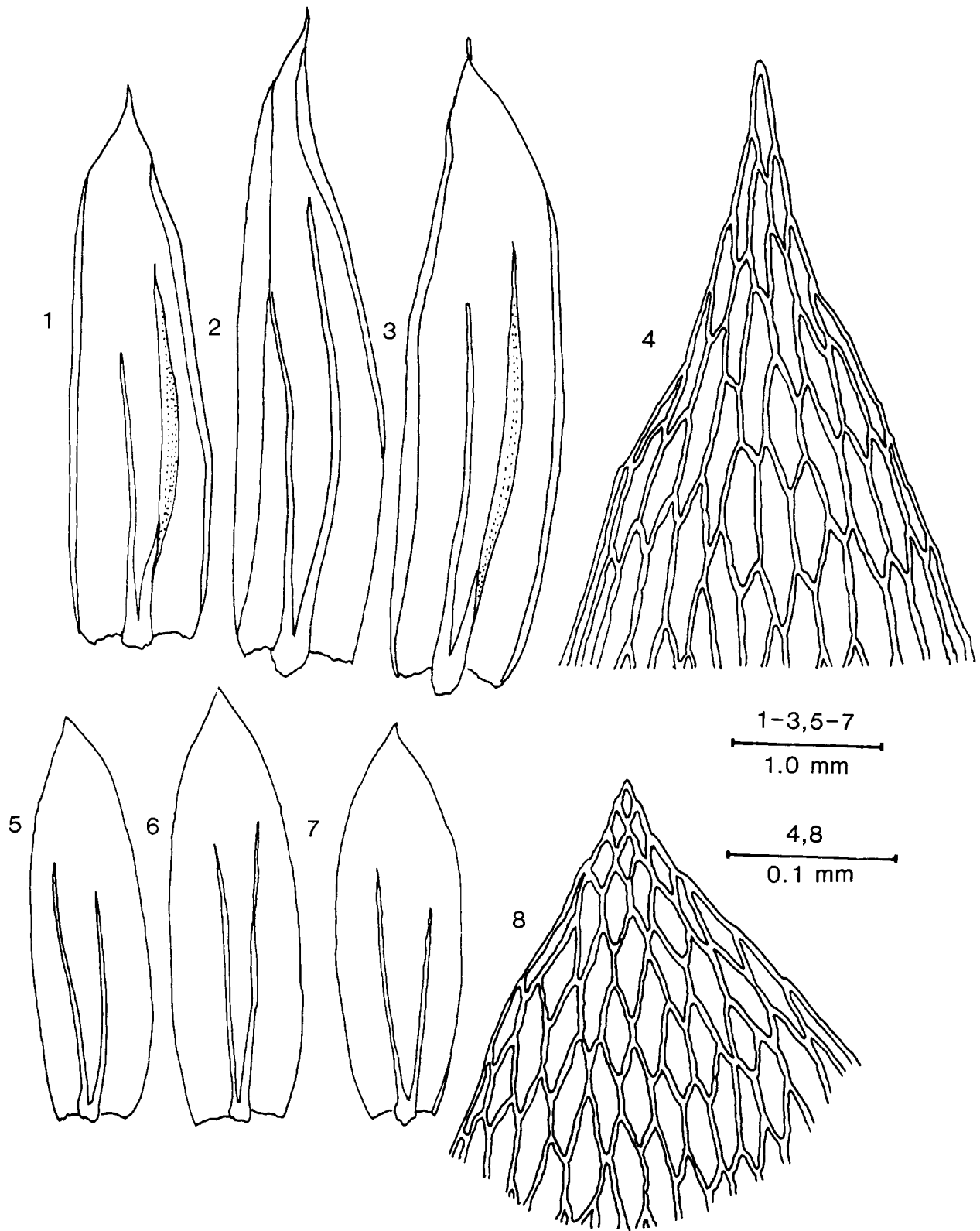
WORLD DISTRIBUTION.—Malaya, Java, Celebes, Borneo, and Philippines.

FERTILITY.—Both collections had sporophytes.

REMARKS.—The differences between this species and *A. ascendens* are discussed under the latter.

Genus *Callicostella*

Callicostella (C. Müller) Mitten, nom. cons., J. Linn. Soc. Bot. Suppl., 1:136, 1859. [Type: *C. papillata* (Montagne) Mitten.] Crosby (1975) showed that *Callicostella* was a later synonym for *Schizomitrium* Bruch, Schimper, and Gumbel. However, Koponen and Isoviita (1984) proposed that the name *Callicostella* which had been used for a long time, be conserved. The proposal was approved at the 1987 Berlin Congress.



FIGURES 1-8.—*Actinodontium*. 1-4, *A. raphidostegum* (Pahang: H. Mohamed & Zamzuri 1052a): 1-3, leaves; 4, cells at leaf apex. 5-8, *A. ascendens* (Pahang: Abdullah & Zamzuri 1127): 5-7, leaves; 8, cells at leaf apex.

Plants slender, yellowish to dark green, in mats; stems creeping, irregularly branched, laxly complanate-foliate; leaves oblong, short-acute to short-acuminate, not bordered, closely serrate above; costae double, thick, reaching beyond midleaf, ending in abrupt apical protrusion; cells firm, hexagonal, or rhomboidal, nearly isodiametric, smooth or with central papilla. Synoicous, autoicous, or dioicous. Calyptra naked, scabrous distally, weakly plicate and lacinate at base. Seta

elongate, often partly or completely roughened; capsule inclined to horizontal, subcylindric; operculum rostrate; exostome teeth outer surface striolate, with median furrow.

This genus is characterised by the presence of two distinct leaf costae which protrude abaxially just below the apex. It resembles *Cyclodictyon* in habit and in having double costae, but the leaves are not bordered and the leaf cells are firm-walled.

Key to the Malayan Species of *Callicostella*

- Leaf cells papillose *C. papillata*
 Leaf cells smooth *C. prabaktiana*

Callicostella papillata

FIGURES 9-15

Callicostella papillata (Montagne) Mitten, J. Linn. Soc. Bot. Suppl., 1:136, 1859.

Hookeria papillata Montagne, London J. Bot., 3:632, 1844. [Type: Java, Prov. Buitenzorg, Miquel s.n. (PC), not seen.]

Plants in flat mats, yellow to dark green; stems creeping, prostrate, irregularly branched; leaves complanate, somewhat curved and plicate when dry, oblong-lingulate, 1-1.8 mm long 0.55-0.65 mm wide, broadly acute to abruptly acuminate; margins not bordered above, a single row of elongate cells below, serrulate to dentate in upper half, often with bigeminate teeth, lower half entire; costae ceasing just below apex in abaxial protrusion, smooth below, toothed above; median cells irregularly 6-7 sided, hexagonal to oblong, 6-14 μm long, 6-9 μm wide, thick-walled, with a single papilla over the lumen, basal cells elongate and smooth, 30-50 μm long, 8-10 μm wide; perichaetial leaves lanceolate, smaller than vegetative leaves, margin serrate. Synoicous. Seta smooth below, weakly papillose above, 0.8-1.5 cm long; capsules ovoid-cylindric.

SELECTED SPECIMENS EXAMINED.—Johore: Gunung Pantii, *H. Mohamed* 9369. Pahang: Fraser Hill, *H. Mohamed & Zamzuri* 945a; Cameron Highlands, Robinson Falls, *Manuel* 3328. Perak: Gunung Hijau Trail, *Manuel* 3240 & 3267a. Selangor: 3 mile mark on old Genting Highlands road, *Manuel* 2806b.

WORLD DISTRIBUTION.—Madagascar, South India, Andaman Islands, Sri Lanka, Thailand, Vietnam, Malaya, Sumatra, Java, Borneo, Philippines, Taiwan, Ryukyus, New Guinea, New Caledonia, Fiji, Tahiti, and Samoa.

FERTILITY.—Twelve of the 16 packets examined had sporophytes.

REMARKS.—*Callicostella papillata* has been collected on logs and rocks in and near streams in mountain forests in partly shaded areas. This is essentially a medium to high altitude species unlike *C. prabaktiana* which has been collected mostly below 400 m. Fourteen of the packets examined were collected

above 1000 m, the highest at 1560 m. It is a polymorphic species; the only reliable specific character is its papillose cells.

Callicostella prabaktiana

Callicostella prabaktiana (C. Müller) Bosch & Lacoste, Bryol. Jav., 2:40, 1862.

Hookeria prabaktiana C. Müller, Syn., 2:678, 1851. [Type: Java, Mt. Prabakti, Zollinger 3503 (B, destroyed).]

This species is similar in all aspects to *C. papillata* except that the leaf cells are smooth and the apical margins are less dentate.

SELECTED SPECIMENS EXAMINED.—Johore: Mersing, *Clear* 1394, 1449; Foothill of Gunung Ledang, *A. Mohamed* 125. Kelantan: Jeram Pasu, Aishah 124. Negeri Sembilan: Perhentian Tinggi, *Ridley* 571 (SING). Pahang: Taman Negara, Lata Berkoh area, on Sungei Tahan, *Manuel* 2551; Cameron Highlands, Robinson's Waterfall, *H. Mohamed & Zamzuri* 1123a. Perak: on rock near waterfall, *H. Mohamed et al.* 8355. Penang: Botanic Gardens, *H. Mohamed* 8414. Selangor: Ulu Gombak, Zarina Mat 4, 10, & 31.

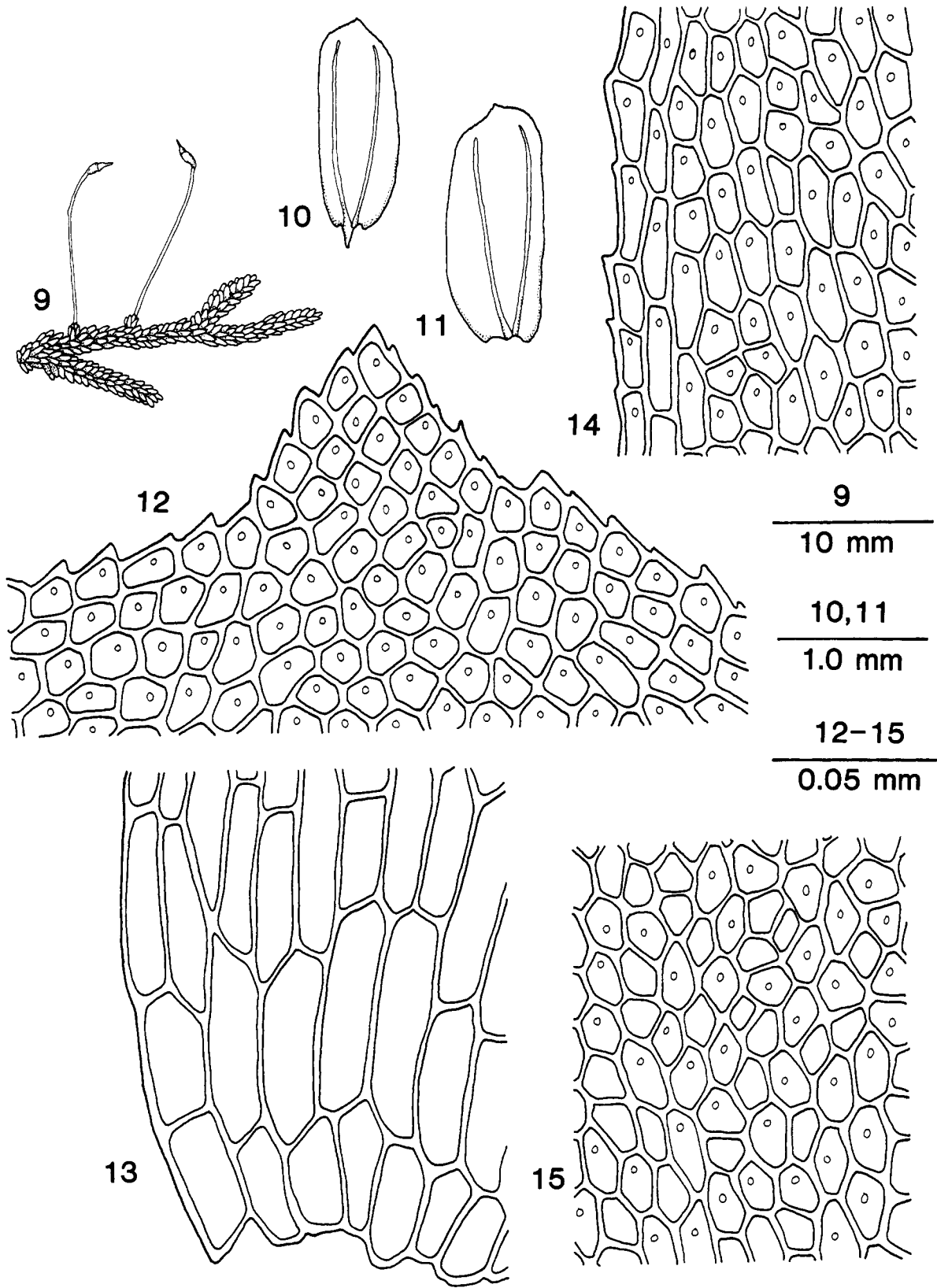
WORLD DISTRIBUTION.—Vietnam, Thailand, Malaya, Java, Borneo, Philippines, and New Guinea.

FERTILITY.—Fourteen of the 25 specimens examined had sporophytes.

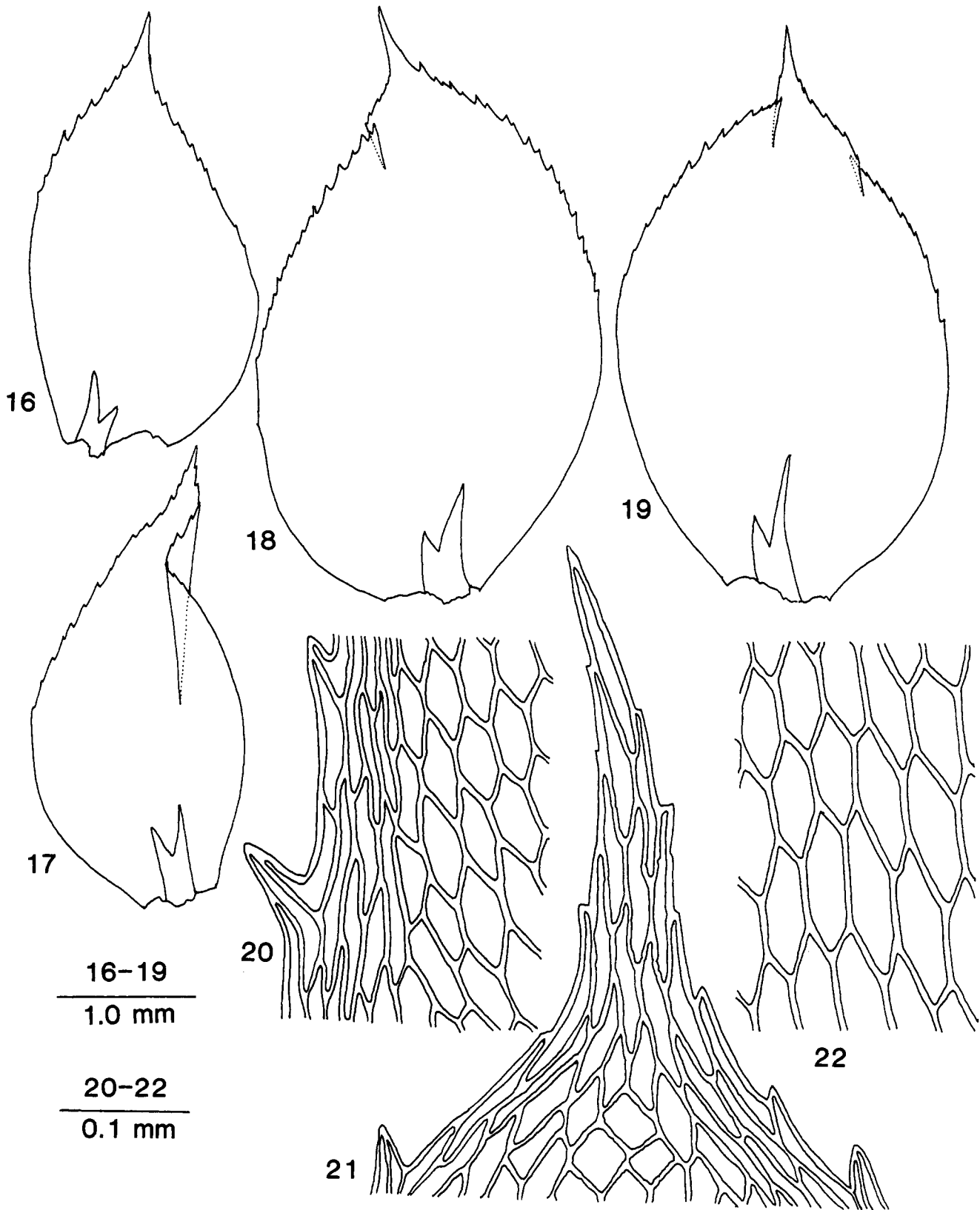
REMARKS.—This species has been collected on rocks, logs, and soil on banks of streams and rivers in lowland forests in the shade. It is sometimes found on rocks which are occasionally inundated. Of the 25 specimens examined, 23 were collected between 50 m and 400 m. Specimen *H. Mohamed & Zamzuri* 1123a and specimen *H. Mohamed & Damanhuri* 1054 were collected at 1460 m and 1580 m respectively.

Excluded Species

Callicostella beccariana (Hampe) Jaeger was reported from Malaya by Mohamed and Tan (1988) based on *Burkill* 6566 collected from Selangor, Telok Reserve (SING). This specimen is in fact *C. prabaktiana*.



FIGURES 9-15.—*Callicostella papillata* (Johore: H. Mohamed 9369): 9, plant, wet; 10, 11, leaves; 12, cells at leaf apex; 13, cells at base of leaf; 14, cells at margin near midleaf; 15, median cells of leaf.



FIGURES 16-22.—*Calypstrochaeta remotifolia* (Pahang: H. Mohamed 7089): 16, 17, dorsal leaves; 18, 19 lateral leaves; 20, cells at upper margin of leaf; 21, cells at leaf apex; 22, median cells of leaf.

Genus *Calyptrochaeta*

Calyptrochaeta Desvaux, Mém. Soc. Linn. Paris, 3:226, 1825. [Type: *Leskea cristata* Hedwig.]

Plants medium-sized to robust, brownish-green, in tufts; stems wiry, prostrate or ascending, mostly simple, sometimes forked, flat, laxly complanate-foliate, usually with clusters of brown, filiform propagules on stems among upper leaves; lateral leaves spreading, dorsal and ventral rows smaller and erect, ovate, short-acuminate, bordered, serrate above; costa short and forked; cells lax, hexagonal or rhomboidal, smooth. Autoicous or dioicous. Calyptra naked or pilose, fringed. Seta strongly spinuliferous; capsule small, pendulous; exostome teeth transversely striolate with a median furrow.

Eriopus, an earlier generic name in common use, has been found to be illegitimate (Margadant 1959; Crosby 1974), and the name *Calyptrochaeta* must be used. A large number of collections from Malaya have been examined, and since no consistent differences in characters have been found, only one species is recognized here. Sporophytes are produced infrequently in the genus and thus sporophyte characters are not useful in keys to the species.

Calyptrochaeta remotifolia

FIGURES 16–22

Calyptrochaeta remotifolia (C. Müller) Iwatsuki, Tan, & Touw, J. Hattori Bot. Lab., 44:150, 1978.

Eriopus remotifolius C. Müller, Bot. Zeit., 5:828, 1847. [Type: Java, Mt Gédé, Reinwardt s.n. (B, destroyed).]

Plants large, pale green to dark green, secondary stems ascending, to 5 cm high, simple or branched, blunt at tips, complanate-foliate, to 8 mm wide with leaves; numerous clusters of brown, filiform gemmae present near leaf bases; lateral leaves oblong-ovate, short-acuminate, to 5 mm long, 2 mm wide; margins coarsely serrate in upper half with long slender spinose teeth; distinctly bordered all around with 3–4 rows of elongate cells, with strongly pitted walls; costa short, forked, weakly defined; median cells rhomboidal with firm walls, 50–75 μ m long, 20–25 μ m wide, basal cells laxer; perichaetial leaves with round to shortly acute apices. Dioicous. Calyptra hairy, lacinate at base. Seta to 6 mm long, spinuliferous; capsule erect or inclined, ovoid.

SELECTED SPECIMENS EXAMINED.—Pahang: Gunung Ulu Kali, corticolous, 1500 m, *H. Mohamed* 7089; Cameron Highlands, Hutan Simpan Hulu Bertam, 1620 m, *H. Mohamed & Zamzuri* 1115c. Perak: Maxwell Hill, 1330 m, *H. Mohamed* 8079.

WORLD DISTRIBUTION.—India (Manipur), Malaya, Sumatra, Java, Borneo, Philippines, and New Guinea.

REMARKS.—This species has been collected between 1200 m and 2000 m. Two different types of habitats seem to be favored by the Malayan plants of this species. One habitat is the base of shrubs and trees in relatively dry areas while the other

habitat is on partially immersed rocks in swift-flowing streams. Those plants growing on bases of shrubs are mostly light-green in color and more strongly toothed in the upper margins while those such as *H. Mohamed & Zamzuri* 1115c, growing on partially immersed rocks, are dark to dark green in color and have upper margins that are not strongly toothed.

Genus *Chaetomitriopsis*

Chaetomitriopsis Fleischer, Musci Fl. Buitenz., 4:1371, 1923. [Lectotype: *C. glaucocarpa* (Schwaegrichen) Fleischer]

Plants slender, wiry, yellowish-green glossy, in compact, intricate tufts; stems creeping, densely pinnate to bipinnate; branch leaves squarrose-spreading with decurved points, ovate-acuminate; border not differentiated; costae double, short; cells elongate, prurlose at apical angles. Calyptra cucullate, sparingly pilose. Seta long, smooth; capsule pendulous; exostome teeth striolate, without median furrow; operculum conical, short.

Chaetomitriopsis glaucocarpa

Chaetomitriopsis glaucocarpa (Schwaegrichen) Fleischer, Musci Fl. Buitenz., 4:1372, 1923.

Hypnum glaucocarpon Reinwardt ex Schwaegrichen, Spec. Musc. Suppl., 3(1):228a, 1828. [Type: In Insulae Javae monte Mulawar: *Pr. Reinwardt* (?), not seen.]

Plants yellowish-green, in dense tufts or mats; stems more than 10 cm long, with pinnate to bipinnate secondary branches; ultimate branches erect with densely inserted squarrose leaves on all sides; leaves cordate-ovate, to 0.8 mm long, 0.4 mm wide, short-acuminate; margins serrate to base; costa short, unequal; leaf cells irregularly rhomboid, 20–30 μ m long, 4–6 μ m wide, prurlose. Autoicous. Seta 2.5 cm long; capsule ovoid-cylindric, 0.6 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Brinchang Rose Garden, on stem of tree fern, 1540 m, *H. Mohamed* 9182.

WORLD DISTRIBUTION.—Nepal, Sikkim, Assam, Laos, Vietnam, Malaya, Java, Celebes, New Guinea, Philippines, and Taiwan.

REMARKS.—*Chaetomitriopsis glaucocarpa* has been collected on branches and twigs of trees at altitudes above 1400 m. This species is easily recognized by the densely branched stems and the crowded, squarrose, deflexed, cordate-ovate branch leaves.

Genus *Chaetomitrium*

Chaetomitrium Dozy & Molkenboer, Musci Frond. Ined. Archip. Indici, 2:117, 1847. [Lectotype: *C. elongatum* (Dozy & Molkenboer) Dozy & Molkenboer.]

Plants small to medium sized; stems long, creeping, usually regularly pinnate, sometimes with clusters of filamentous

gemmae among leaves on ultimate branches; leaves erect-spreading, widely spreading or appressed, ovate, concave, acuminate to rounded; margins usually dentate, without differentiated border; costae short and double or none; cells linear, shorter near apex, generally prorulose; perichaetial

leaves larger than vegetative leaves. Autoicous or dioicous. Calyptra mitrate or cucullate, always strongly hispid or spinose-ciliate, usually fringed at the base. Seta elongate, papillose or setose; capsule more or less inclined; operculum rostrate; exostome teeth striolate, not furrowed.

Key to the Malayan Species of *Chaetomitrium*

1. Branch leaves arranged in spirally seriate rows 2
 Branch leaves evenly spaced, not in spirally seriate rows 3
2. Upper leaf margins serrulate; setae papillose above *C. borneense*
 Upper leaf margins spinose-serrate; setae setulose above *C. setosum*
3. Branch leaves homomallous; leaf margins only weakly toothed above
 *C. papillifolium*
 Branch leaves not homomallous; leaf margins strongly toothed above 4
4. Leaves less than 0.7 mm long, leaf apices not constricted below tips; setae papillose above *C. leptopoma*
 Leaves more than 1 mm long, leaf apices constricted below apices; setae setulose above 5
5. Leaves up to 1.2 mm long, ovate-lanceolate, margins serrate; papillae on seta to 50 μ m high *C. orthorrhynchum*
 Leaves up to 1.7 mm long, ovate, upper margin spinose-serrate; papillae on seta up to 90 μ m high *C. setosum*

Chaetomitrium borneense

Chaetomitrium borneense Mitten, Rep. Sci. Res. Voyage Challenger Bot., 1:213, 1885. [Type: Borneo, *Motley 4* (NY!).]

Chaetomitrium seriatum Brotherus, Bot. Jahrb., 49:350, 1913. [Isotype: Southern Borneo, Hayup. *H. Winkler 2522* (L!).]

Pilotrichella perakensis Brotherus in Dixon, J. Linn. Soc., Bot., 43:314, 1916. *nom. nud. in synonym.* [Based on: Malaya, Perak, Upper Perak, 300 ft, June 1889, *L. Wray Jr. 3550 & 3636* (BM!).]

Plants golden green; primary stems creeping, up to 16 cm long; branches erect, to 1.5 cm long; branch leaves spirally seriate, ovate-oblong, cucullate above, abruptly acute to rounded with a short apiculus, constricted below apex, 0.8–1.3 mm long, ~0.55 mm wide, widest below midleaf, concave, plicate below; margins serrulate above; costae short and weak; cells linear, weakly prorulose; perichaetial leaves long-acuminate, with spinose-serrate marginal teeth. Dioicous. Calyptra mitriform, hirsute with branched hairs, fringed below with long hairs. Seta up to 1 cm, papillose above, the papillae up to 25 μ m high, smooth below; capsule cylindrical, operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Temerloh, epiphytic on tree, *Poore B1128*. Trengganu: Dungun, Kampong Pasir Raja, Sungei Pertang, 60 m, on tree, *H. Mohamed 9523*.

WORLD DISTRIBUTION.—Malaya and Borneo.

REMARKS.—This species is easily recognized by the spirally seriate arrangement of the leaves on the stem similar to the arrangement in some South American species of *Pilotrichella* and *Orthostichopsis*. However, there are collections such as *H. Mohamed 9523* and *A. Damanhuri 2143* in which the seriate

foliation is indistinct. It is possible that *C. elongatum* from Java may be synonymous with this species. A study of the type specimens of both species shows no appreciable differences in the sporophytic and gametophytic characters except for the indistinct spirally seriate foliation and the more acuminate leaf apices in *C. elongatum*. The nomenclatural problems surrounding this species have been dealt with by Mohamed (1985).

Chaetomitrium leptopoma

Chaetomitrium leptopoma (Schwaegrichen) Bosch & Lacoste, Bryol. Jav., 2:52, 1862.

Hypnum leptopoma Schwaegrichen, Spec. Musc. Suppl., 4:323b, 1842. [Type: Java, *Reinwardt & Blume* (G), not seen, (FH!).]

Plants small, densely branched in compact tufts; leaves erect-spreading, ovate with an acute apex, 0.3–0.7 mm long, 0.08–0.3 mm wide, widest just below midleaf, concave; margins serrulate in upper $\frac{2}{3}$ of leaf length; costae short and weak; median cells linear, distinctly prorulose; perichaetial leaves often plicate, to 1.8 mm long, 0.35 mm wide, oblong-lanceolate with a long flexuose apex, spinose-serrate on margins in upper $\frac{2}{3}$. Dioicous. Calyptra mitriform, spinose-hispid on surface, fringed with short hairs. Seta to 1 cm high, papillose above, smooth below; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Perak: Birch's Hill, 4200 ft, on a branch, *Burkill* (BM). Selangor: Ginting Bidai, 1896, *Ridley 405* (SING).

WORLD DISTRIBUTION.—Java, Malaya, Borneo, and Philippines.

REMARKS.—This species is the smallest of all the *Chaetomitrium* species in Malaya. It is recognized by its dense branching, small ovate leaves with serrulate margins and papillose seta.

Chaetomitrium orthorrhynchum

Chaetomitrium orthorrhynchum (Dozy & Molkenboer) Bosch & Lacoste, Bryol. Jav., 2:45, 1862.

Hookeria orthorrhynchum Dozy & Molkenboer, Ann. Sci. Nat. Bot., sér. 3, 2:305, 1844. [Type: Java, Zippelius (L), not seen, (FH!).]

Chaetomitrium perakense Brotherus ex Dixon, Bull. Torrey Bot. Club, 51:237, 1924. [Type: Perak, Bidor, Tapah, *H.N. Ridley 159* (BM!).] syn. nov.

Plants small, in golden-green mats; stems pinnate to bipinnate; leaves ovate-lanceolate, acuminate, ~ 1.2 mm long, to 0.4 mm wide, widest below midleaf; ultimate branch leaves smaller, concave, constricted below the apex; margin sharply serrate in upper $\frac{2}{3}$ of leaf, entire below; costae short, faint; cells linear, prorulose, especially on the back of leaf; perichaetial leaves ciliate-dentate. Dioicous. Calyptra mitriform, spinose-hispid above, fringed with long hairs. Seta 6–10 mm long, setulose above, with setulae to 50 μ m long, smooth below; capsule cylindrical; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Johore: Sungei Pelepah, *Md. Nur 19138* (SING). Pahang: Taman Negara, on leaf, *Damanhuri s.n.* (UKMB). Perak: Bidor, Tapah, *Ridley 164* (SING). Selangor: Gua Batu, *Ridley 474* (SING). Trengganu: Ulu Trengganu District, Sungei Berua, off Tapah Road, *H. Mohamed 9653*.

WORLD DISTRIBUTION.—Malaya, Indonesia, and Philippines.

REMARKS.—This species in Malaya is known only from below 150 m on rotten logs, twigs, and trees in moist places. The Malayan specimens have larger leaves and more pronounced serrations on the margin when compared to the Javan type specimen.

Chaetomitrium papillifolium

Chaetomitrium papillifolium Bosch & Lacoste, Bryol. Jav., 2:50, 1862. [Type: Java, Von Teysmann, ex Herb. Sande Lac. (FH!).]

Primary stems creeping; branches to 0.8 cm long, homomallous; branch leaves usually ovate-lanceolate to oblong-lanceolate, acute to acuminate, slightly constricted below apex, 1.0–1.4 mm long, 0.4–0.5 mm wide, widest near midleaf; margin weakly toothed to denticulate above, minutely toothed below; costa short; cells linear, prorulose at apical angles, shorter at apex; perichaetial leaves ciliate-dentate. Dioicous. Calyptra mitriform, with a few scattered, appressed long hairs on surface, fringed with long ciliate hairs below. Seta 0.6–1.4 cm long, smooth below, papillose above, the papillae up to 15 μ m high; capsule cylindrical, 1.4 mm long, operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Johore: Mersing, on slender twig 9" above ground, *Clear 1452*. Penang: Western

Hill, 2500 ft, wet logs, *Spare 3181* (BM). Perak: Dindings, *Ridley 373* (BM). Selangor: Ulu Gombak forest Reserve, on twig 6' from ground in forest, *Burkill 9964* (SING). Pahang: Janda Baik, 400 m, on tree, *H. Mohamed 8883*. Trengganu: Dungun district, Kampong Pasir Raja, 60 m, on tree along Sungei Pertang, *H. Mohamed 9660*.

WORLD DISTRIBUTION.—Sri Lanka, Indochina, Malaya, Java, Borneo, and Philippines.

REMARKS.—*Chaetomitrium papillifolium* is distinguished by the homomallous arrangement of branch leaves, ovate-lanceolate to oblong-lanceolate leaf shape, weakly toothed leaf margins and a seta which is weakly papillose above. *Chaetomitrium orthorrhynchum* is distinct from the present species in the more coarsely serrate leaves and the setulose seta.

Chaetomitrium setosum

Chaetomitrium setosum Brotherus ex Dixon, Bull. Torrey Bot. Club, 52:237, 1924. [Type: Perak, Tapah, Nov. 1908, *Ridley 169* (BM!).]

Primary stems creeping, secondary stems simple or branched, to 1.5 cm high; leaves arranged in more or less seriate rows; somewhat tumid, erect-spreading, ovate with an acuminate apex, concave, often cucullate and constricted near the tip, 1.3–1.7 mm long, 0.6–0.7 mm wide, widest near midleaf; upper margins spinose-serrate, with teeth less prominent below; costa weak, short; leaf cells linear, prorulose; basal region of attachment to stem yellowish; perichaetial leaves to 2 mm long, to 0.55 mm wide, long-acuminate, teeth on upper margin large, spinose. Autoicous. Calyptra mitriform, densely hirsute, fringed with long hairs. Seta to 1 cm long, setulose above, with setulae to 90 μ m long, papillose or smooth below; capsule cylindrical; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Kedah: Choong Meng, on stem of shrub, 100 ft, *Spare 2804* (BM). Sarawak: Gunung Dulit, 300 m, twigs and leaves of small tree in rain forest near torrent, Oxford Expedition 1932, *No. 1144* (BM).

WORLD DISTRIBUTION.—Malaya and Borneo.

REMARKS.—This species is distinct in having a combination of leaves constricted below the apices, leaf margins with spinose-serrate teeth, and setae setulose. The leaves are larger, more ovate, the margins more sharply serrate and the setae much more setulose than those of *C. orthorrhynchum*.

Excluded Species

Chaetomitrium ciliatum Bosch & Lacoste was reported from Malaya by Tixier (1980) based on *Tixier 5234* collected in Pahang, Cameron Highlands, Parit Waterfalls, on twigs in forest, Dec. 25, 1970 (PC). This has proven to be *C. orthorrhynchum*.

Chaetomitrium elongatum Dozy & Molkenboer was reported from Malaya by Dixon (1926). The report was based on two collections, *Ridley 373* from Perak, Dindings, 1897 (BM,

SING) and *Burkill 16569* from Pahang, Sungei Perting, Bentong (BM). In both specimens the leaves are much smaller and the apices are much more acute than in *C. elongatum*. The specimens are *C. papillifolium*.

Chaetomitrium lanceolatum Bosch & Lacoste was reported by Tixier (1980) based on *Tixier 5234*. The specimen has the same number, same locality, and same station as that given for *C. ciliatum* above, and it also proves to be *C. orthorrhynchum*.

Chaetomitrium muricatum Bosch & Lacoste was reported by Dixon (1926) based on *Ridley 405* and *411* from Selangor, Ginting Bidai, 1896 (BM). These specimens are *C. leptopoma*.

Chaetomitrium nematosum Brotherus in Dixon was reported by Dixon (1926) based on *Ridley 205* from Perak, Kuala Kenering (BM). Despite the peculiar brood-filaments and the color of the plant, it is certainly *C. orthorrhynchum*.

Chaetomitrium torquescens Bosch & Lacoste was reported by Tixier (1971) based on *Tixier 4809* collected from Pahang, Fraser's Hill, Dec. 27, 1969 (PC). The specimen is in fact *C. papillifolium*.

Genus *Cyclodictyon*

Cyclodictyon Mitten, J. Linn. Soc., Bot., 7:163, 1864. [Type: *C. laetevirens* (Hooker & Taylor) Mitten.]

Plants medium-sized, soft, delicate, in mats; stems prostrate, branched, complanate-foliate; leaves very laxly areolate, oblong-ovate, acute, narrowly bordered, weakly toothed above; costa double, extending beyond midleaf; cells large, round-hexagonal, smooth. Synoicous, autoicous or dioicous. Calyptra naked. Seta elongate, smooth; capsule horizontal; exostome transversely striolate with a wide median furrow; operculum rostrate.

Cyclodictyon blumeanum

Cyclodictyon blumeanum (C. Müller) O. Kuntze, Revis. Gen. Pl., 2:835, 1891. *Hookeriana blumeana* C. Müller, Syn., 2:676, 1851. [Type: Java, *Blume s.n.* (B, destroyed).]

Plants, light-green, irregularly branched, branches 2 cm long, to 2 mm wide with leaves; leaves weakly complanate, slightly distorted when dry, ovate to oblong-lingulate, 1.2–1.8 mm long, 0.6–0.9 mm wide, broadly acute to shortly acuminate, the apiculus 50–80 µm long; margins weakly

toothed above near apex, plane below; border distinctly differentiated, with two rows of linear cells; costa reaching $\frac{4}{5}$ the length of leaf, with several dorsal spines towards apex; cells large, 33–50 µm wide, irregularly hexagonal above, becoming rectangular towards base. Synoicous or autoicous. Calyptra mitrate, covering operculum and capsule mouth when mature, smooth, yellowish, lacinate at base. Seta up to 1.6 cm high, reddish brown, smooth; capsule dark brown, suberect to cernuous, ovoid-cylindrical; urn 1.5 mm; mouth enlarged, mamilllose.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Hutan Simpan Hulu Bertam, 1620 m, *H. Mohamed & Zamzuri 1207b*; Genting Highlands, near water tank, ~1500 m, *H. Mohamed 4558*.

WORLD DISTRIBUTION.—Sri Lanka, Sumatra, Java, Bali, Malaya, Borneo, Philippines, Taiwan, New Guinea, and Fiji.

FERTILITY.—Three out of the 5 packets examined had sporophytes.

REMARKS.—*Cyclodictyon blumeanum* is recognized by its bicostate leaves, and the lax areolation formed by its large leaf cells. It may be confused locally only with the genus *Callicostella* which is also bicostate. However, the smaller firm leaf cells which may or may not be papillose and the unbordered leaf apices of *Callicostella* separate it from *Cyclodictyon blumeanum*. This species has been collected on wood and rocks near moist, shady places such as waterfalls and streams.

Genus *Daltonia*

Daltonia Hooker & Taylor, Musci Brit., 80, 1818, nom. cons. [Type: *D. splachnoides* (J.E. Smith) Hooker & Taylor.] The nomenclatural history of *Daltonia* leading to conservation is given by Crosby (1968).

Plants small to medium-sized, often tufted, more or less glossy; stems laxly erect, often simple, rarely forked, densely radially foliate; leaves ovate or lanceolate, acuminate, bordered, carinate along costa below; costae single, ending some distance below apex; upper cells oval-rhomboidal, linear at margins in a distinct border. Synoicous, autoicous, or dioicous. Calyptra deeply fringed at the base. Seta scabrous above; capsule suberect; exostome teeth papillose, without median furrow.

The plants of this genus in Malaya are generally epiphytic, growing in small tufts on bark of trees and bases of small shrubs.

Key to the Malayan Species of *Daltonia*

1. Leaves more than 3 mm long, ending in a long arista; costa ending below middle or distal third of leaf *D. armata*
Leaves less than 3 mm long, acuminate; costa reaching $\frac{4}{5}$ of leaf length 2
2. Leaves strongly twisted or contorted when dry, oblong-lanceolate; margins plane, the apices abruptly short acuminate *D. contorta*
Leaves flexuose when dry, narrowly lanceolate to linear; margins recurved above, apices gradually acuminate *D. angustifolia*

Daltonia angustifolia

FIGURES 23-29

Daltonia angustifolia Dozy & Molkenboer, Ann. Sci. Nat., sér. 3, 2:302, 1844. [Type: Borneo, sine loco, *Korthals s.n.* (L), not seen.]

Plants small, yellowish-green to green, forming cushions; stems simple or rarely branched, 5-8 mm high; leaves crowded, erect and flexuose when dry, erect-spreading when moist, 2.0-2.6 mm long, 0.3-0.4 mm wide, widest below midleaf, narrowly lanceolate to linear, apex gradually acuminate; margins entire, strongly recurved above but often only on one side below; border well differentiated, with 1-2 rows of linear cells above, to six rows of linear cells below; costa reaching $\frac{4}{5}$ of leaf length; cells oval to narrowly rhomboidal, 20-33 μm long, 5-8 μm wide, with walls slightly thickened; basal cells rectangular, lax, 25-42 μm long, 6-12 μm wide; perichaetial leaves shorter and narrower than vegetative leaves. Synoicous. Calyptra fringed with long hairs at base, covering only operculum. Seta 5-8 mm long, scabrous in upper half, smooth below; capsules ovoid, erect to suberect, 1 mm long; exostome teeth reflexed when wet.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, 1900 m, *H. Mohamed 9139*; Genting Highlands, 1690 m, on moist wood, *H. Mohamed 7662*; Gunung Ulu Kali, 1770 m, on rotten log, *A. Damanhuri 3809*.

WORLD DISTRIBUTION.—Central Africa, Madagascar, Sri Lanka, Nepal, Vietnam, Malaya, Philippines, Java, Borneo, New Guinea, and New Zealand.

REMARKS.—*Daltonia angustifolia* occurs in extensive mats on moist trunks and branches of trees at altitudes from 1900-2000 m. This is the most common and smallest species of the genus in Malaya. It is distinct in having linear-lanceolate leaves and distinctly recurved leaf margins. *Daltonia contorta* has ovate-lanceolate leaves which are strongly contorted when dry whereas leaves of *D. angustifolia* are hardly altered when dry.

Daltonia armata

FIGURES 37-42

Daltonia armata Bartram, Farlowia, 1:508, 1944. [Type: Philippines, Mindanao, Sacred Mountain, Lanao, *Zwickey 638* (FH!).]

Plants moderately robust, yellowish green, in lax cushions; stems rarely branched, to 1.5 cm high; leaves crowded, erect to erect-spreading, flexuose, 3.0-3.8 mm long, 0.7-0.9 mm wide, widest at or above midleaf, broadly ovate-oblong to obovate, acuminate with long spirally contorted arista 200-300 μm long; margins entire, with 1(-2) rows of distinct elongate cells, often involute below; costa weak, less than $\frac{1}{2}$ to $\frac{2}{3}$ leaf length, hidden in strong basal carina; median leaf cells 50-84 μm long, 15-20 μm wide, narrowly hexagonal to oval, with thin walls; basal cells irregularly hexagonal, 80-120 μm long, 18-22 μm wide, orange; propagulae numerous, fusiform,

140-170 μm long, of 6-8 cells; perichaetial leaves smaller, ovate-lanceolate, long-acuminate, ecostate. Dioicous. Seta 5-7 mm long, strongly scabrous above; capsules 1 mm long.

SELECTED SPECIMEN EXAMINED.—Pahang: Cameron Highlands, Strawberry Park Road, on base of tree, 1500 m, *H. Mohamed 9307* (KLU, US).

WORLD DISTRIBUTION.—Malaya, Sumatra, and Philippines.

FERTILITY.—The Malayan specimen had no sporophytes.

REMARKS.—*Daltonia armata* is distinct in possessing large ovate-oblong to obovate leaves which are particularly strongly carinate, a weakly defined costa often not reaching to midleaf, a weak border of 1(-2) rows of cells and a long arista. The weak costa, which is unusual in *Daltonia*, is hidden in the carina of the leaf. Philippine material of the species has been described as having a stronger costa reaching $\frac{2}{3}$ the leaf length (Tan & Robinson 1990).

Daltonia contorta

FIGURES 30-36

Daltonia contorta C. Müller, Syn., 2:660, 1851. [Type: Java, sine loco, *Blume s.n.* (B, destroyed).]

Medium-sized yellow to brownish plants in dense tufts; stems to 1.5 cm high, rarely branched; leaves crowded, erect and strongly twisted and contorted when dry, erect-spreading when moist, ovate-lanceolate, 2.2-2.7 mm long, 0.4-0.6 mm wide, widest below midleaf, abruptly short-acuminate; margins entire and plane; border well differentiated, with 1-2 rows of cells above, to 7 rows of linear cells below; costa strong, extending $\frac{4}{5}$ of leaf length; median cells oval-rhomboidal with firm pale walls, rather opaque, 9-15 μm long, 7-9 μm wide; cells at base rectangular, 20-40 μm long, 8-12 μm wide. Calyptra deeply fringed. Seta 6-8 mm long, scabrous in upper half only, smooth below; capsule erect to suberect, ovoid, 1.2 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, 1890 m, *H. Mohamed 9146*; Genting Highlands, 1600 m, *Sadih & Zamzuri 1590 & 1563*.

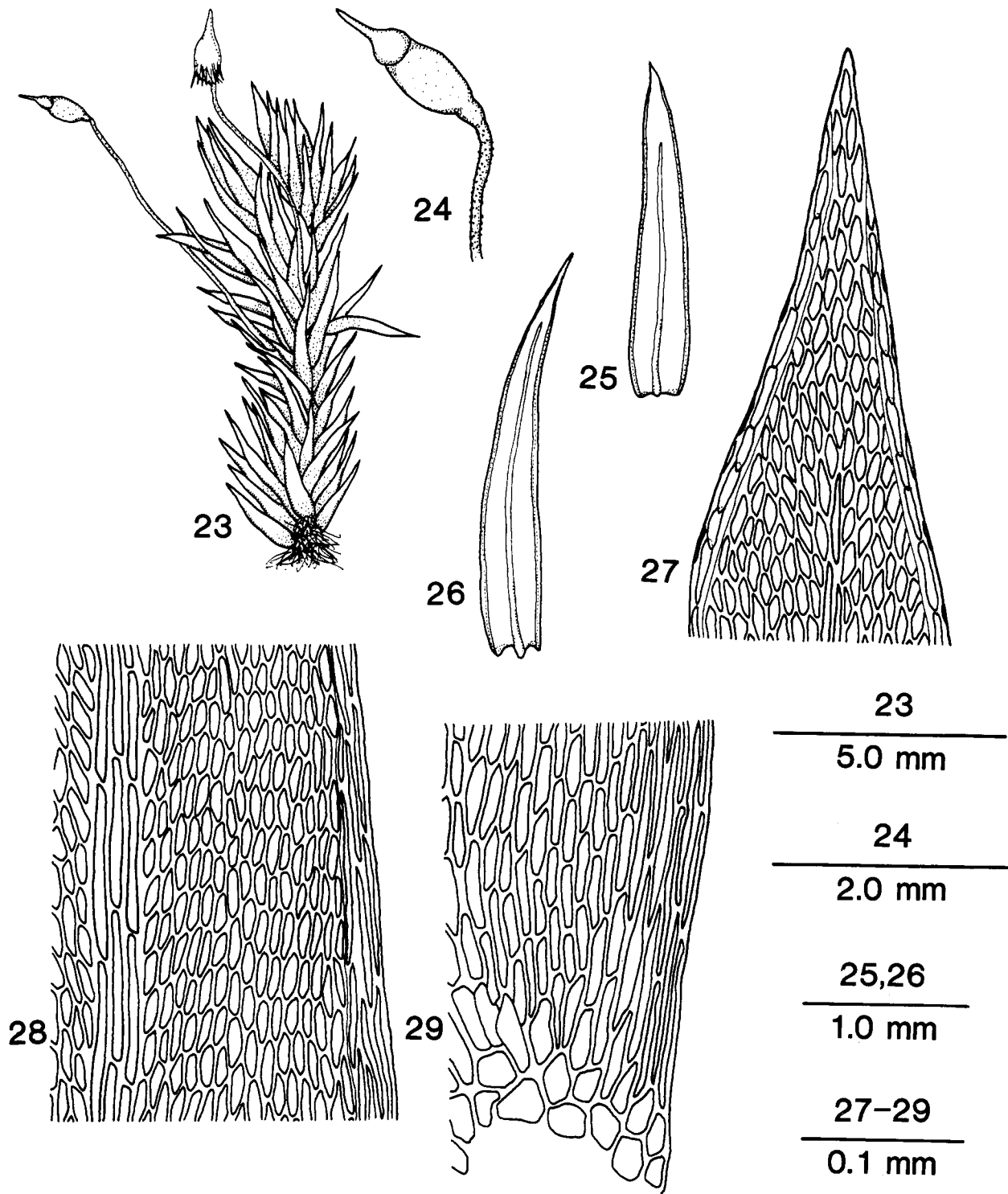
WORLD DISTRIBUTION.—Sri Lanka, Malaya, Java, Philippines, Fiji, and Hawaii.

FERTILITY.—All 4 packets examined had sporophytes.

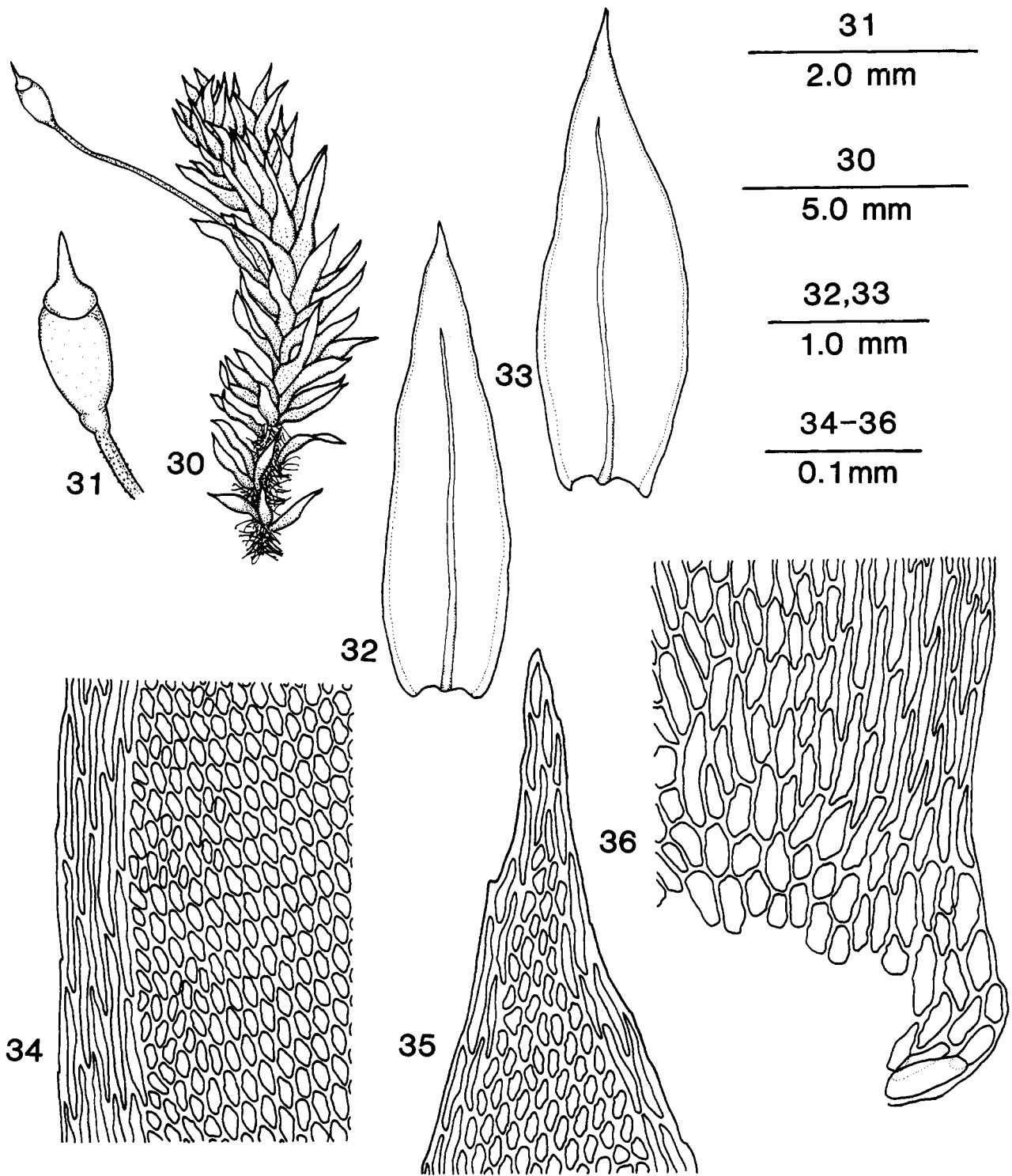
REMARKS.—This species has been collected only on the bases of shrubs at altitudes between 1400 m and 1900 m. The combination of distinctly twisted and contorted ovate-lanceolate leaves, plane leaf margins, wide borders below, and short-acuminate non-aristate apex will differentiate this species from other Malayan members of the genus.

Excluded Species

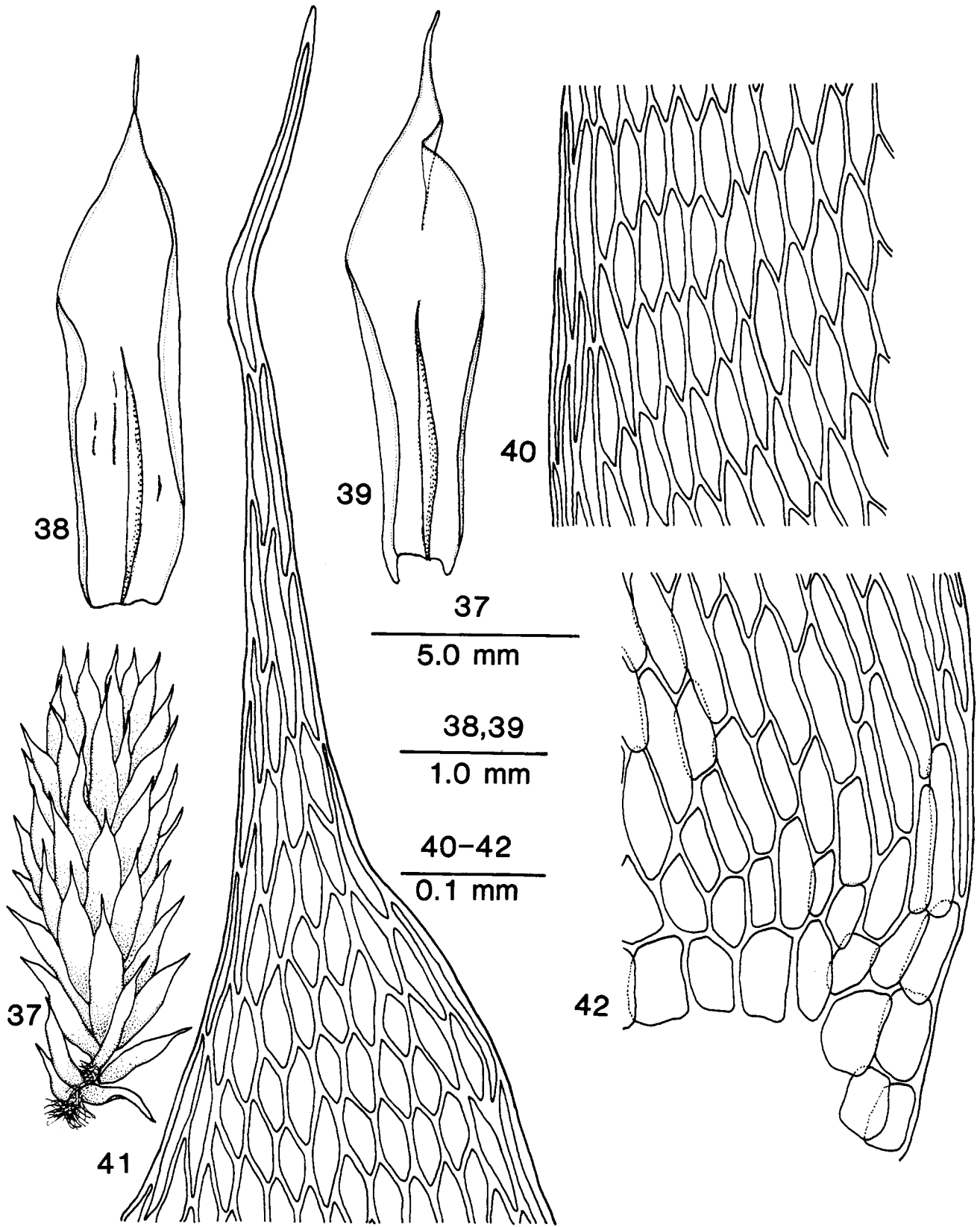
Daltonia aristifolia Renault & Cardot was reported from Malaya by Tixier (1980) based on *Tixier 5220* collected from Pahang, Cameron Highlands, Parit Waterfalls, on twigs, 1400 m, Oct. 26, 1970 (PC). The specimen has been found to be *Distichophyllum cuspidatum*.



FIGURES 23-29.—*Daltonia angustifolia* (Pahang: H. Mohamed 9139): 23, plant, wet; 24, capsule, wet; 25, 26, leaves; 27, cells at leaf apex; 28, cells at margin near midleaf; 29, cells at base of leaf.



FIGURES 30-36.—*Daltonia contorta* (Pahang: H. Mohamed 9146): 30, plant, wet; 31, capsule, wet; 32, 33, leaves; 34, cells at margin near midleaf; 35, cells at leaf apex; 36, cells at leaf base.



FIGURES 37-42.—*Daltonia armata* (Pahang: H. Mohamed 90 9037): 37, plant, wet; 38, 39, leaves showing carina, costa not shown; 40, cells at margin near midleaf; 41, cells at leaf apex; 42, cells at base of leaf.

Genus *Distichophyllidium*

Distichophyllidium Fleischer, Musci Fl. Buitenz., 3:966, 1908.

Plants small, stems branched, densely foliate; leaves erect to erect-spreading, ovate, acuminate with long flexuose arista; margin entire above, recurved below; leaf border narrow; ecostate; median cells hexagonal, homogeneous. Autoicous. Calyptra smooth, lacinate at base. Seta smooth; capsules erect to suberect, ovoid; peristome double, exostome teeth papillose, without median furrow, segments not perforated; operculum rostrate.

Distichophyllidium nymanianum

Distichophyllidium nymanianum Fleischer, Musci Fl. Buitenz., 3:967, 1908.

[Type: West-Java vor Tjibodas am Gedeh, 1200 m, *Nyman s.n.* (FH), not seen.]

Plants small, in light green mats, to 1 cm; stems often branched; leaves erect when dry, erect-spreading when wet, slightly crispate when dry, ovate, 1.1–1.4 mm long, 0.4–0.5 mm wide, widest at midleaf or just below, concave, base distinctly carinate forming a basal pocket, apex acute to obtuse, ending in a long flexuose arista, arista to 0.5 mm long; leaf border well differentiated, with 1 row of linear cells from base to apex; margin entire above, recurved below; median cells hexagonal, 15–22 μm wide, thin-walled, more or less homogeneous, cells near base elongate-hexagonal. Calyptra smooth, fringed at base. Seta smooth, 3–4.5 mm high; capsules erect to suberect, ovoid; urn expanded at mouth, 0.4 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, 1500 m, *H. Mohamed & A.D. Mohamad 1118*.

WORLD DISTRIBUTION.—Malaya, Java, and New Guinea.

FERTILITY.—All 3 packets examined had sporophytes.

REMARKS.—*Distichophyllidium nymanianum* grows in large mats on the bark of trees in shaded moist areas between 1500 m and 1750 m. The absence of a costa, the presence of a long flexuose arista, a strongly carinate leaf base and a papillose peristome will differentiate this species from species of *Distichophyllum*.

Genus *Distichophyllum*

Distichophyllum Dozy & Molkenboer, Musci Frond. Ined. Archip. Indici, 4:99, 1846.

Plants small to robust; stems sparingly branched; leaves complanate, weakly dimorphous, dorsal and ventral rows usually weakly differentiated, crowded, ovate or spatulate, usually entire, usually with a border of elongated cells; costa single, extending from midleaf to leaf apex; upper cells isodiametric, smooth, more lax and elongated at base. Calyptra mitriform, fringed at base. Seta smooth or papillose; capsule erect to pendulous; peristome double; exostome teeth transversely striolate, with a wide median furrow; endostome with high basal membrane, segments sometimes perforated; operculum conic-rostrate.

Distichophyllum is the genus of Hookeriaceae with the most species in Malaya. The members of this genus generally grow on moist, shady substrates such as rocks, soil, humus, and rotten logs at high elevations. Only *Distichophyllum schmidtii* has been collected at low elevations. They also occasionally occur as epiphytes.

Key to Malayan Species of *Distichophyllum*

I. With Sporophytes

(excepting *D. malayense*)

1. Calyptra with long hairs on the surface *D. maibarae*
 Calyptra scabrous or smooth but without long hairs on surface, long hairs only in basal fringe 2
2. Seta scabrous throughout or in part 3
 Seta smooth 8
3. Seta scabrous only near capsule, smooth below *D. brevicuspes*
 Seta scabrous throughout 4
4. Leaf apices not bordered by elongated cells *D. osterwaldii*
 Leaf apices bordered by at least one row of elongated cells 5
5. Submarginal cells of leaf distinctly smaller than paracostal cells; leaf border narrow, consisting of 1–2 rows of elongated cells 6
 Leaf cells more or less homogeneous; leaf border wider, consisting of 2–3(–4) rows of elongated cells 7
6. Plants dioicous *D. spathulatum*
 Plants autoicous *D. mittenii*
7. Median leaf cells 40–55 μm wide; leaf apiculus 50–100 μm long . . . *D. tortile*
 Median leaf cells 14–16(–20) μm wide; leaf apiculus shorter, 30–50(–60) μm long *D. schmidtii*

8. Leaf contracted to a long cuspidate apiculus more than 200 μm long *D. cuspidatum*
 Leaf apiculus less than 100 μm long 9
9. Leaves mostly less than 1.5 mm long; costa reaching midleaf, rarely longer *D. jungermannioides*
 Leaves mostly longer than 1.5 mm; costa reaching $\frac{2}{3}$ of leaf length 10
10. Leaves distinctly crispate and contorted when dry; submarginal cells in upper half of leaf much smaller than juxtacostal cells *D. cirratum*
 Leaves scarcely crispate and contorted when dry; cells in upper half of leaf homogeneous *D. nigricaula*

Key to the Malayan Species of *Distichophyllum*

II. Based on Gametophytic Material

1. Leaf apices with marginal cells quadrate to hexagonal *D. osterwaldii*
 Leaf apices bordered by elongated cells 2
2. Leaves contracted to a long cuspidate point, the leaf acumen more than 200 μm 3
 Leaf apices round or obtuse, mucicous or shortly mucronate, the acumen if present, less than 100 μm long 4
3. Costa less than $\frac{1}{2}$ of leaf length *D. malayense*
 Costa ending just below apex *D. cuspidatum*
4. Leaves more than 3 mm long 5
 Leaves 3 mm long or shorter 8
5. Submarginal cells of leaf distinctly smaller than paracostal cells; leaf border narrow, consisting of 1-2 rows of cells; leaf apiculus less than 20 μm long 6
 Submarginal cells and paracostal cells more or less similar in size; leaf border wider, consisting of 2-3(-4) rows of elongated cells 7
6. Plants dioicous *D. spathulatum*
 Plants autoicous *D. mittenii*
7. Median leaf cells 40-55 μm wide; leaf apiculus 50-100 μm long *D. tortile*
 Median leaf cells 14-16(-20) μm wide; leaf apiculus 30-50(-60) μm long *D. schmidtii*
8. Median leaf cells less than 14 μm wide *D. maibarae*
 Median leaf cells more than 14 μm wide 9
9. Leaves strongly crispate and contorted when dry; submarginal cells much smaller than paracostal cells *D. cirratum*
 Leaves hardly contorted and crisped when dry; cells in upper half of leaf more or less homogeneous 10
10. Leaves often carinate along costa near base; leaf cells collenchymatous; leaf apices acute to obtuse *D. brevicuspis*
 Leaves not carinate along costa; leaf cells not collenchymatous; leaf apices obtuse to round 11
11. Plants with stems less than 8 mm high; costa reaching midleaf, rarely longer *D. jungermannioides*
 Plants with stems to 2.0-3.5 cm long; costa reaching at least $\frac{2}{3}$ of leaf length 12
12. Leaves ovate to broadly elliptic; median cells 16-23 μm wide *D. nigricaula*
 Leaves oblong-ovate to obovate; median cells 14-16(-20) μm wide *D. schmidtii*

Distichophyllum brevicuspes

Distichophyllum brevicuspes Fleischer, Musci Fl. Buitenz., 3:979, 1908. [Type: Java, am Poentjak Pass, *Fleischer s.n.* (lectotype, FH!).]

Plants small to medium sized, mat forming; stems to 1.4 cm long, 2.5 mm wide with leaves, often simple, sometimes branched; leaves yellowish green to green, slightly crisped, ovate to oblong-elliptic, rarely lingulate, often carinate along costa near the base, 1.3–2.3 mm long, 0.7–1.0 mm wide, acute to obtuse, cuspidate, the apiculus (25–)50–82 μm long, not twisted; margin entire above, weakly revolute below; border well differentiated, with 1–2 rows of linear cells near apex, 2(–3) rows below; median cells round to hexagonal, collenchymatous, 13–17 μm wide, more or less homogeneous in upper half of leaf, cells at base hexagonal to rectangular, 40–90 μm long, 18–25 μm wide. Dioicous. Calyptra dark brown and smooth above, yellowish and fringed below. Seta to 6 mm high, scabrous just below neck, smooth below; capsule ovoid cylindrical, 1.5 mm long, mamilllose; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, alt. 1890 m on moist *Cyathea* and wood in partly shaded area, *H. Mohamed* 9071 & 9091.

WORLD DISTRIBUTION.—Java, Philippines, and Malaya.

FERTILITY.—Both specimens examined had sporophytes.

REMARKS.—*Distichophyllum brevicuspes* is a new record for Malaya. Fleischer (1908) compared it to *D. montagneanum* sensu Fleischer (= *D. maibarae*). Although it resembles *D. maibarae* in areolation and leaf apex, it differs in a number of characters. *Distichophyllum brevicuspes* has a carinate leaf base, median leaf cells 13–17 μm wide, setae scabrous just below the capsule and smooth calyptrae, while *D. maibarae* has a plane leaf base, median cells 9–15 μm wide, smooth setae and hairy calyptrae. *Distichophyllum brevicuspes* may also be confused with *D. schmidtii*. It differs in having smaller leaves, shorter leaf apiculi, and setae which are scabrous only just below the neck. In *D. schmidtii* the leaves are larger, the apiculi longer, and the setae are scabrous throughout. In addition, *D. brevicuspes* has been collected only above 1000 m, while *D. schmidtii* has only been collected below 800 m.

Distichophyllum cirratum

FIGURES 50, 52, 53, 56

Distichophyllum cirratum Renaud & Cardot, Rev. Bryol., 23:104, 1896. [Type: Java, Tjibodas, *Massart* 1397 (isotype, FH!).]

Distichophyllum nigricaulae var. *cirratum* (Renaud & Cardot) Fleischer, Musci Fl. Buitenz., 3:982, 1908.

Distichophyllum elmeri Brotherus, Leaflets Philipp. Bot., 2:656, 1909. [Type: Luzon, Baguio, Benguet Prov., *Elmer* 10453 (holotype, H-BR!).]

Distichophyllum sinuosulum Dixon, J. Siam Soc., Nat. Hist., Suppl. 10 (1):15, 1935. [Type: Malaysia, Perak, Birch's Hill, *Burkill* 12606 (holotype, BM!).]

Distichophyllum nigricaulae var. *elmeri* (Brotherus) Tan & Robinson, Smithsonian Contributions to Botany, 75:20, 1990. syn. nov.

Small plants in lax tufts, dull yellowish green; stems

prostrate, 6–10 mm high, up to 3 mm wide with leaves, dark brown or black, laxly foliate, usually simple; leaves strongly crisped and contorted when dry, 1.8–2.5 mm long, 1.0–1.4 mm wide, widest at midleaf or slightly above, ovate to obovate, base often narrowed, apically rounded and apiculate, the apiculus (10–)30–50(–75) μm long; ventral and dorsal leaves smaller; margin entire, somewhat undulate; leaf border well differentiated with 2–3 rows of linear cells near the apex, 4–6 rows of linear cells near the base; costa length variable, $\frac{3}{5}$ to $\frac{4}{5}$ of leaf length, sometimes percurrent; paracostal cells irregularly hexagonal, 22–35 μm wide, gradually decreasing in size towards margins, collenchymatous; marginal cells hexagonal to round, 12–16 μm wide, cell walls slightly thickened, weakly collenchymatous; basal cells hexagonal to short rectangular, 50–75 μm long, 15–25 μm wide. Dioicous. Calyptra scabrous above, fringed with long cilia. Seta 7–8 mm long, smooth; capsule horizontal to inclined; urn 1 mm long, mamilllose; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Perak: Maxwell Hill, 1180 m, *H. Mohamed et al.* 8107. Pahang: Cameron Highlands, 1560 m, *H. Mohamed* 9132 & 9172; Tanah Rata, 1440 m, *H. Mohamed & Zamzuri* 1059a.

WORLD DISTRIBUTION.—Nepal, Thailand, Ryukyu Islands, Taiwan, Malaya, Sumatra, Java, Borneo, Philippines, and New Guinea.

FERTILITY.—Of the 16 packets examined, 10 had sporophytes.

REMARKS.—*Distichophyllum cirratum* has been collected between the altitudes of 1180 m and 1880 m on the mainland and at 800 m on the island of Tioman. Thirteen of the packets were collected on moist soil while three packets were collected on moist rocks.

Distichophyllum cirratum is characterised by dark stems, strongly crisped and contorted leaves when dry, wide borders, and submarginal cells which are smaller than paracostal cells. In addition, the median cells of the Malayan specimens are collenchymatous. Differences between this species and *D. nigricaulae* are discussed under the latter.

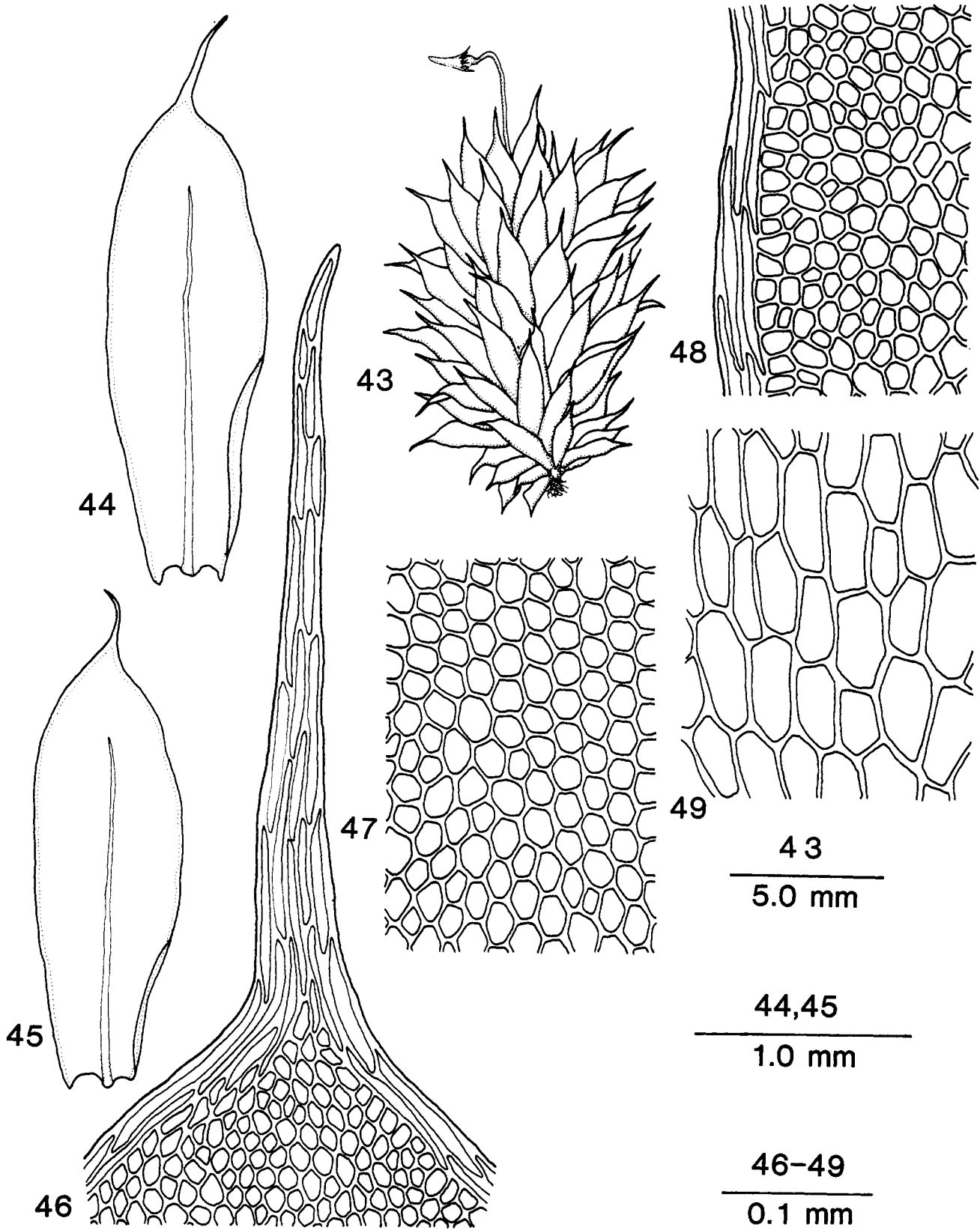
Distichophyllum cuspidatum

FIGURES 43–49

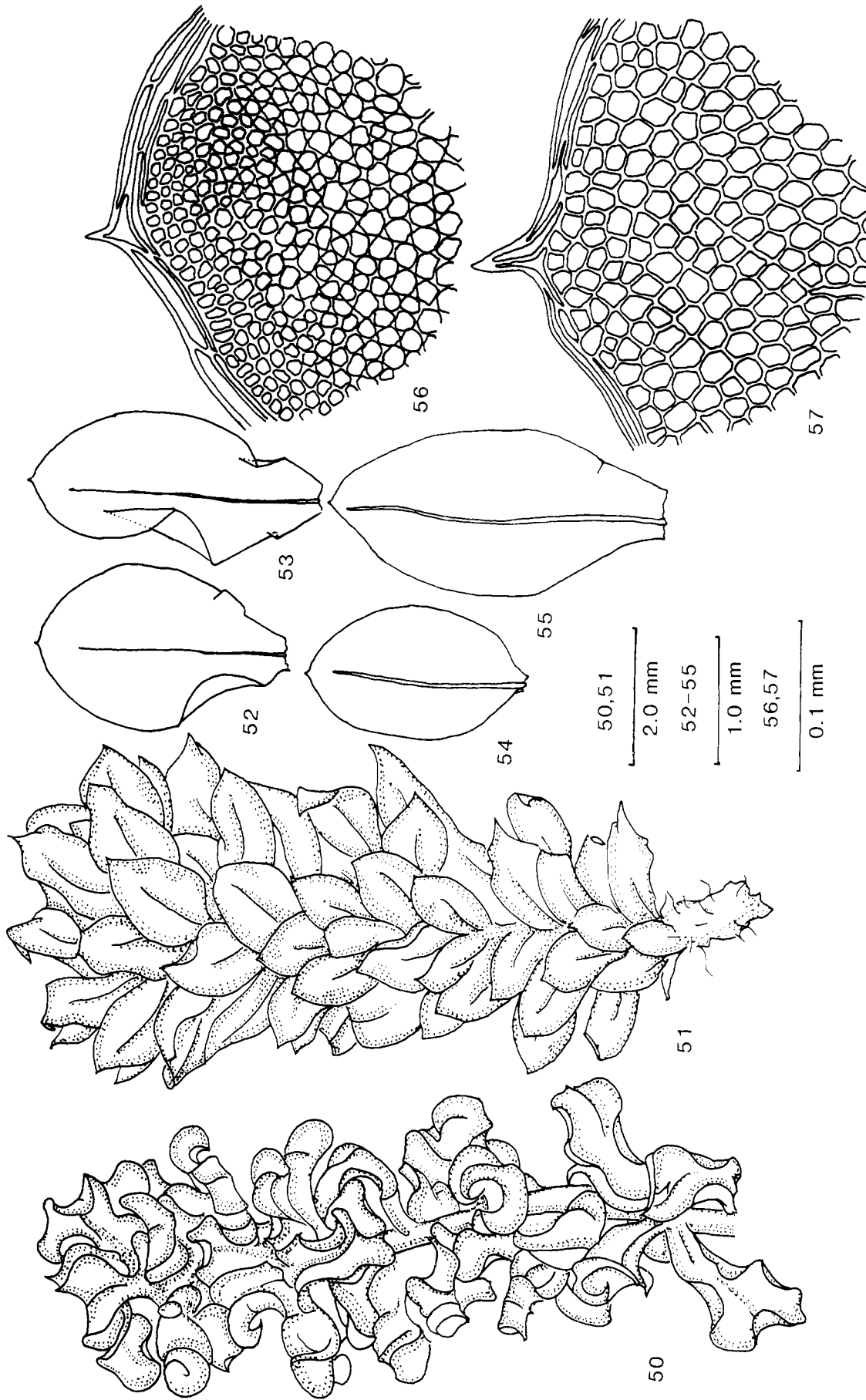
Distichophyllum cuspidatum (Dozy & Molkenboer) Dozy & Molkenboer, Musci Frond. Ined. Archip. Indici, 4:101, 1846.

Hookeria cuspidata Dozy & Molkenboer, Ann. Sci. Nat. Bot., sér. 3, 2:305, 1844. [Types: Java, prope Limbang, *Zippelius s.n.*, *Korthals s.n.* (L), not seen; Sumatra, Batang-Bessie, *Korthals s.n.* (L), not seen.]

Plants dark green above, yellow below, prostrate, in tufts; stems to 2 cm long; leaves compressed on the stem in a dorsi-ventral arrangement, 3–4.6 mm long, 0.9–1.3 mm wide, elliptic-oblong to oblanceolate, abruptly contracted to a long cuspidate point to 650 μm in length; margins entire, slightly



FIGURES 43-49.—*Distichophyllum cuspidatum* (Pahang: *M.G. Manuel 2729*): 43, plant, wet; 44, 45, leaves; 46, cells at leaf apex; 47, median cells of leaf; 48, cells at margin near midleaf; 49, cells at base of leaf.



FIGURES 50-57.—*Distichophyllum*; 50, 52, 53, 56, *D. cirratum* (Pahang: H. Mohamed 9132); 50, plant, dry; 52, 53, leaves; 56, cells at leaf apex; 51, 54, 55, 57, *D. nigricaulis* (Pahang: H. Mohamed & Zamzuri 9225a); 51, plant, dry; 54, 55, leaves; 57, cells at leaf apex.

revolute at leaf base; borders well developed, with 2–3 rows of thick walled elongated cells; costa extending to near apex; median cells round, (6–)9–15(–17) μm , thick walled, collenchymatous; basal cells lax, rhomboidal, 40–60 μm long, 18–24 μm wide. Synoicous and autoicous. Calyptra naked, fringed at base. Seta smooth, up to 5 mm long; capsule erect to inclined, 1 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Gunung Ulu Kali, 5000 ft., *Manuel* 2729, 3417; Cameron Highlands, Gunung Chantek, *Sadiah* and *Zamzuri* 1114. Perak: Maxwell Hill, trail to Microwave Station, *H. Mohamed et al.* 8085. Penang: Moniot Road, on branches near ground, *Burkill* 2584 (SING).

WORLD DISTRIBUTION.—Sri Lanka, Sumatra, Thailand, Malaya, Java, Borneo, Philippines, Taiwan, Japan, New Guinea, New Caledonia, and Society Islands.

FERTILITY.—All 8 specimens examined had sporophytes.

REMARKS.—All the specimens examined were collected on wood or trees in moderately shaded places between 1200 m and 1800 m. This is one of the few epiphytic *Distichophyllum* species in Malaya. It is not likely to be confused with any other species of the genus in Malaya by virtue of its long cuspidate arista, collenchymatous leaf cells, and costa ending just below the apex.

Distichophyllum jungermannioides

FIGURES 58–64

Distichophyllum jungermannioides (C. Müller) Bosch & Lacoste, Bryol. Jav., 2:22, 1861.

Mniadelphus jungermannioides C. Müller, Syn., 2:660, 1851. [Type: Java, *Blume s.n.* (B, destroyed).]

Mniadelphus nanus (Dozy & Molkenboer) Jaeger, Ber. St. Gall. Naturw. Ges., 1875–1876:324, 1877 (Ad. 2:228).

Distichophyllum nanum Dozy & Molkenboer in Zollinger, Syst. Verzeichn., 32, 1855. [Type: Java, Herb. van den Bosch (L!).]

Distichophyllum ulukaliense Damanhuri & Mohamed, J. Bryol., 14:329, 1986. [Type: Pahang, Gunung Ulu Kali, *Damanhuri* 2645 (KLU!).] syn. nov.

Plants small, in mats, light green; stems suberect, to 8 mm long, 2.5 mm wide with leaves when wet, simple or branched; leaves crispate and slightly shrunken when dry, ovate to obovate, 1.1–1.5(–1.9) mm long, 0.7–1 mm wide, widest between midleaf and $\frac{3}{4}$ from base of leaf, obtuse to rounded, apiculate, the apiculus (50–)70–90 μm long, often twisted; margins entire, plane; borders well differentiated, with 1–2 rows of linear cells near apex, 2(–3) rows towards base; costa rarely extending beyond midleaf; median cells rounded to hexagonal, thin walled, weakly collenchymatous, 20–25 μm long, 16–21 μm wide, more or less homogeneous in upper half of leaf; basal cells hexagonal to rectangular, 40–50 μm long, 18–22 μm wide. Dioicous. Calyptra smooth, brown above, colorless and fringed below. Seta to 4 mm, smooth; capsule ovoid; urn 0.7 mm long; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Pulau Tioman, Gunung Kajang, 840 m, *Zamzuri* 162; Cameron Highlands,

1560 m, *H. Mohamed* 9117a; Gunung Ulu Kali, 5000 ft, *Manuel* 2726b.

WORLD DISTRIBUTION.—Java, Malaya, Sumbawa, Botel Tobago, and Taiwan.

FERTILITY.—Eight of the 10 packets examined had sporophytes.

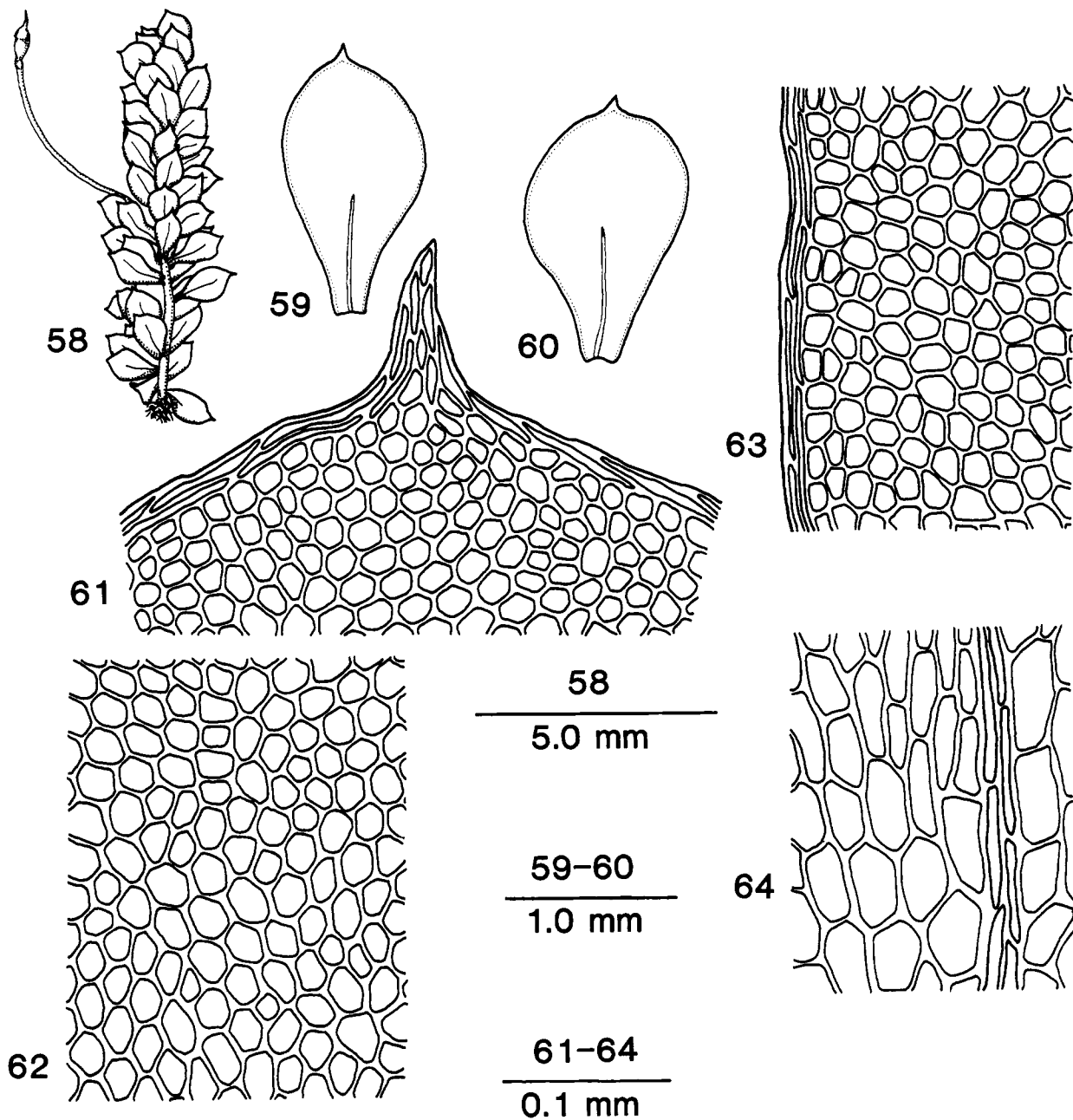
REMARKS.—*Distichophyllum jungermannioides* is a new record for Malaya. It has been collected on the lower trunk of trees above 1400 m on the mainland while on the island of Tioman it has been collected at 800 m. This is a highly variable species. The type specimen has apiculi measuring 84–108 μm long whereas the Malayan specimens rarely have apiculi exceeding 90 μm . *Zamzuri* 162 is a robust specimen in which the median cells measure 15–20 μm wide and the costa sometimes extends to $\frac{3}{4}$ of leaf length. The leaves are also larger, measuring 1.5–1.9 mm long, 0.7–1 mm wide. This species is easily recognised by its small size, short costa, and a distinct apiculus. The type specimen of *Distichophyllum ulukaliense* Damanhuri & Mohamed differs from the type specimen of *D. jungermannioides* in having a shorter apiculus, 40–60(–80) μm long, which is not twisted, and in having smaller leaves and leaf cells than those of *D. jungermannioides*, but they are similar in all other aspects. *Distichophyllum brevicuspes* differs from the present species in having much larger leaves which are distinctly carinate along the costa and median cells which are collenchymatous.

Distichophyllum maibarae

Distichophyllum maibarae Bescherelle, J. Bot. (Morot), 13:40, 1899. [Type: Central Japan, Maibara, *Faurie* 11130 (holotype, BM!).]

Plants small to medium sized, in loose tufts; stems creeping, to 8 mm long, 3 mm wide with leaves when wet, simple, rarely branched; leaves slightly shrunken and crisped when dry, ovate-oblong to obovate, 1.3–2 mm long, 0.6–1.0 mm wide, widest between midleaf and $\frac{3}{4}$ from base, slightly asymmetrical, rounded to obtuse with a stout apiculus, the apiculus (30–)45–80 μm long; margin entire and plane; borders well differentiated, with 1–2 rows of linear cells near the apex, 2–3 rows towards the base; costa flexuose above, extending $\frac{3}{5}$ to $\frac{4}{5}$ of leaf length; median cells small, round to hexagonal, 9–14 μm in width, thin-walled, not collenchymatous, more or less homogeneous in upper half of leaf and in submarginal region towards base; paracostal cells in lower half of leaf larger than submarginal cells, hexagonal to rectangular, 35–60 μm long, 18–25 μm wide. Autoicous. Calyptra with several hairs on the surface, fringed at base. Seta smooth, to 7 mm long; capsule inclined, ovoid, 1 mm long; exothecial cells mamillate, collenchymatous; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, 1760 m, lower montane forest, on tree base facing fast flowing stream, *H. Mohamed* & *Zamzuri* 1186 (mixed with *Distichophyllum cuspidatum*).

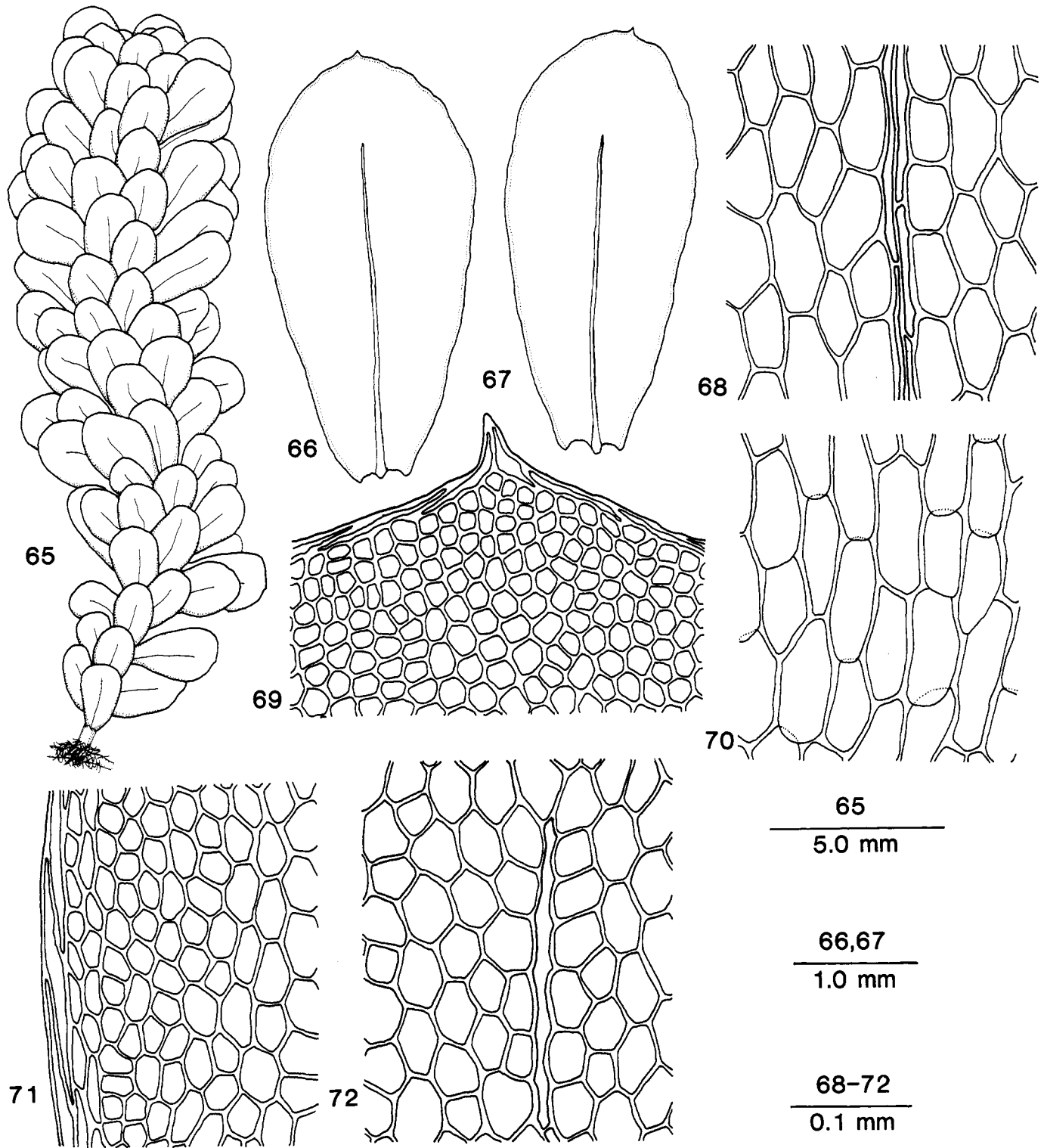


FIGURES 58-64.—*Distichophyllum jungermannioides* (Pahang: H. Mohamed 9117a): 58, plant, wet; 59, 60, leaves; 61, cells at leaf apex; 62, median cells of leaf; 63, cells at margin of midleaf; 64, paracostal cells at base of leaf.

WORLD DISTRIBUTION.—Japan, China, Taiwan, Malaya, and Philippines.

REMARKS.—*Distichophyllum maibarae* is newly recorded for Peninsular Malaysia. This is the only species of the genus in Malaya which possesses hairy calyptrae. Apart from this character, the homogeneous nature of the cells in the upper half of leaf, the small size of the cells, and the distinct apiculus will set it apart from other species. Although Bescherelle (1899) compared it to *D. nigricaulis*, Noguchi (1956) and Tan &

Robinson (1990) believed that it is more closely related to *D. montagneanum* (C. Müller) Bosch & Lacoste. To study the relationships between these two species, the type specimens of both the species as well as non-types were examined. The type specimen of *D. maibarae* specifically differs from the type of *D. montagneanum* in having a longer, stouter apiculus on the leaf. The type of *D. montagneanum* does not possess sporophytes. However, a number of specimens of this species from Sri Lanka and India have sporophytes which have smooth



FIGURES 65-72.—*Distichophyllum mittenii* (Pahang: H. Mohamed & Damanhuri 5057): 65, plant, wet; 66, 67, leaves; 68, paracostal cells near midleaf; 69, cells at leaf apex; 70, cells at base of leaf; 71, cells at margin of midleaf; 72, paracostal cells at tip of costa.

calyptra. In his keys to the genus *Distichophyllum* in Indonesia, Fleischer (1908) described *D. montagneanum* as having a hairy calyptra (...haube mit aufrechten Cilien besetzt.). By courtesy of the staff at FH, we were able to examine the three specimens from Java cited by Fleischer: (1) bei Tjibodas am Gedeh 1450 m, (2) bei Huis Ten Bosch am Gedeh 2100 m, (3) Tjibodas-Trawas Pandjang, 1900 m. All three specimens have sporophytes with hairy calyptrae. The fourth specimen cited by Fleischer, which is from Nilghiris, India, could not be located. However, another specimen labelled by Fleischer as *D. montagneanum* has sporophytes which have smooth calyptrae. Because *D. montagneanum* and *D. maibarae* are similar in leaf shape, areolation, and in the size of the leaf cells, Fleischer confused the two species. *Distichophyllum montagneanum* evidently is restricted to India and Sri Lanka, and the specimens from Java under the name *D. montagneanum* with hairy calyptrae are *D. maibarae*.

Distichophyllum malayense

Distichophyllum malayense Damanhuri & Mohamed, J. Bryol., 14:327, 1986. [Type: Pahang, Genting Highlands, *Damanhuri* 2723 (KLU!).]

Plants in lax tufts, pale green; stems to 6 mm high and 2.5 mm wide with leaves, brown to reddish brown, mostly simple, rarely branched; leaves slightly contorted and undulate when dry, elliptic to ovate-lanceolate, 1.8–2.5 mm long, 0.5–0.7 mm wide, acuminate with a long subulate point, usually twisted when dry, the apiculus 250–450 μ m long; margins entire; border distinctly differentiated, consists of 1–2 rows of linear thin-walled cells; costa weakly defined, reaching up to $2/5$ of leaf length, rarely longer; median leaf cells more or less uniform in size, lax, thin-walled, large, hexagonal, 38–77 μ m long, 30–57 μ m wide; basal cells lax, rectangular, 64–123 μ m long, 25–40 μ m wide; perichaetial leaves without costa, oblong-lanceolate, 0.9–1.2 mm long, 0.2–0.3 mm wide; apex subulate. Dioicous. Sporophyte unknown.

SELECTED SPECIMENS EXAMINED.—Pahang: Genting Highlands, 960 m, *Damanhuri* 2723; 750 m, *Damanhuri* 3028 (KLU, UKMB).

WORLD DISTRIBUTION.—Endemic to Malaya.

REMARKS.—*Distichophyllum malayense* has been collected on rotten logs in shade near streams between 750 m and 1000 m. It is distinct in having leaves with a long subulate point and a weakly developed costa extending less than $1/2$ the leaf length. It may be confused with *D. cuspidatum*, but the distinct costa extending to $3/4$ of the leaf length and the narrower leaf cells in the latter will set it apart.

Distichophyllum mittenii

FIGURES 65–72

Distichophyllum mittenii Bosch & Lacoste, Bryol. Jav., 2:25, 1861. [Types: Java, sine loco, *Teysmann* s.n. (L), not seen; *Holle* s.n. (L), not seen; prope Toegoe, pr. Bogor, *Amann* s.n. (L), not seen.]

Plants robust, forming mats; stems simple or branched, prostrate, rarely ascending, complanate, to 9 cm long, 1 cm wide with leaves; leaves densely set on stem, contorted and moderately crisped when dry, 3.4–6.0 mm long, 1.4–2.2 mm wide, widest above mid-leaf, spatulate to obovate, broadly rounded above with one or two tiny apiculi, apiculus often less than 20 μ m long; costa strong, reaching $3/4$ to $4/5$ of leaf length; margins entire; borders narrow, with 1 row of linear cells at the apex and 2 rows below; submarginal cells much smaller than paracostal cells, quadrate to oval, 10 to 20 μ m wide, forming several rows near margin above; paracostal cells hexagonal to polygonal, 30 to 60 μ m long, 25 to 35 μ m wide, thick-walled; cells at base rectangular or long-hexagonal, 70 to 100 μ m long, 20–35 μ m wide. Autoicous. Calyptra scabrous, base fringed with long cilia. Seta up to 8 mm, scabrous throughout, the projecting papillae 25 to 35 μ m long; capsules inclined to horizontal, ovoid to ovoid-oblong, exothecial cells mamillate; operculum conic-rostrate.

SELECTED SPECIMENS EXAMINED.—Pahang: *H. Mohamed & Damanhuri* 5057; Cameron Highlands, Gunung Brinchang, *H. Mohamed & Zamzuri* 1169; Gunung Ulu Kali, *Stone* 13378. Perak: Maxwell Hill, Gunung Hijau Trail, *Manuel* 2341.

WORLD DISTRIBUTION.—Sri Lanka, Thailand, Malaya, Java, Sumatra, Borneo, Philippines, Taiwan, Japan, New Guinea, New Caledonia, and Vanuatu.

FERTILITY.—Eight of the 12 packets examined had sporophytes.

REMARKS.—This species has been collected above 1000 m on rotten logs, humus, and soil in moist shady places.

Distichophyllum nigricaula

FIGURES 51, 54, 55, 57

Distichophyllum nigricaula Mitten ex Bosch & Lacoste, Bryol. Jav., 2:20, 1861. [Types: Java, Mt. Pangerango, *Molley* s.n. (lectotype, NY!); sine loco, *Teysmann* s.n. (syntypes, BO, L), not seen.]

Distichophyllum gracilicaule Fleischer, Musci Fl. Buitenz., 3:983, 1908. [Types: West Java, um Tjibodas am Gedeh, *Fleischer* s.n. (lectotype, FH!); am Poentjak, *Fleischer* s.n. (syntype, FH!).]

Plants in medium-sized mats, light green; stems with leaves to 2 cm long, to 3.5 mm wide when wet, simple or branched; leaves distantly placed on stem, scarcely shrunken and only slightly crisped when dry, slightly concave, ovate to broadly elliptic, rarely obovate, 1.5–2.2 mm long, 0.95–1.1 mm wide, widest at midleaf, obtuse to rounded with a distinct apiculus, the apiculus (25–)30–60 μ m long; margin entire and plane; borders well differentiated, with 1–2 rows of linear cells near apex, 3–4 rows below; costa flexuose above, extending from $3/4$ to $4/5$ of leaf length; median cells hexagonal to rounded, 16–23 μ m wide, moderately thick-walled, weakly collenchymatous, more or less homogeneous in upper half of leaf and submarginal region towards base; paracostal cells towards base larger, hexagonal to rectangular, 45–90 μ m long, 20–27 μ m wide. Dioicous. Calyptra smooth, fringed, and yellowish

below, dark brown above. Seta smooth, to 7 mm long; capsule too young to be examined.

SELECTED SPECIMENS EXAMINED.—Pahang: Fraser Hill, 980 m, *H. Mohamed & Zamzuri 9225a & 9226*; Genting Highlands, *Damanhuri 2556, 2568, 2570 & 2574*; Pulau Tioman, Gunung Kajang, 920 m, *Zamzuri 170*.

JAVA: Batavia, Gunung Pasir Angin, near Gadok, regio calida, 500 m, *Schiffner 12732 (US)*.

WORLD DISTRIBUTION.—Java, Borneo, Malaya, and Thailand.

REMARKS.—Tan & Robinson (1990) noted that when Fleischer (1908) described *D. gracilicaule*, he had been misguided by atypical specimens of *D. nigricaule*. Fleischer stated that the costa of *D. nigricaule* is often percurrent and that the submarginal cells are distinctly smaller than the inner ones. The lectotype of *D. nigricaule* from NY does not show such distinctions. Evidently as a result of Fleischer's misconception of *D. nigricaule*, many later authors such as Bartram (1939) have mistakenly cited *D. cirratum* as a synonym of *D. nigricaule*.

Distichophyllum nigricaule differs from *D. cirratum* in the wider leaf border near the apex and homogeneous size of the leaf cells in the upper half of the leaf. In addition, *D. nigricaule* differs from *D. cirratum* by its leaves which are only slightly crispate when dry. In *D. cirratum* the leaf cells are often lax and collenchymatous whereas in *D. nigricaule* the cells are often firm and only slightly collenchymatous. In Malaya, *D. cirratum* has been collected only above 1000 m, whereas *D. nigricaule* has only been collected below 1000 m.

Distichophyllum osterwaldii

FIGURES 73–79

Distichophyllum osterwaldii Fleischer, Musci Fl. Buitenz., 3:994, 1908. [Type: West Java, Gedegebirge bei Tjibodas, *Fleischer s.n. (FH!)*.]

Plants robust, laxly tufted, green to dark green; stems ascending from a rhizomatous base, to 4 cm high, often branched, laxly foliate, flat, to 6 mm wide with leaves; leaves weakly undulate-crispate when dry, lateral rows widely spreading, lingulate, 4–6 mm long, 1.7–2.5 mm wide, rounded above and mucous; margins sometimes undulate, minutely crenulate above where unbordered; not bordered at apex, bordered below by 2–3 rows of linear pellucid cells for $\frac{3}{4}$ of leaf length; costa extending to $\frac{4}{5}$ of leaf length; median cells isodiametric to irregularly hexagonal, 15–22 μm wide near apical margin, quadrate to hexagonal, 25–40 μm wide near apical portion of costa; cells near base laxer, rectangular to elongate-hexagonal, 50–115 μm long, 20–27 μm wide. Dioicous. Calyptra fringed at base and scabrous above. Seta 0.8–1.2 cm long, flexuose, distinctly papillose throughout, papillae to 23 μm high; capsule inclined, 1 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, *H. Mohamed & Damanhuri*

5059b & 5074; Damanhuri 2014; Gunung Ulu Kali, area between microwave station and radar station, *Manuel 2457*.

WORLD DISTRIBUTION.—Malaya, Borneo, Java, Philippines, Taiwan, Mainland China, and Japan.

FERTILITY.—Only 5 of the 8 specimens examined had sporophytes.

REMARKS.—*Distichophyllum osterwaldii* has been collected on shaded moist humus and wood in montane ericaceous forest. All 8 specimens examined were collected between 1600 m and 2100 m. The Malayan specimens of *D. osterwaldii* differ in a number of ways from the type from Java. The type specimen is extremely large, measuring to 8 cm long, while the Malayan specimens rarely measure above 4 cm. The leaves in the type are distantly arranged on the stem and are distinctly undulate whereas the local specimens are densely set on the stem and only slightly undulate. Further, the leaves in the type are unbordered in the upper half of the leaf while the Malayan specimens are unbordered only in the upper quarter of the leaf. *Distichophyllum osterwaldii* is closely related to *D. denticulatum* Dixon from Borneo and *D. obtusifolium* Thériot from Japan. However, the latter two species differ in being much smaller in size and in having at least one row of differentiated cells at the apex. *Distichophyllum denticulatum* has a distinctly denticulate margin at the apex whereas *D. osterwaldii* has at most a crenulate margin. *Distichophyllum obtusifolium* differs from the present species in having wide, homogeneous median cells in the upper half of the leaf.

Distichophyllum schmidtii

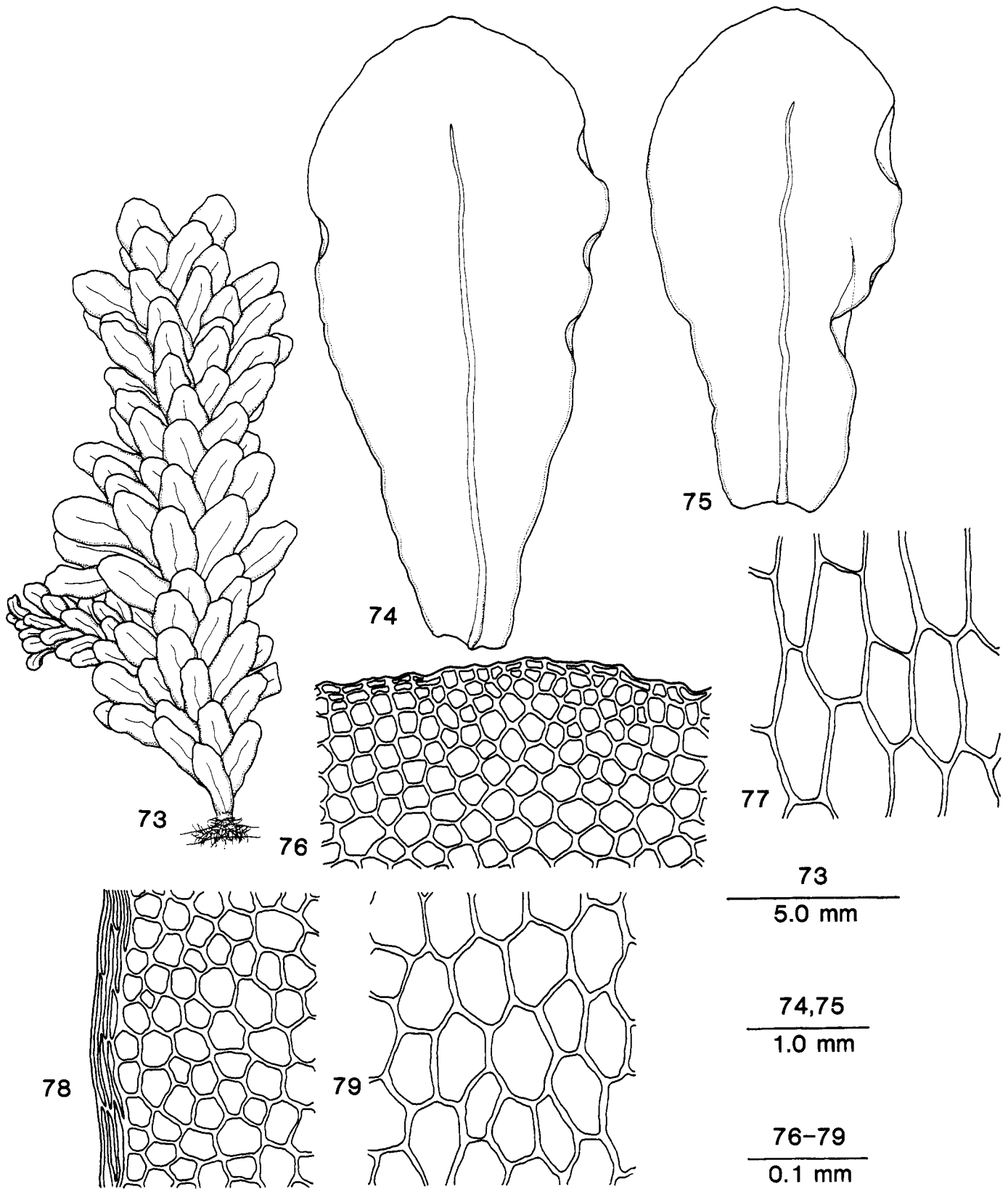
FIGURES 80–86

Distichophyllum schmidtii Brotherus, Bot. Tidskr., 24:122, 1901. [Holotype: Siam, Ins. Koh Chang, ad rupos irror in silvos, 1900, *J. Schmidt (H-BR!)*.]

Plants medium- to large-sized, in mats; stems prostrate, to 3.5 cm long, 5 mm wide with leaves when wet, simple or branched; leaves scarcely shrunken and slightly crisped when dry, oblong-ovate to obovate, 2–3 mm long, 0.9–1.1 mm wide, widest between $\frac{3}{5}$ to $\frac{4}{5}$ from base of leaf, round to obtuse with a small mucro, the mucro 30–50(–60) μm long; margins entire and plane; borders well differentiated, with 1–2 rows of linear cells near the apex, 2–3(–4) rows of linear cells near the base; costa flexuose on top, extending from $\frac{3}{4}$ to $\frac{4}{5}$ of leaf length; median and upper cells irregularly hexagonal, 20–35 μm long, 14–16(–20) μm wide, thin-walled, more or less homogeneous in upper quarter of leaf and submarginal region to midleaf; paracostal cells much larger below, lax, hexagonal to rectangular, 50–95 μm long, 15–28 μm wide. Dioicous. Calyptra smooth, fringed at base. Setae up to 8 mm high, scabrous throughout, the projecting papillae 8–10 μm long; operculum rostrate.

SELECTED SPECIMENS EXAMINED.—Selangor: Templer Park, *Manuel 2692, 2823; Sadiyah & Zamzuri 1565, 1568*.

SINGAPORE: Bukit Timah, *Holtum 19328*.



FIGURES 73-79.—*Distichophyllum osterwaldii* (Pahang: *Damanhuri* 2014): 73, plant, wet; 74, 75, leaves; 76, cells at apex of leaf; 77, basal cells of leaf; 78, cells at margin at midleaf; 79, paracostal cells at tip of costa.

73

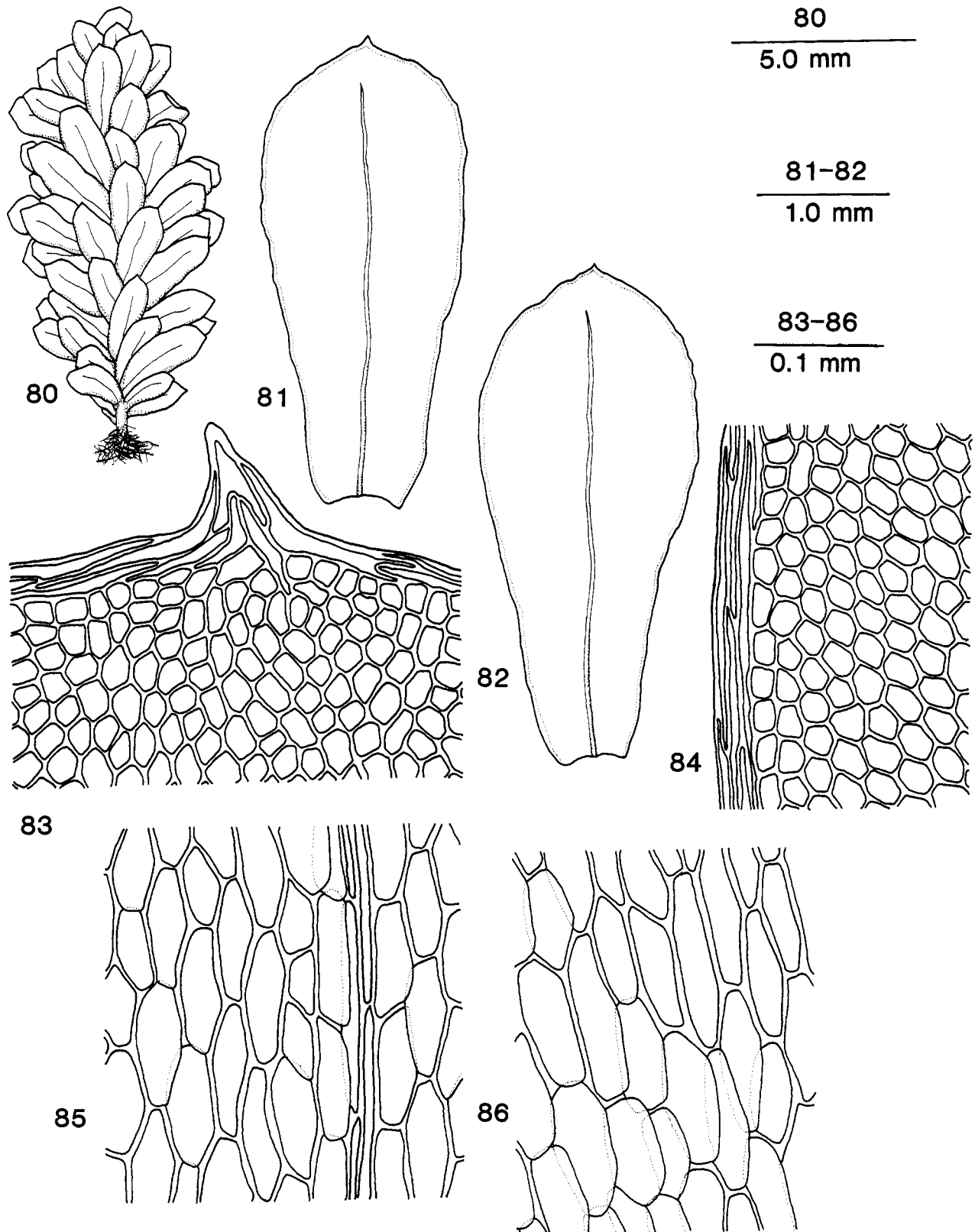
 5.0 mm

74,75

 1.0 mm

76-79

 0.1 mm



FIGURES 80-86.—*Distichophyllum schmidtii* (Pahang: Manuel 2692): 80, plant, wet; 81, 82, leaves; 83, cells at apex of leaf; 84, cells at margin near midleaf; 85, paracostal cells below midleaf; 86, cells at base of leaf.

THAILAND: Payap, ~30 km S of Khun Sam, *Touw 11323*.

WORLD DISTRIBUTION.—Singapore, Malaya, Thailand, and Bangladesh.

FERTILITY.—Of the 6 packets examined, 5 had sporophytes.

REMARKS.—Unlike other species of this genus in Malaya, *D. schmidtii* grows at very low altitudes. The type was collected near Lem Dan which has an altitude of around 100 m. In Malaya and Singapore, it has been collected below 100 m while *Touw 11323* (L) was collected at 550 m. It grows on moist rocks and bases of trees near streams. *Distichophyllum schmidtii* superficially resembles *D. mittenii*. However, *D. schmidtii* differs from the latter in the smaller size of the plants and leaves, homogeneous areolation in the upper quarter of the leaf, broader leaf border, longer apiculi, and smooth calyptrae. In addition, *D. mittenii* is a plant of higher altitudes (above 1000 m). The present species seems to be closely related to *Distichophyllum lorianum* Fleischer from New Guinea in having leaves with similar morphology, homogeneous leaf areolation, short apiculi, and a narrow border. More specimens of the latter must be studied to ascertain the relationship to the present species. Although *D. schmidtii* resembles *D. tortile* in possessing homogeneous upper leaf cells, it has narrower leaf cells 14–16(–20) μm compared to cells wider than 30 μm in the latter.

Distichophyllum spathulatum

FIGURES 87–93

Distichophyllum spathulatum (Dozy & Molkenboer) Dozy & Molkenboer, Musci Frond. Ined. Archip. Indici, 4:103, 1846.

Hookeria spathulata Dozy & Molkenboer, Ann. Sc. Nat. Bot., sér. 3, 2:305, 1844. [Type: West-Java, Buitenzorg? *Miquel* (L), not seen.]

This species is similar in all aspects to *D. mittenii* except that it has a dioicous inflorescence.

SELECTED SPECIMENS EXAMINED.—Pahang: *H. Mohamed & Damanhuri 5015*; Cameron Highlands, *Holtum 23369* (SING); Fraser's Hill, *Burkill 2088* (SING). Perak: Maxwell Hill, *Burkill 13197* (SING).

WORLD DISTRIBUTION.—Thailand, Malaya, Java, Sumatra, Taiwan, New Caledonia, and Tahiti.

FERTILITY.—Thirty-one of the 42 specimens examined had sporophytes.

REMARKS.—This species is the largest and most common of the genus in Malaya, and forms extensive mats on moist shaded humus and rotting logs in montane ericaceous forests. Plants are rarely found growing on soil and rocks. Thirty nine of the specimens were collected between 1500 m and 2100 m and three of them were collected between 1200 m and 1400 m. Bosch & Lacoste (in Dozy & Molkenboer, 1861) distinguished this species from *D. mittenii* on the basis of sexuality; *D. spathulatum* being dioicous and *D. mittenii* being autoicous. Such a distinction is present in Malayan plants although there are no differences in other gametophytic characters or in the sporophytic characters. Both species are found in the same

locality but *D. spathulatum* is much more common than *D. mittenii*.

Distichophyllum tortile

FIGURES 94–98

Distichophyllum tortile Dozy & Molkenboer ex Bosch & Lacoste, Bryol. Jav., 2:27, 1862. [Types: Java, Gedeh, *Teysmann s.n.* (L), not seen; Banca, sine loco, *Amann s.n.* (L), not seen.]

Plants robust, green to dark green; stems to 4 cm long, to 6 mm wide with leaves; leaves loosely inserted on stem, crisped when dry, oblong-lingulate to slightly obovate, 3.3 to 4.4 mm long, 1.0–1.4 mm wide, widest at distal $\frac{1}{4}$, obtuse above, apiculate, the apiculus 50–100 μm long; margins entire, plane; borders distinct, with 2 rows of linear cells near the apex, 3(–4) rows below; costa reaching $\frac{3}{4}$ to $\frac{4}{5}$ of leaf length; median leaf cells large, homogeneous in the upper part of leaf, hexagonal, 40 to 55 μm wide, thin-walled; basal cells rectangular to long-hexagonal, 70–110 μm long, 30–40 μm wide. Dioicous. Calyptra smooth above, fringed below. Seta 5–7 mm long, papillose, the projecting papillae to 15 μm high.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, *H. Mohamed, et al. 9181e, 9185a, 9207, 9224* and *9235*; Fraser Hill, trail to Pine Tree Hill, *Manuel 2766*. Perak: Gunung Hijau trail, *Manuel 3248, 3256*.

WORLD DISTRIBUTION.—Thailand, Malaya, Indochina, Java, Banka, Borneo, and Philippines.

FERTILITY.—Only 2 of the 9 specimens examined had sporophytes.

REMARKS.—*Distichophyllum tortile* has invariably been collected on rocks and humus in constantly moist and shady habitats in moderately high altitudes between 950 m and 1640 m. This species is very distinct in the large median cells which are homogeneous in the upper part of the leaf. The wide, distinct borders also set this species apart from other large *Distichophyllum* species in Malaya.

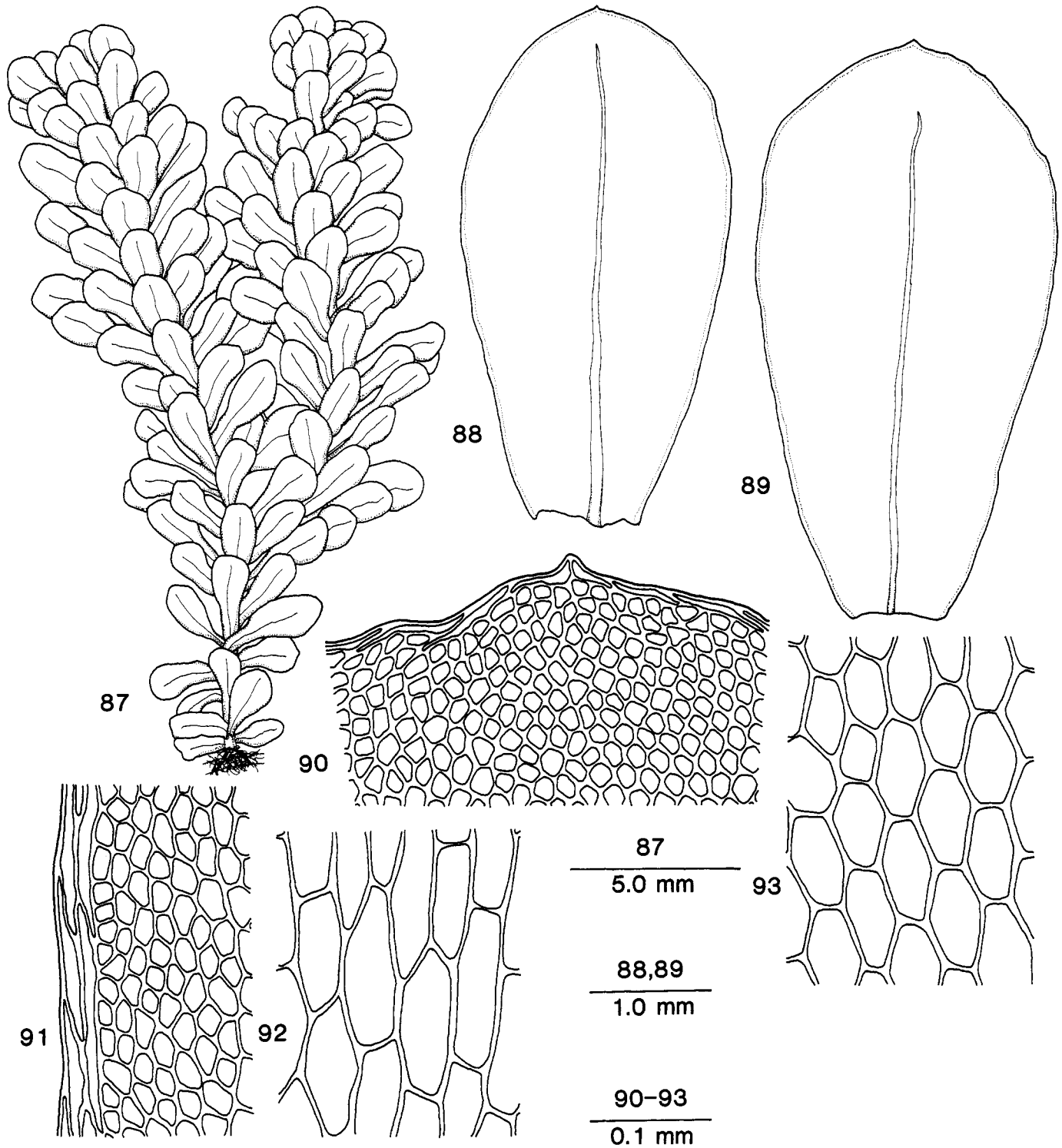
Excluded Species

Distichophyllum undulatum Dozy & Molkenboer ex Bosch & Lacoste was reported from Malaya by Dixon (1926) based on *Wray 945* collected from Perak, Gunung Batu Puteh (BM, SING). The species was also reported by Noguchi (1973) based on the specimens *Inoue 10432, 16345, 16356, and 16364* collected in Pahang, Cameron Highlands (NICH). All the specimens are *D. mittenii*.

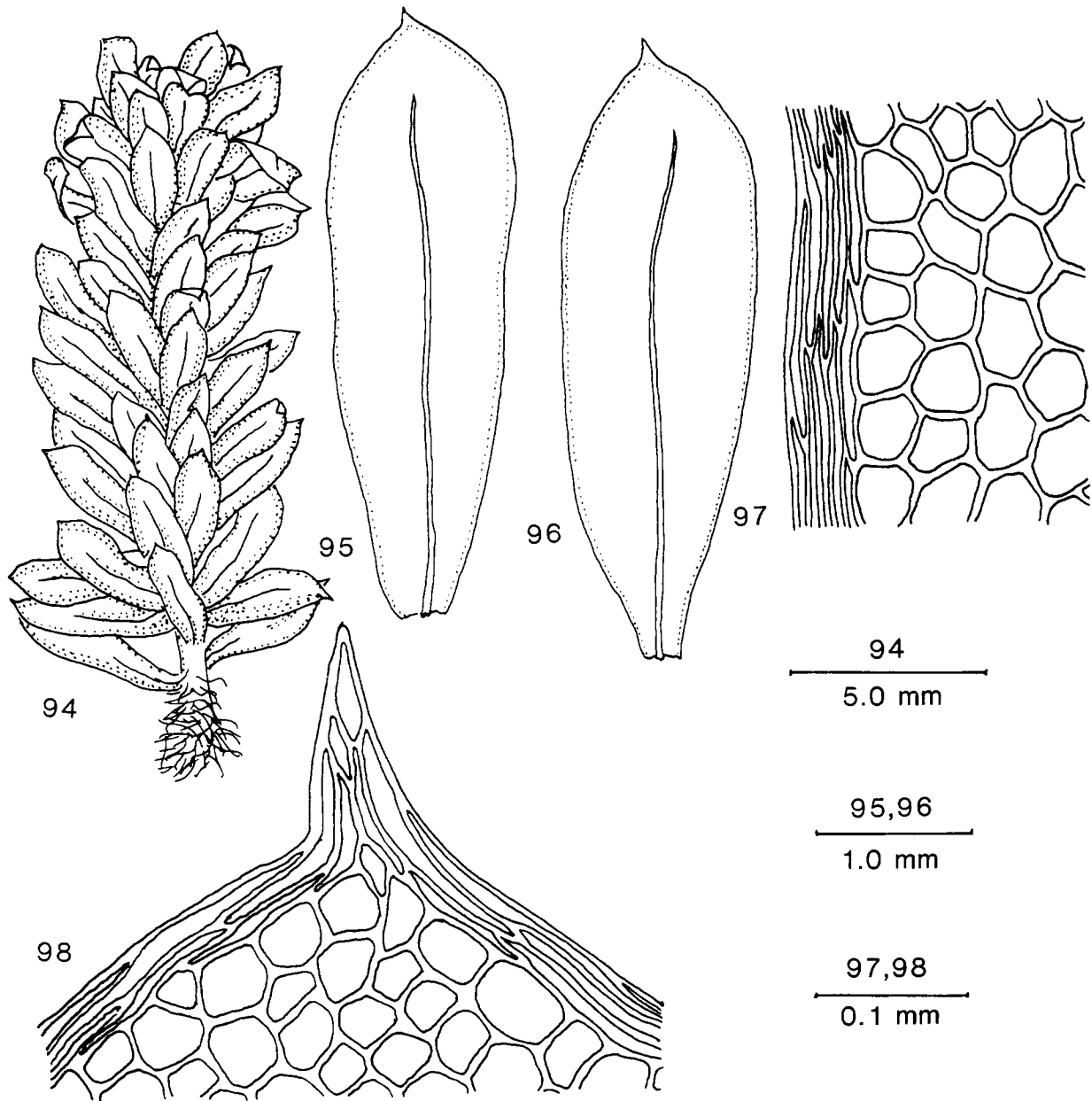
Family HYOPTERYGIACEAE

HYOPTERYGIACEAE Kindberg, Hedwigia, 40:277, 1901.

Plants medium-sized to robust, primary stems elongate or creeping, densely tomentose; secondary stems simple,



FIGURES 87-93.—*Distichophyllum spathulatum* (Pahang: H. Mohamed & Damanhuri 5015): 87, plant, wet; 88, 89, leaves; 90, cells at leaf apex; 91, cells at margin near midleaf; 92, cells at base of leaf; 93, median cells of leaf.



FIGURES 94-98.—*Distichophyllum tortile* (Pahang: H. Mohamed et al. 9181e): 94, plant, wet; 95, 96, leaves; 97, cells at margin near midleaf; 98, cells at leaf apex.

plumose, or dendroid, often with clusters of brood filaments on stems among upper leaves; leaves dimorphous, lateral rows complanate, ovate, asymmetrical, serrate, narrowly bordered; costae single, ending below tip or excurrent; cells hexagonal, smooth; ventral leaves (amphigastria) smaller, symmetrical, appressed to stem, acuminate. Calyptra cucullate or conical, naked. Capsules exserted, erect or pendulous; peristome double, teeth papillose or striolate, with a zig-zag median line; operculum rostrate.

The relationship of this family to Hookeriaceae has been discussed in detail by various authors (Miller, 1971; Buck, 1987; Whittemore & Allen, 1989; Tan & Robinson, 1990). In this treatment, the traditional placement of *Cyathophorella*, *Lopidium*, and *Hypopterygium* in the Hypopterygiaceae is followed. Most members of this family inhabit forests at moderately high to high altitudes. *Hypopterygium aristatum* occurs on limestone at low altitudes, but it also grows in non-limestone habitats at high altitudes.

Key to the Genera of Malayan Hypopterygiaceae

1. Secondary stems simple, caudate at tips; exostome teeth papillose; costae less than $\frac{1}{2}$ leaf length *Cyathophorella*
Secondary stems branched, not caudate at tips; pinnately branched or dendroid; peristome teeth striolate; costae more than $\frac{1}{2}$ leaf length 2
2. Plants often dendroid; stem with central strand; costae ending just above $\frac{1}{2}$ - $\frac{3}{4}$ leaf length in lateral leaves *Hypopterygium*
Plants pinnately branched, often plumose; stem without central strand; costae excurrent in lateral leaves *Lopidium*

Genus *Cyathophorella*

Cyathophorella (Brotherus) Fleischer, Musci Fl. Buitenz., 3:1088, 1908.
Cyathophorum Sect. *Cyathophorella* Brotherus, Nat. Pfl., 1(3):965, 1907.

Large, dull green plants in lax tufts; primary stems creeping, rhizomatous, tomentose; stems with central strand; secondary stems simple, rarely forked, distantly foliate, tips caudate and often with abundant brood filaments; lateral leaves in two rows, asymmetrical, widely spreading, smaller toward base and tip, ovate, acuminate, unbordered or weakly bordered, more or less

toothed; costae short, single or forked; cells oval-hexagonal, smooth; amphigastria smaller, symmetrical, in one row, with axis parallel with stem. Dioicous. Calyptra conic, covering only rostrum of operculum, mostly naked, not fringed. Setae short, smooth; capsule erect; exostome teeth papillose; cilia lacking; operculum rostrate.

The members of this genus are easily distinguished within the family by the simple, usually unbranched secondary stems. In Malaya, the genus is only found at high altitudes on tree bark.

Key to the Malayan Species of *Cyathophorella*

1. Leaf margins spinose-serrate *C. spinosa*
Leaf margins weakly toothed 2
2. Amphigastria ovate *C. hookeriana*
Amphigastria broadly ovate to orbicular *C. burkillii*

Cyathophorella burkillii

FIGURES 99-109

Cyathophorella burkillii (Dixon) Brotherus, Nat. Pfl., ed. 2, 11:278, 1925.
Cyathophorum burkillii Dixon, Rec. Bot. Surv. India, 6:67, 1914. [Type: Abor, 2800 ft, on tree trunk, *Burkill 37737* (SING!).]

Plants robust, dull green; secondary stems to 5 cm high, to 8 mm wide with leaves, densely foliate, caudate at tips, tomentose at base; leaves asymmetrical, ovate, 4.6-5.4 mm long 1.9-2.4 wide, ovate-lanceolate, short-acuminate with a long arista, the arista to 400 μ m long; margins weakly toothed above; border well differentiated, with 2-4 rows of elongate cells; costae short, single or forked; cells oval-hexagonal; amphigastria symmetrical, broadly ovate to orbicular, obtuse to rounded with a long apiculus to 650 μ m long; margins serrulate above; border weak or lacking; costae absent or only weakly developed; perichaetial leaves ovate, apex long-acuminate. Dioicous. Seta to 6 mm long; capsule horizontal to pendulous, 2.6 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, 1400 m, Brinchang Road, on tree in forest, *H. Mohamed et al. 9224, 9229d*.

WORLD DISTRIBUTION.—India and Malaya.

REMARKS.—This species is distinguished from *C. hookeri-*

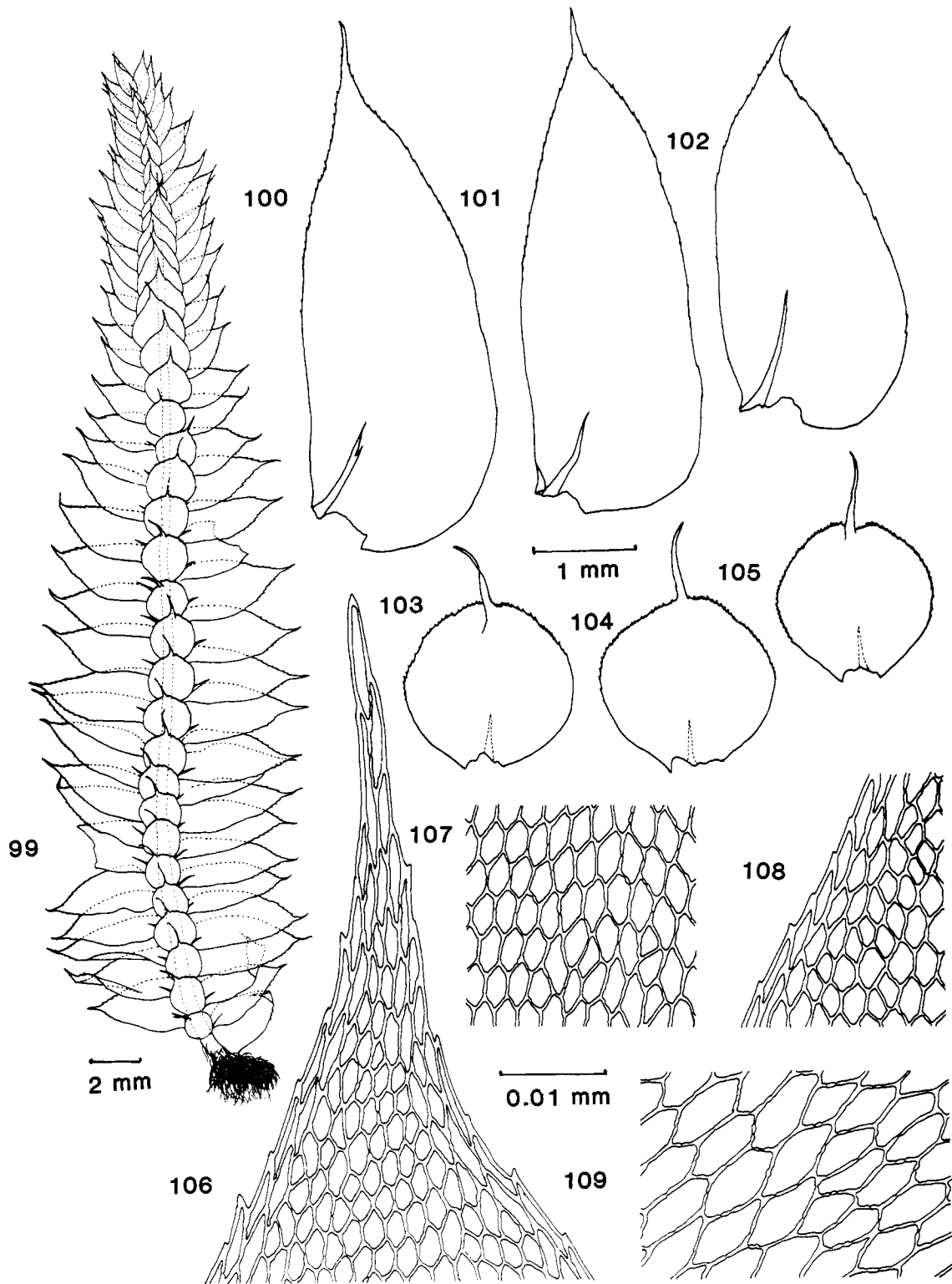
ana by its broadly ovate to orbicular amphigastrial leaves. The amphigastrial leaves of *C. hookeriana* are simply ovate.

Cyathophorella hookeriana

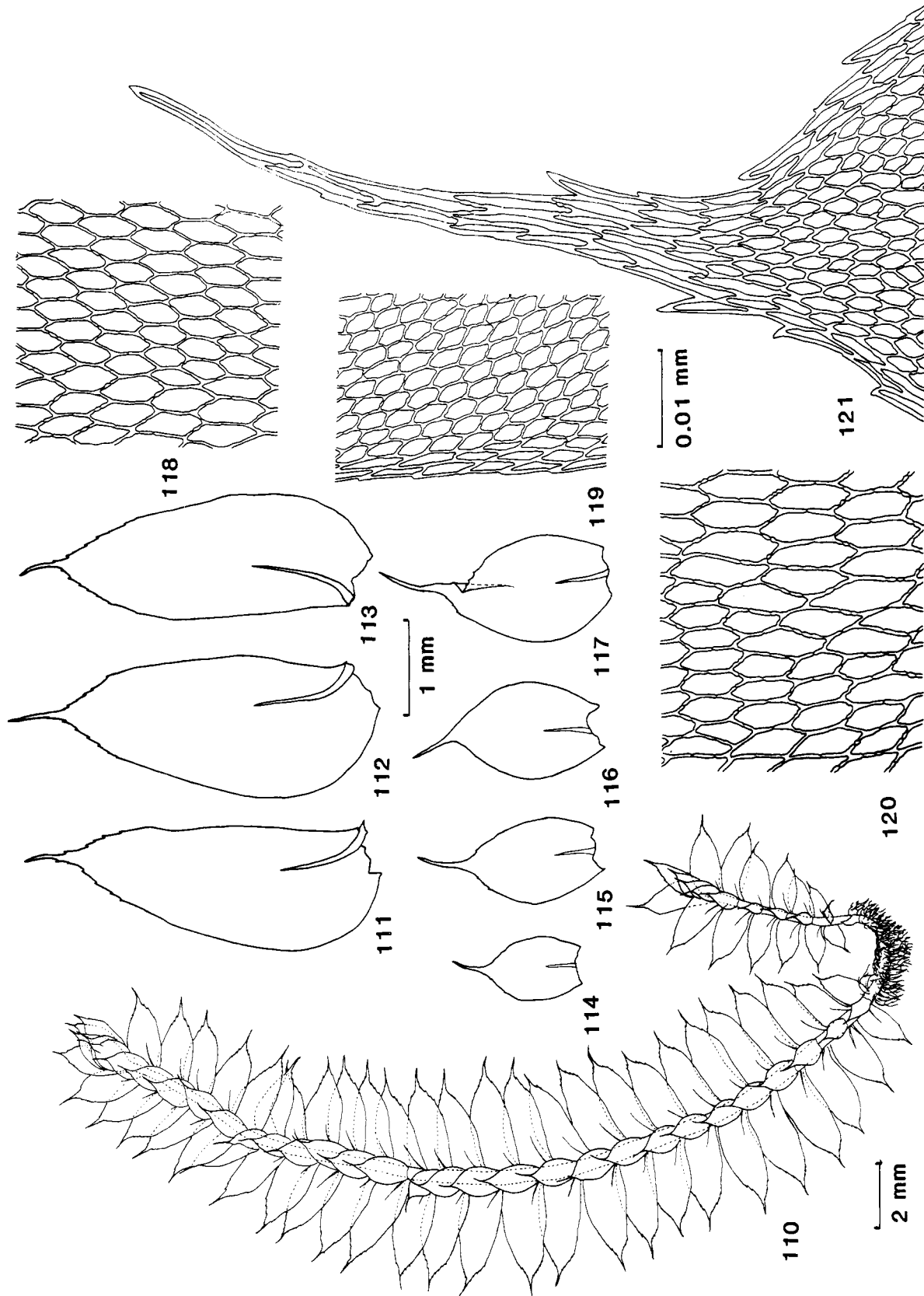
FIGURES 110-121

Cyathophorella hookeriana (Griffith) Fleischer, Musci Fl. Buitenz., 3:1094, 1908.
Neckera hookeriana Griffith, Notul. Pl. As., 2:464, 1849 (plate legend) and Icon Pl. As., 2: pl. 84, fig. 2A, 1849. [Type: Khasia Hills, *Griffith 187* (BM!).]

Plants robust, dull green; secondary stems to 5 cm high, to 8 mm wide with leaves, densely foliate, caudate at tips, tomentose at base; leaves asymmetrical, gradually decreasing in size towards tips, 4.4-5.0 mm long, 1.4-2 mm wide, ovate-lanceolate, narrowed to an aristate point at apex, arista up to 400 μ m long; margins distantly and irregularly toothed above, sometimes almost entire; border weakly differentiated, with 1-3 rows of elongate cells, often on one side only; costae short, ending below midleaf, forked; cells oval-hexagonal, 52-84 μ m long, 14-22 μ m wide, larger and laxer towards base. Amphigastria symmetrical, ovate, 2.6-3.4 mm long, 1.6-1.9 mm wide, short-acuminate with a long arista to 600 μ m; margin weakly toothed above, entire below; border weak



FIGURES 99-109.—*Cyathophorella burkillii* (Pahang: H. Mohamed et al. 9224): 99, plant, wet; 100-102, lateral leaves; 103-105, amphigastral leaves; 106, cells at leaf apex; 107, median cells of leaf; 108, cells at upper margin of leaf; 109, cells at base of leaf.



FIGURES 110-121.—*Cyathophorella hookeriana* (Pahang: *H. Mohamed 9083*): 110, plant, wet; 111-113, lateral leaves; 114-117, amphigastral leaves; 118, median cells of leaf; 119, cells at margin near midleaf; 120, cells at base of leaf; 121, cells at leaf apex.

or lacking; costae variable, absent or ending below midleaf. Dioicous. Calyptra scabrous above. Seta to 1 cm long; capsule cylindrical, to 3 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, 1890 m, on rotten log and tree, semi-shaded area, *H. Mohamed* 9083, 9181, 9182, 9293a.

WORLD DISTRIBUTION.—India, Sikkim, Vietnam, Malaya, Philippines, China, and Japan.

REMARKS.—*Cyathophorella hookeriana* is the most common of the three species of the genus in Malaya. The plants are found growing on rotten logs, twigs and bases of trees in moist, shaded areas between 1700 m and 2000 m. The distinguishing characters of *C. hookeriana* are the ovate-lanceolate leaves with margins distantly irregularly toothed above and the strictly ovate amphigastrial leaves. The type specimen has almost entire margins, however, there are Malayan specimens that have leaves with almost entire margins as well as weakly toothed margins in the same plant. The type of *C. anisodon* Dixon & Herzog in BM (Darjeeling, Sikkim, Himalaya, *Kerstan* 13c) has leaves of similar shape and size and is irregularly and distantly toothed above as in Malayan plants, but it differs from the Malayan plants in possessing caudate branch tips. *Cyathophorella burkillii* is very similar in all aspects except in the shape of the amphigastrial leaves. The amphigastrial leaves in *C. hookeriana* are ovate whereas the amphigastria of *C. burkillii* are broadly-ovate to orbicular. The plants of *C. hookeriana* from Japan are much smaller than the Malayan specimens.

Cyathophorella spinosa

FIGURES 122-130

Cyathophorella spinosa (C. Müller) Fleischer, Musci Fl. Buitenz., 3:1091, 1908. *Hookeria spinosa* C. Müller, Syn., 2:677, 1851. [Type: Java, *Blume*. Hb. Al Braun (B), not seen.]

Plants robust, dull green; secondary stems to 5 cm long, tips caudate, to 1 cm wide with leaves, frequently with conspicuous clusters of orange-red brood filaments among leaves; leaves widely spreading, asymmetrical, broadly ovate, short-acuminate with an arista to 200 µm long, 4.5-6.0 mm long, 2.4-2.8 mm wide, widest below midleaf; margin spinose-serrate in upper third with long multicellular teeth; border not or weakly differentiated; costae short, single or forked; cells oval-hexagonal, 77-95 µm long, 25-36 µm wide, thin-walled; amphigastria broad, rounded ovate with an apiculus to 250 µm

long, distantly spinose above; costae short, unequally forked; perichaetial leaves smaller than lateral leaves; ovate with a long arista. Dioicous. Sporophytes not seen.

SELECTED SPECIMEN EXAMINED.—Pahang: Cameron Highlands, Gunung Jasar, 1440 m, on base of *Cyathea* sp., *H. Mohamed* 9322.

WORLD DISTRIBUTION.—Thailand, Malaya, Java, Borneo, Moluccas, Philippines, Vanatua, and New Guinea.

REMARKS.—This species is recognized by the spinose-serrate margins in the upper part of the leaves. Closest relationship is to two other species with spinose-serrate margins which are found in adjacent regions, *C. adiantum* (Griffith) Fleischer (Himalayas, Assam, Thailand, Philippines, and Borneo) and *C. tonkinensis* (Brotherus & Paris) Brotherus (Japan, Ryukyus, Taiwan, Vietnam, Thailand, and Borneo). *Cyathophorella tonkinensis* is distinct in having more densely foliate stems, mostly unicellular marginal teeth, and smaller amphigastria. *Cyathophorella adiantum* differs from *C. spinosa* in the less robust plants, the narrowly ovate leaves with longer acuminate apices, and the less toothed ovate amphigastria.

Excluded Species

Cyathophorella tenera (Bosch & Lacoste) Fleischer was reported from Malaya by Tixier (1971) based on *Tixier* 4827 collected from Pahang, Fraser's Hill (PC). The specimen is actually *C. hookeriana*.

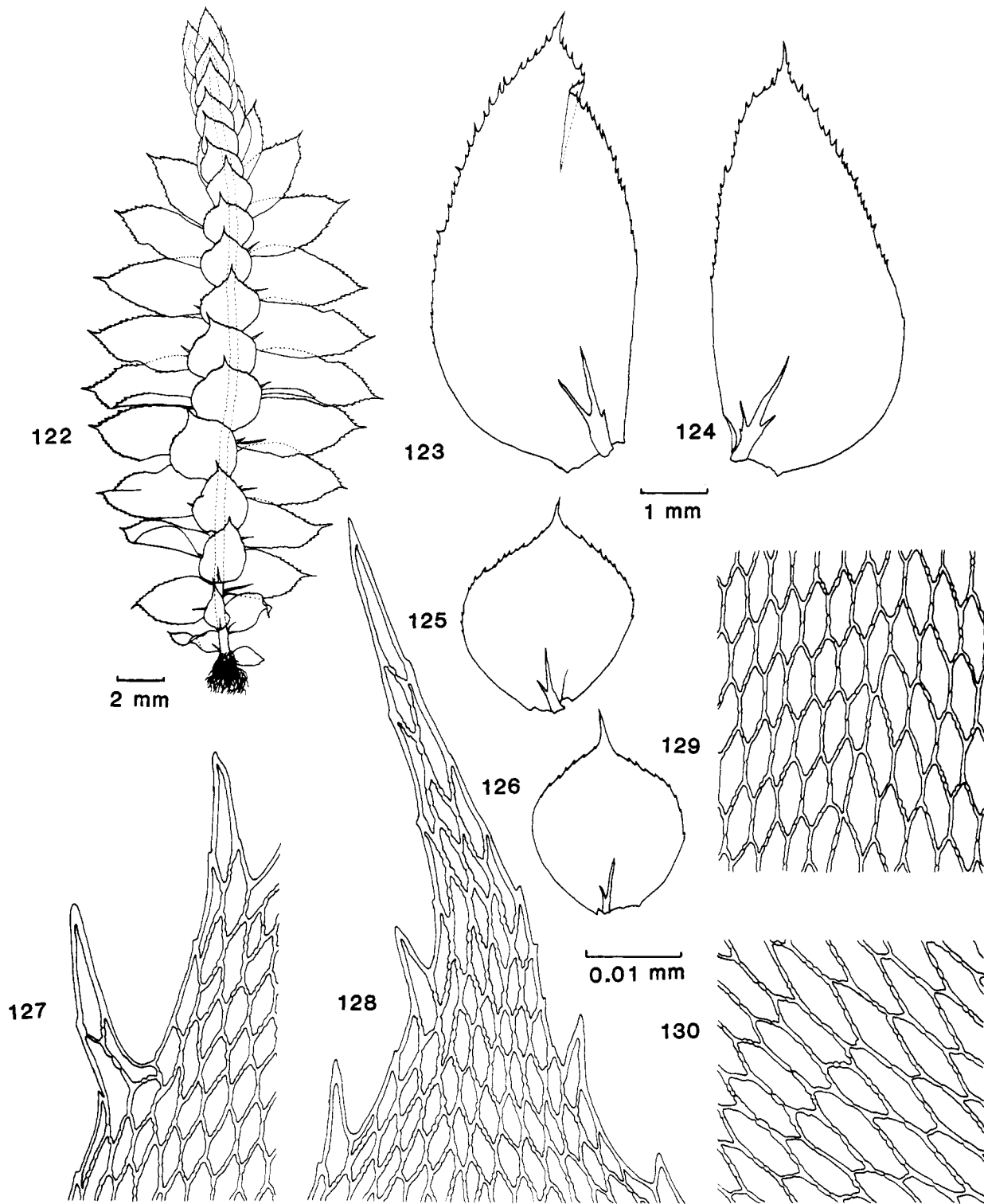
Genus *Hypopterygium*

Hypopterygium Bridel, Bryol. Univ., 2:709, 1827.

Medium-sized yellowish green plants with primary stems creeping, radiculose; stems with central strand; secondary stems erect, with a fan-shaped cluster of tertiary stems arising in upper part; leaves dimorphous, lateral leaves asymmetrically inserted, complanate, usually bordered by 1-3 rows of elongate cells; costae single, reaching from midleaf to 3/4 of leaf length; ventral row of leaves (amphigastria) symmetrically inserted, appressed to the stem; bordered by 1-2 rows of elongate cells; costae single, weakly defined to excurrent. Autoicous, dioicous, or heteroicous. Calyptra cucullate or conical, naked, not fringed. Seta elongate, smooth; Capsule inclined or pendulous; exostome teeth transversely striolate; cilia 2-3; operculum rostrate.

Key to the Species of Malayan *Hypopterygium*

- Lateral leaves subulate acuminate, costae reaching to 3/4 of leaf length; costae of amphigastria distinct and excurrent *H. aristatum*
- Lateral leaves short-acuminate, costae reaching to 3/5 of total leaf length; costae of amphigastria weakly defined, ending well below apex *H. tenellum*



FIGURES 122-130.—*Cyathophorella spinosa* (Pahang: H. Mohamed 9322): 122, plant, wet; 123, 124, lateral leaves; 125, 126, amphigastral leaves; 127, multicellular teeth on upper margin of lateral leaf; 128, cells at leaf apex; 129, median cells of leaf; 130, cells at base of leaf.

Hypopterygium aristatum

FIGURES 131-140

Hypopterygium aristatum Bosch & Lacoste, Bryol. Jav., 2:12, pl. 141, 1861. [Type: West-Java, am Gedeh und Pangerango 2090-3000 m, Motley (L), not seen.]

Plants dendroid, to 2.5 cm in height, dull green; lateral leaves pinnately spreading, ovate, 1.2-1.5 mm long, 0.6-0.9 mm wide, widest below midleaf; apex subulate-acuminate with a distinct arista, to 200 µm long; margin toothed in upper part on one side of leaf, entire below; bordered all around by 1(-2) rows of elongate cells; costae reaching 3/4 of leaf length; median cells hexagonal, 20-35 µm long, 15-20 µm wide; amphigastria orbicular, 0.8-1.1 mm long, 0.6-0.8 mm wide; margin entire below, weakly and distantly toothed above; bordered all around by 1(-2) rows of elongate cells; costae distinct, excurrent, ending in a long arista to 350 µm long; median cells hexagonal, 20-35 µm in long, 13-20 µm wide. Synoicous. Seta smooth, to 1.4 cm long; capsule suberect to horizontal; urn oval-cylindrical, to 2 mm long; operculum to 2 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Robinson's Waterfall, *H. Mohamed & Zamzuri 1439*; Taman Negara, Gua caves (limestone), *Manuel 2619, 2608*.

WORLD DISTRIBUTION.—Philippines, Malaya, and Java.

REMARKS.—*Hypopterygium aristatum* grows mostly on rocks and sometimes on logs at altitudes above 1000 m. Specimens have been collected at 200 m but at such low altitudes the species invariably grows only on limestone. The species fruits abundantly throughout the year. *Hypopterygium aristatum* is generally much larger than *H. tenellum* and dendroid in habit. Other differences are discussed under *H. tenellum*.

Hypopterygium tenellum

FIGURES 141-150

Hypopterygium tenellum C. Müller, Bot. Zeit., 12:557, 1854. [Type: India, In cortice arborum una cum *Hypopt. struthiopteris* circa Ootacamund a Perrotet (B), not seen.]

Plants to 2.0 cm in height, dull green; lateral leaves pinnately spreading, 0.8-1.4 mm long, 0.6-0.8 mm wide, widest below midleaf, ovate with a short-acuminate apex, apiculate, the

apiculus to 50 µm long; margin toothed in upper part, entire below, bordered all around by 1(-2) rows of linear cells; costae reaching 3/5 of leaf length; median cells hexagonal, 25-50 µm long, 12-15 µm wide; amphigastria 0.6-0.8 mm long, 0.5-0.7 mm wide, orbicular with a sharp apiculus to 150 µm long; margins crenulate above, entire below, weakly bordered all around with 1(-2) rows of cells; costae weakly defined, extending up to 1/2 of leaf length; median cells hexagonal, 25-35 µm in length, 16-20 µm in width. Synoicous. Seta smooth, to 1 cm in length; capsule horizontal to cernuous; urn oval-cylindrical, 1 mm long.

SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Robinson Falls, *Manuel 3344, 3344a, 3362*; Pulau Tioman, Gunung Kajang, *Zamzuri 216, 226*.

WORLD DISTRIBUTION.—Sri Lanka, Malaya, Sumatra, Java, Borneo, Philippines, and New Guinea.

REMARKS.—*Hypopterygium tenellum* has been collected on the island of Tioman, at 600 m, but on the mainland it has been collected only above 1200 m. It has been collected on rocks and trees. This species is distinguished from *Hypopterygium aristatum* by its smaller size, amphigastria that have weakly defined costae which seldom reach midleaf, and a shorter apiculus (to 150 µm). *Hypopterygium aristatum* is a larger plant, has an excurrent costa on the amphigastria, and a longer arista (to 350 µm).

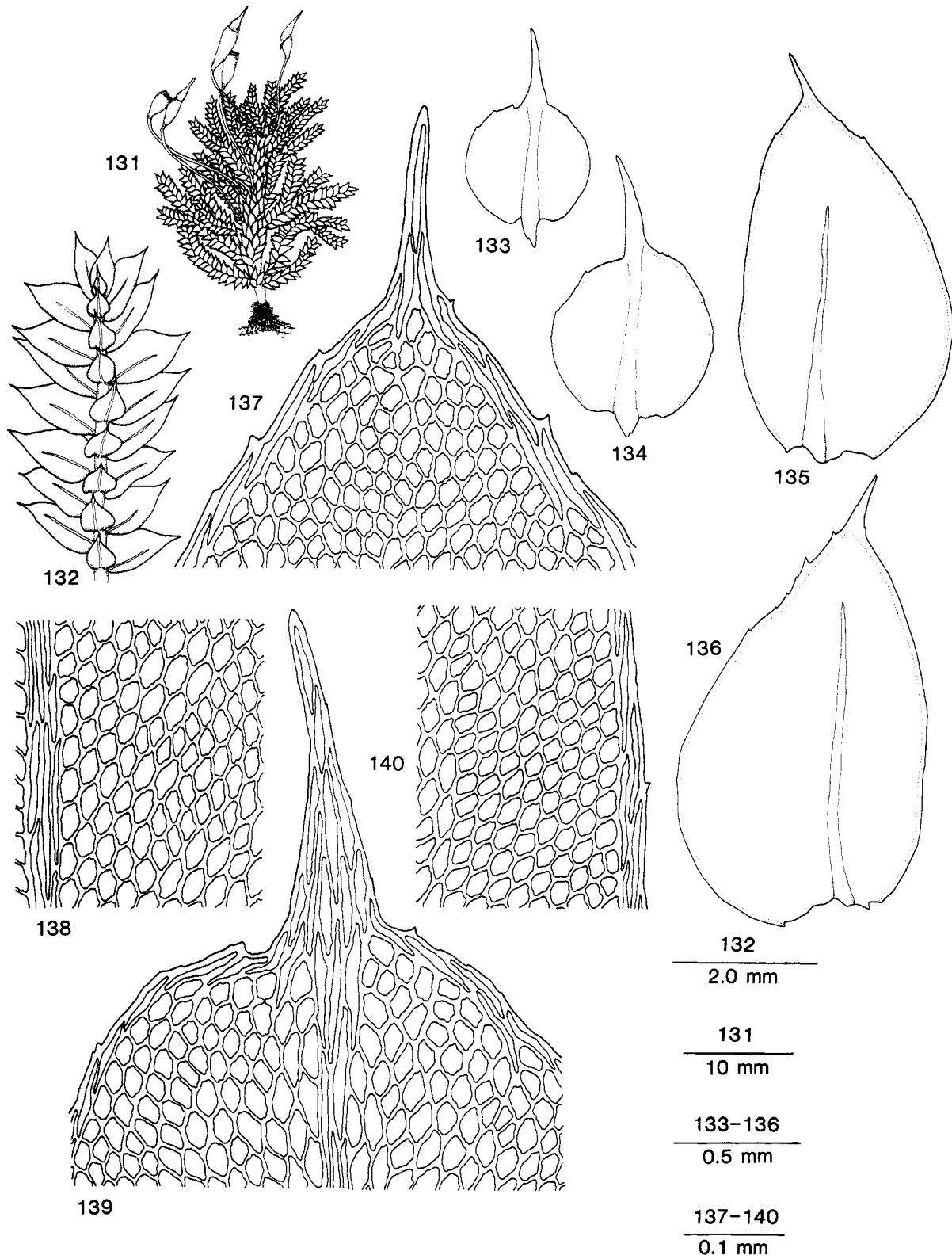
Genus *Lopidium*

Lopidium Hooker f. & Wilson, Fl. Nov. Zel., 2:119, 1854. [Lectotype: *L. concinnum* (Hooker) Wilson cf. Dixon, New Zealand Inst. Bull., 3(5):293, 1927.]

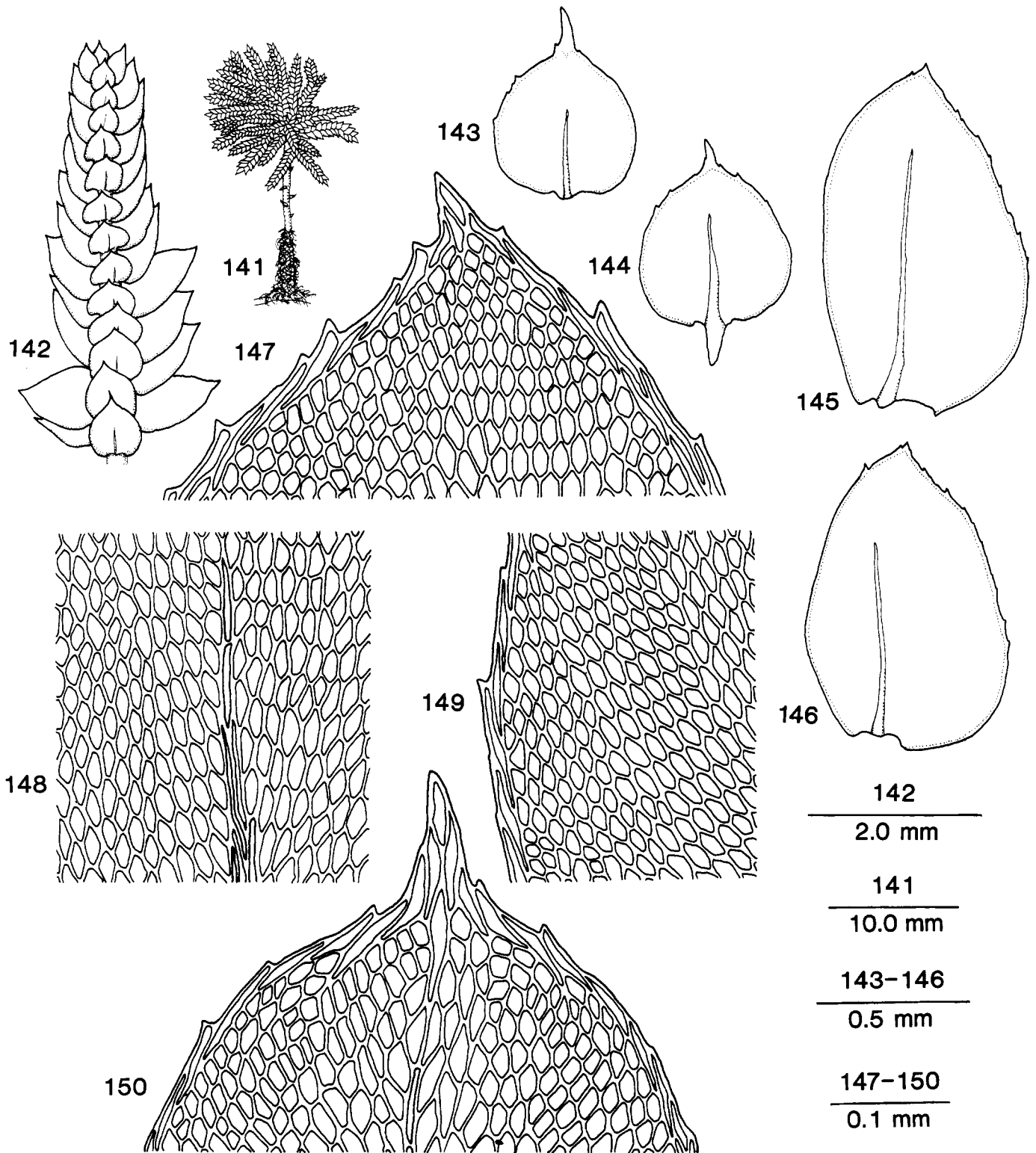
Plants moderately robust, light green to green, with creeping stoloniform shoots; stems without central strand; fronds erect, elongate, more or less regularly pinnate, with simple or slightly pinnate branches; leaves complanate, distinctly dimorphic; lateral leaves spreading, narrow, oblong-lingulate, acute with a distinct apiculus; margin denticulate to entire; costae single, excurrent; cells small, rounded, smooth, incrassate; amphigastria smaller than lateral leaves, ovate with a broad base; margin denticulate; bordered on both sides; unicostate, percurrent to excurrent. Autoicous or dioicous. Calyptra cucullate, short, naked, not fringed. Seta short, variably papillose; capsule suberect; exostome teeth transversely striolate; cilia lacking; operculum long-rostrate.

Key to the Malayan Species of *Lopidium*

- Lateral leaves bordered on both sides of the lamina *L. struthiopteris*
- Lateral leaves bordered only on one side of the lamina *L. trichoclodon*



FIGURES 131-140.—*Hypopterygium aristatum* (Pahang: Manuel 2619): 131, plant, wet; 132, lateral branch, wet; 133, 134, amphigastral leaves; 135, 136, lateral leaves; 137, cells at apex of lateral leaf; 138, median paracostal cells of leaf; 139, cells at apex of amphigastral leaf; 140, cells at margin near midleaf.



FIGURES 141-150.—*Hypopterygium tenellum* (Pahang: Zamzuri 216): 141, plant, wet; 142, a lateral branch; 143, 144, amphigastral leaves; 145, 146, lateral leaves; 147, cells at leaf apex of lateral leaf; 148, median paracostal cells of lateral leaf; 149, cells of margin at middle of lateral leaf; 150, cells at apex of amphigastral leaf.

Lopidium struthiopteris

FIGURES 151-158

Lopidium struthiopteris (Bridel) Fleischer, Musci Fl. Buitenz., 3:1073, 1908.
Hypnum struthiopteris Bridel, Spec. Musc., 2:87, 1812. [Type: In Insula Bourbonis, unde *Commerson* (Bridel herb. B), not seen.]

Primary stems creeping, to 8 cm long; secondary stems erect, to 3.5 cm high, yellowish green, dull, densely bipinnate in an elongate plumose frond, branched nearly to base; stem leaves widely spreading, slightly arched with deflexed points when dry, ovate-lingulate from a broad, slightly clasping base, acuminate, 1.8-2.4 mm long, 0.8-1.1 mm wide, widest near the base; margins distantly denticulate in upper half; bordered all around with 1-2(-3) rows of linear cells (except at the base); costae excurrent in an arista to 150 μ m long; basal portion of lamina often folded on one side; median cells rounded, 8-12 μ m long, 6-10 μ m wide, thick-walled, distinctly collenchymatous; amphigastria ovate-lanceolate with a wide base, subulate-acuminate, 0.7-1.2 mm long, 0.9-1.1 mm wide, widest near base; distinctly bordered by 1-2 rows of linear cells except near the base; costae long-excurrent in an arista to 200 μ m high. Sporophytes not seen.

SELECTED SPECIMEN EXAMINED.—Pahang: Cameron Highlands, Brinchang Rose Garden, 1540 m, on tree, *H. Mohamed et al.* 9185d.

WORLD DISTRIBUTION.—Reunion Island, India (Nilghiris), Sri Lanka, Malaya, Thailand, Sumatra, Java, Philippines, New Guinea, and New Caledonia.

REMARKS.—*Lopidium struthiopteris* has been collected between 1300 m and 1620 m on trees in partly shaded areas. The long plumose fronds of this genus are easily distinguished from the fanlike fronds of the genus *Hypopterygium*. Apart from the presence of the border on both sides of the lamina on

the lateral leaves, there are no other clear-cut differences between this species and *L. trichocladon*.

Lopidium trichocladon

FIGURES 159-168

Lopidium trichocladon (Bosch & Lacoste) Fleischer, Musci Fl. Buitenz., 3:1069, 1908.

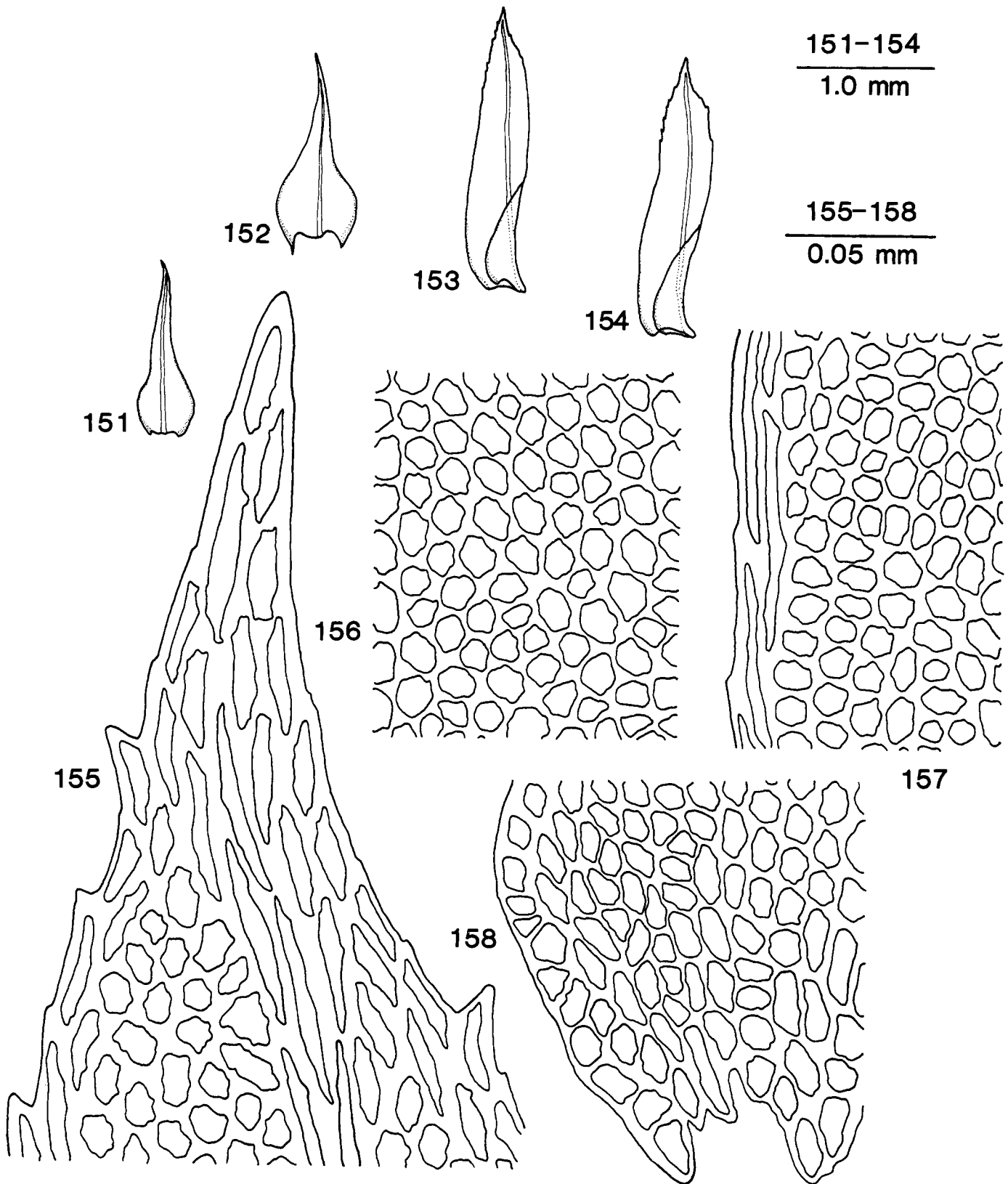
Hypopterygium trichocladon Bosch & Lacoste, Bryol. Jav., 2:9, 1861. [Type: West-Java, am Berg Salak, 600-800 m, *Amann* (L), not seen.]

Primary stems creeping, to 6 cm long, secondary stems erect, to 3 cm high, generally smaller than *L. struthiopteris*; stem leaves oblong-lanceolate, with a slightly broader base, 1.5-1.8 mm long, 0.5-0.6 mm wide, short-acuminate; margins entire to slightly crenulate, bordered on only one side by 1(-2) rows of linear cells; costae excurrent in an arista, the arista up to 85 μ m long; median cells round to hexagonal, thick-walled, distinctly collenchymatous, 8-13 μ m wide; amphigastria broadly ovate, long-acuminate, 0.9-1.2 mm long, 0.6-0.8 mm wide, bordered on both sides of lamina by 1(-2) rows of linear cells, with border ceasing just above the base; margins weakly toothed above; costae percurrent to excurrent. Sporophytes not seen.

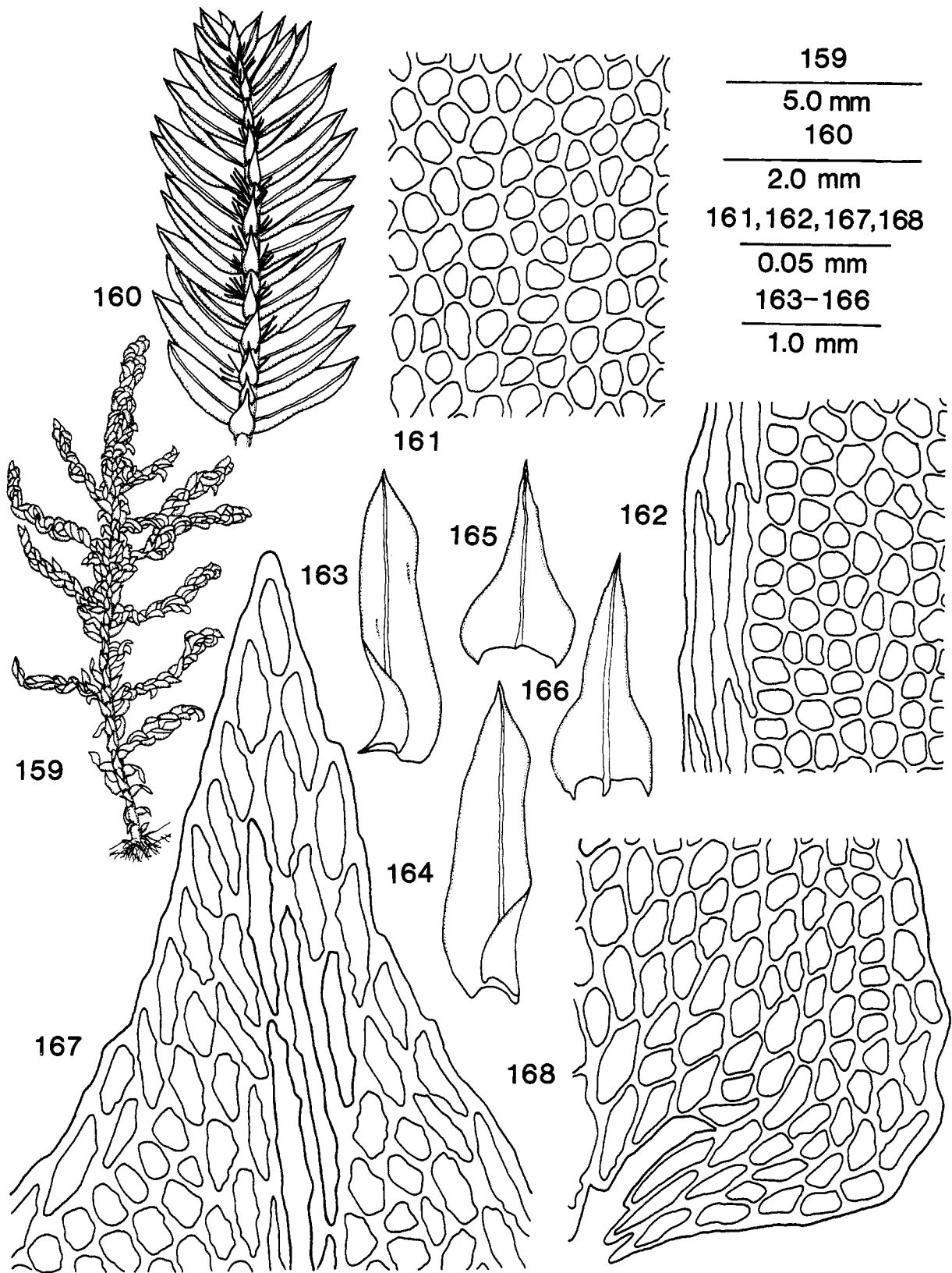
SELECTED SPECIMENS EXAMINED.—Pahang: Cameron Highlands, Gunung Brinchang, 1760 m, on *Cyathea* sp., *H. Mohamed & Zamzuri* 1160c, 1113b; Gunung Ulu Kali, 3500 ft, *Manuel* 3427; Pulau Tioman, Gunung Kajang, 480 m, on rock, *Zamzuri* 128. Perak: Maxwell Hill, 1280 m, on bark, *H. Mohamed et al.* 8091.

WORLD DISTRIBUTION.—Thailand, Indochina, Malaya, Java, Sumatra, Borneo, Moluccas, Philippines, and Taiwan.

REMARKS.—*Lopidium trichocladon* has been collected on living trees between 1000 m and 1700 m on the mainland but on Tioman Island, it has been collected on rocks at 480 m, and on trees at 840 m.



FIGURES 151-158.—*Lopidium struhiopteris* (Pahang: H. Mohamed et al. 9185d): 151, 152, amphigastrial leaves; 153, 154, lateral leaves; 155, cells at leaf apex; 156, median cells of lateral leaf; 157, cells of margin at middle of lateral leaf; 158, cells at base of lateral leaf.



FIGURES 159-168.—*Lopidium trichocladon* (Pahang: H. Mohamed & Zamzuri 1160c): 159, plant, dry; 160, lateral branch; 161, median cells of lateral leaf; 162, cells of margin at midleaf; 163, 164, lateral leaves; 165, 166, amphigastrial leaves; 167, cells at leaf apex; 168, cells at base of lateral leaf.

Literature Cited

- Bartram, E.B.
1939. Mosses of the Philippines. *Philippine Journal of Science*, 68:1-423.
- Bescherelle, E.
1898-1899. Bryologiae japonicae supplementum I. *Journal de Botanique*, 12:280-300; 13:37-45.
- Buck, W.R.
1987. Taxonomic and Nomenclatural Rearrangement in the Hookeriales with Notes on the West Indian Taxa. *Brittonia*, 39:210-224.
- Crosby, M.R.
1968. Proposal for the Conservation of the Name *Daltonia* Brid. (Musci-Hookeriaceae). *Taxon*, 17:443-444.
1974. Toward a Revised Classification of the Hookeriaceae (Musci). *Journal of the Hattori Botanical Laboratory*, 38:129-141.
1975. Lectotypification of *Schizomitrium* B.S.G. (Musci, Hookeriaceae). *Taxon*, 24:353-355.
- Damanhuri, A., and M.A.H. Mohamed
1986. Two New Species of *Distichophyllum* from Malaya. *Journal of Bryology*, 14:327-331.
- Dixon, H.N.
1924. New species of Mosses from the Malay Peninsula. *Bulletin of the Torrey Botanical Club*, 51:225-259.
1926. A List of the Mosses of the Malay Peninsula. *Gardens' Bulletin, Straits Settlements*, 4:1-46.
1931. New Genera of Asiatic Mosses. *Journal of Botany*, 69:1-7.
- Dozy, F., and J.H. Molkenboer
1845-1854. *Musci Frondosi Inediti Archipelagi Indici*. Leiden.
- Dozy, F., and J.H. Molkenboer (completed by R.B. van den Bosch, C.M. van der Sande Lacoste)
1855-1870. *Bryologia Javanica*. 2 volumes. Leiden.
- Fleischer, M.
1908. *Die Musci der Flora von Buitenzorg*. Volume 3. Leiden.
- Gangulee, H.C.
1977. *Mosses of Eastern India and Adjacent Regions*. Fascicle 6 (Hookeriales). Calcutta, India.
- Harrington, A.J., and H.A. Miller
1979. The Affinities of *Sclerohyllum* Dix. *Journal of Bryology*, 10:277-280.
- Johnson, A.
1980. *Mosses of Singapore and Malaysia*. Singapore: University Press.
- Koponen, T., and P. Isoviita
1984. Proposal to Conserve *Callicostella* against *Schizomitrium* (Musci, Hookeriaceae). *Taxon*, 33:112-113.
- Margadant, W. D.
1959. Typification and Conservation of Generic Names in Musci. *Acta Botanica Neerlandica*, 8:271-276.
- Miller, H.A.
1971. An Overview of the Hookeriales. *Phytologia*, 21:243-252.
- Mohamed, M.A.H.
1985. On the Identity of *Chaetomitrium borneense* Mitt., *C. seriatum* Broth., *C. seriatum* Broth. ex Bartr. and *C. elmeri* Broth. *Lindbergia*, 11:80-82.
- Mohamed, M.A.H., and A. Damanhuri Mohamed
1986. Four Genera of Mosses New to Peninsular Malaysia. *Journal of Bryology*, 14:333-338.
- Mohamed, M.A.H., and B.C. Tan
1988. A Checklist of Mosses of Peninsular Malaysia and Singapore. *The Bryologist*, 91:24-44.
- Noguchi, A.
1956. Musci Japonici, V: The Genus *Distichophyllum*. *Journal of the Hattori Botanical Laboratory*, 17:19-31.
1973. Mosses of Malaya Collected by Dr. Hiroshi Inoue. *Bulletin of the National Science Museum*, 16:293-304.
- Robinson, H.
1971. A Revised Classification for the Orders and Families of Mosses. *Phytologia*, 21:289-293.
1986. On the Relationships of the Hookeriaceae. *The Bryological Times*, 35:2-3.
- Tan, B.C., and H. Robinson
1990. A Review of Philippine Hookeriaceous Taxa (Musci). *Smithsonian Contributions to Botany*, 75:1-41.
- Tixier, P.
1971. A Contribution to the Bryological Knowledge of Fraser's Hill Station (Malaysia). *Gardens' Bulletin, Singapore*, 25:335-353.
1980. Contributions to the Bryological Knowledge of Malaysia, III: Cameron Highlands, Mosses, and Epiphyllous Liverworts. *Nova Hedwigia*, 32:377-392.
- Townsend, C.C.
1982. Notes on Mosses from Ceylon and India, 6: An Illustrated Key to *Distichophyllum* in Ceylon and South India. *Journal of Bryology*, 12:15-21.
- Whittemore, A., and B. Allen
1989. The Systematic Position of *Adelothecium* Mitt. and the Familial Classification of the Hookeriales. *The Bryologist*, 92:261-272.

Index

(Synonyms and page numbers of principal accounts in italics)

- Actinodontium, 3, 4
ascendens, 4, figs. 5-8
rhapidostegum, 1, 4, figs. 1-4
- Callicostella, 3, 4, 6, 12
beccariana, 1, 6
papillata, 4, 6, figs. 9-15
prabaktiana, 6
- Calypstrochaeta, 3, 9
remotifolia, 9, figs. 16-22
- Chaetomitriopsis, 1, 3, 9
glaucocarpa, 9
- Chaetomitrium, 1, 3, 9, 10, 11
bomeense, 10
ciliatum, 1, 11, 12
elongatum, 1, 9, 10, 11, 12
lanceolatum, 1, 12
leptopoma, 10, 12
muricatum, 1, 12
nematosum, 1, 12
orthorrhynchum, 1, 10, 11, 12
papillifolium, 10, 11, 12
perakense, 1, 11
seriatum, 10
setosum, 10, 11
torquescens, 1, 12
- Cyathophorella, 3, 31, 32
adiantum, 35
anisodon, 35
burkillii, 32, 35, figs. 99-109
hookeriana, 1, 32, 35, figs. 110-121
spinosa, 1, 32, 35, figs. 122-130
tenera, 1, 35
tonkinensis, 35
- Cyathophorum, 32
burkillii, 32
- Sect. *Cyathophorella*, 32
- Cyclodictyon, 3, 6, 12
blumeanum 12
- Daltonia, 3, 12, 13
angustifolia, 1, 12, 13, figs. 23-29
aristifolia, 1, 13
armata, 1, 12, 13, figs. 37-42
contorta, 12, 13, figs. 30-36
splachnoides, 12
- Distichophyllidium, 3, 17
nymanianum, 17
- Distichophyllum, 3, 17, 18, 22, 25, 29
brevicuspes, 1, 17, 18, 19, 22
cirratum, 18, 19, 26, figs. 50, 52, 53, 56
cuspidatum, 13, 18, 19, 22, 25, figs. 43-49
denticulatum, 26
elmeri, 19
gracilicaule, 25, 26
jungermannioides, 1, 18, 22, figs. 58-64
lorianum, 29
maibarae, 1, 17, 18, 19, 22, 23, 25
malayense, 1, 17, 18, 25
mittenii, 17, 18, 25, 29, figs. 65-72
montagneanum, 19, 23, 25
nanum, 22
nigricaulis, 18, 19, 23, 25, 26, figs. 51, 54, 55, 57
nigricaulis var. *cirratum*, 19
nigricaulis var. *elmeri*, 19
obtusifolium, 26
osterwaldii, 17, 18, 26, figs. 73-79
schmidtii, 17, 18, 19, 26, 29, figs. 80-86
sinuosulum, 19
spathulatum, 17, 18, 29, figs. 87-93
tortile, 17, 18, 29, figs. 94-98
ulukaliense, 1, 22
undulatum, 1, 29
- Eriopus*, 9
remotifolius, 9
- Hookeria, 4, 6, 11, 12, 19, 29, 35
blumeana, 12
cuspidata, 19
orthorrhynchum, 11
papillata, 6
prabaktiana, 6
rhapidostegia, 4
spathulata, 29
spinosa, 35
- Hypnum, 9
glaucocarpon, 9
leptopoma, 10
struthiopteris, 40
- Hypopterygium, 31, 32, 35, 40
aristatum, 31, 35, 37, figs. 131-140
tenellum, 35, 37, figs. 141-150
trichocladon, 40
- Lopidium, 31, 32, 37
struthiopteris, 37, 40, figs. 151-158
trichocladon, 37, 40, figs. 159-168
- Mniadelphus*, 22
jungermannioides, 22
nanus, 22
- Neckera, 32
hookeriana, 32
- Orthostichopsis, 10
- Pilotrichella, 10
perakensis, 10
- Schizomitrium, 4
- Sclerohypnum riparium, 1