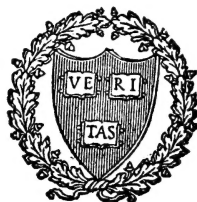




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THE
GARDENS' BULLETIN
SINGAPORE

Vol. XXII, Part I

20th January, 1967

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To be purchased at the Botanic Gardens, Singapore
Price: \$8

Published by Authority

Printed by Lim Bian Han, Government Printer, Singapore

1967



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**THE
GARDENS' BULLETIN
SINGAPORE**

A scientific periodical for the publications of results of original research in Botany in general and Plant Taxonomy in particular. Edited by the *Director of Botanic Gardens, Singapore*, it is published as material becomes available. Price ca. M\$25 per volume payable in advance. It is also available for exchange.

All manuscripts, enquiries, purchases and exchanges are to be addressed to:—

The Director,
Botanic Gardens,
Singapore 10,
Singapore.

THE
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Vol. XXII, Part I

20th January, 1967

Notes on the Systematy of Solomon Islands' Plants and
some of their New Guinea Relatives, I-VII

by

T. C. WHITMORE

*Forest Botanist, British Solomon Islands**

Summary

This paper adds to the bonfire of optimically proposed 'paper-species' whose incineration is inevitable following a critical examination of the abundant collections now available from Malesia and Melanesia.

The amount of morphological variation differs from group to group studied. Several classes may be distinguished and interpreted as stages in the evolution of species, as follows:

1. Homogeneous groups, without morphological discontinuities; previously optimistically divided:
 - (a) *Camposperma brassii* reduced to *C. brevipetiolata* (p. 4).
 - (b) 3 *Syzygiums* transferred to *Eugenia* (p. 16).
 - (c) *Calophyllum kiong* reduced to *C. soulattri* (p. 15).
 - (d) 2 spp. reduced to *Tristiropsis acutangula* (p. 17).
 - (e) *Gmelina salomonensis* reduced to *G. moluccana* (p. 18).
2. Evolution to a wide range of habitats but morphologically uniform, various *Calophyllums* (p. 13).
3. 'Ochlospecies', i.e. a group showing complex reticulate variation which cannot be treated taxonomically:
 - 4 spp. reduced to *Schizomeria serrata* (p. 5).
4. Widespread polymorphic species with variously distinct local populations:
 - (a) *Buchanania arborescens* (p. 2); of which *B. novo-hibernica* and *B. solomonensis* are synonyms.
 - (b) *Pometia pinnata* (p. 17).
5. Closely related but distinct allopatric species pairs:
 - (a) *Camposperma brevipetiolata* and *C. auriculata* (p. 4).
 - (b) *Endospermum medullosum* and *E. malaccense* (p. 8).

* Now at: Forest Research Institute, Kepong, Selangor, Malaya.

Introduction

I have found it necessary in connection with the preparation of a 'Guide to the Forests of the Solomon Islands' (Whitmore 1966, pp. 208, Oxford University Press) to investigate the taxonomy of a number of the common, big trees of the archipelago. These trees are important components of the rain-forests and some of them have already or soon will enter commerce. For both the student of ecology and the forester a sound taxonomic base is essential. In these notes are set out the results of my studies.

In the Solomons, as in Malesia, it is being discovered that many formerly recognised species cannot be maintained now that abundant collections from many localities are to hand. Earlier botanists, with few collections from widely separate localities, saw distinct species where now various patterns of morphological variation are revealed which show different stages in the evolution of species (see summary). The early splitting was aided by a firm preconception in the minds of the investigators of the richness of tropical floras. Thus many of these notes follow the current trend and involve the reduction of local "endemics" to synonymy with the earliest described species of each group. In each case I have pursued the problem as far as necessary to provide what I hope will prove a stable name for the Solomons' taxon, a name which future monographers will uphold. The implications of this reduction of "species" for our conception of the Malesian and Melanesian floras and on plant geography are huge and important, and the time is coming when a reassessment must be made.

The notes are based mainly on the set of specimens retained in the Forest Herbarium Honiara, BSIP. Replicates are at K, L, LAE, SING and US; the last two sets are incomplete.

It is a pleasure to acknowledge the substantial assistance I have received at Lae and Leiden with this work; in addition Kew, British Museum, Singapore and Brisbane have kindly allowed me to use their facilities and loaned me material for examination. Dr. B. C. Stone kindly read a draft of this paper.

Professor H. Godwin F.R.S. very kindly allowed me to work in the Cambridge University Botany School to complete these studies.

I. Anacardiaceae

A. Buchanania Roxburgh

There grows in the Solomons a species of *Buchanania* as a scattered component of disturbed lowland rain-forest. It is a tree of moderate size in the upper canopy and reaches about 6 ft. girth and 120 ft. tall, with a tall, narrow, dense crown. It is easily recognisable in the forest from various features (Whitmore 1966); and diagnostic is its red middle bark (phelloderm) revealed when the papery superficial outer bark (phellem) is scraped off.

In considering the name of this species I have examined the following diagnostic features of all collections at Lae from the Solomons and Bismarcks. The *leaf apices* are acute, sometimes acuminate or, uncommonly, obtuse; both acute and obtuse leaves are sometimes found on a single twig (BSIP 1472). The *petiole* length varies from 15–50 mm.; on a single tree the variation between leaves is about 10 mm. There are from 15–15 pairs of *secondary nerves* whose spacing varies and whose parallelness increases with closeness; they run more or less parallel towards the margin but loop upwards well within it. The *inflorescences* are commonly tomentose on the minor axes and have scattered hairs on the main axes, sometimes they are almost glabrous but only on BSIP 315 and BSIP 1087 could no hairs at all be found. The *carpels* are hairy all over, or, more commonly, are glabrous on the exposed side and hairy on the inner sides, the degree of hairiness varies considerably but no completely glabrous carpels were seen.

This *Buchanania* fits *B. solomonensis* Merr. et Perry (J. Arn. Arb. 22, 530–1, 1941, based on Kajewski 1873 type, 2123 and Brass 2745 which is the only species so far recorded from the Solomons. I have seen an isotype at the British Museum; it matches my own collections. Merrill and Perry based their species on three fruiting collections. The remnants of a flower were found attached to one of the fruits, and within this flower lies the only stated difference from *B. novo-hibernica* Ltb. (Bot. Jahrb. 65, 349, 1921), namely the gynoecium is pubescent not glabrous. In view of the variation in hairiness of the carpels in my collections I do not consider this character alone enough to establish a new species and I cannot discover others in the descriptions. Accordingly I consider *B. solomonensis* to be the same as *B. novo-hibernica*. Unfortunately this decision must be made without seeing the type and only cited collection of *B. novo-hibernica* (Peckel 812) which appears to have been lost; but I have examined both the figure in Peckel's manuscript flora (Nachtr. 84–5) and the description, which he bases on many observations of living material, of what he describes as a very common species, and can see no difference between *B. solomonensis* and *B. novo-hibernica*.

Lauterbach based *B. novo-hibernica* on a single collection. In the same paper he mentions *B. arborescens* Bl. (Mus. Bot. Lugd. — Batav., 183, 1826), a widespread polymorphic species, which he calls *B. florida* Schauer. Unfortunately he does not give a diagnosis for *B. arborescens* and the differences from *B. novo-hibernica* must be taken from his key. There is in fact only one, namely side nerves 'unter sich siemlich parallel' versus 'nicht parallel'. This is a very slight distinction (see above) which I consider inadequate to maintain two species, so *B. novo-hibernica* becomes a synonym of *B. arborescens*.

There is a number of species described since *B. arborescens* in this group. In W. Malesia I note solely *B. lucida* Bl. which appears superficially very similar from the many sheets at Kew.

In Queensland, E. Malesia and Melanesia are *B. florida* Schauer, *B. mangoides* F. Muell.*, *B. longifolia* Span.*, *B. montana* Ltb.*, *B. nabirensis* Kan. et Hat.*, *B. monticola* Kan. et Hat.*, *B. papuana* C. T. White* and *B. vitiensis* Engl. (from Fiji). I have examined at Kew and/or Leiden (on loan from Bogor) type or authentic collections of the species starred (*) and descriptions of all those listed. It appears to me that we are dealing with a single, wide-ranging, polymorphic species with local morphological variants which may or may not be distinct enough to be considered separate species. The problem must await a monographer. As far as the Solomons and Bismarcks are concerned however it looks as though the regional variants, *B. novo-hibernica* and *B. solomonensis*, are not sufficiently distinct from each other or from the main plexus to be given specific rank and I think they can both be considered as part of *B. arborescens*.

BSIP 1656 from Vanikoro, Santa Cruz Islands, matches the type, viewed at Kew, of *B. attenuata* A. C. Smith, from Fiji. This appears distinct from *B. arborescens* which has not been collected from the Santa Cruz islands yet.

Buchanania specimens examined from Solomons
and Bismarcks

SOLOMONS (BSIP series unless indicated otherwise).

Bougainville *Kajewski* 1873, 2123.

Choiseul 4038, 5215.

Rob Roy 5311.

New Georgia Islands Baga 1327, 1375 Kolombangara 1472

New Georgia 275, 3277, 4701, *Waterhouse* 227 Gizo 3046,
5636 Gatukai 315 Vangunu 915, 948, 983.

Guadalcanal 49, 745, 786, 1072, 1087, 1137, 2558.

Malaita 71, 3442, 3496, 4457.

Santa Ysabel 2479, 2627, 2737, 3614, 4075.

San Cristobal 4276.

BISMARCKS.

New Britain NGF 1838, NGF 10067.

B. *Camptosperma* Thwaites

C. *brevipetiolata* Volkens Bot. Jahrb. 31, 446, 1902.

C. brassii Merr. et Perry J. Arn. Arb. 22, 535, 1941.

The type and only collection of *C. brassii*, Brass 3355, comes from Santa Ysabel, Garona. I revisited this locality and with some difficulty penetrated the coastal swamp on to the foothills where, as Brass states, it is a conspicuous tree. Brass 3355 (isotype from Brisbane viewed on loan) has leaves very hairy below and has dried a rich chestnut brown. The very many collections we have now made of *C. brevipetiolata* have variable tomentum on the

lower leaf surface but some sheets including the collection from Garona are as hairy as *C. brassii*. As my material was all collected into spirit, using Mr. Womersley's technique, and Brass's was dried in the field the colour of the specimen is not significant. In all other respects *C. brassii* is identical with *C. brevipetiolata*. Like so many of the species founded by Merrill and Perry on one or two collections this 'Solomons' endemic' is revealed for what it is and must be sunk into synonymy with a widespread species.

C. brevipetiolata is very similar in the herbarium to *C. auriculata* Hk. f. of western Malesia, also a species of disturbed places. The two species look rather different in the forest, *inter alia* young trees of *C. auriculata* have very much bigger leaves. Pending a monographic study I prefer to leave the two distinct.

II. Cunoniaceae

Schizomeria D. Don

Schizomeria serrata Hochreutiner Ann. Cons. Jarb. Bot Genève 10, 188, 1907.

S. floribunda Schlechter Bot. Jahrb. 52, 156, 1915.

S. pulleana O. C. Schmidt Nova Guinea 14, 150, 1924.

S. brassii Mattfeld J. Arn. Arb. 20,435, 1939.

S. whitei Mattfeld loc. cit. 435-6.

In the lowland rain-forests of the Solomons is a *Schizomeria*. It is a variable tree and the problems are whether it is one or more species and then what to call it. The bark varies from smooth to scaly to fissured, a wide range for a single species, and there is considerable variation in the characters of herbarium specimens.

From twenty-six collections we have made in B.S.I.P. great variation can be seen in leaf margin, leaf base, inflorescence size and shape. Concerning *leaf characters*, at one extreme are collections with lanceolate, cuneate-based, closely serrate leaves (BSIP 313, 1225, 1397, 1455, 2891, 3565) and at the other extreme collections with broadly ovate, round-based, crenate leaves (BSIP 308, 1144, 2764, 4050). There is a series between these extremes, and some collections even have both cuneate and round-based leaves (BSIP 1144, 2764, 4050, 5613); nor is there a sharp disjunction between serrate and crenate margin. Concerning *inflorescence characters* the panicle varies very much in size. At one extreme are BSIP 976, 1225, 1397, 2748 with compact panicles less than 3 cm. cross and these are connected via BSIP 2764-5269, 5270 with panicles 10 cm. long \times 7 cm. across to the very large open panicles of BSIP 1144, 18 \times 15 cm. There are intermediates between these stages. There is a rough but not invariable correlation between the series or spectrum of leaf characters and those of the inflorescence. However it also appears to matter how

mature the inflorescence was at collection, the flowers on the compact inflorescences are mostly in bud suggesting that these are young and would later have expanded. Concerning *fruit shape*, one collection, BSIP 3140, has spherical fruits, some, BSIP 893, 976, 2891, 3383, 3565, 5613, NGF 8445, have ellipsoidal fruits, and a few collections have both spherical and ellipsoidal fruits, BSIP 821, 1328, 1397, 4050. Fruit shape is not correlated with the other characters described and probably depends on degree of maturity. The fruits sometimes reach 15 mm. long but are usually 8–10 mm. In none of these three series of characters are there sharp disjunctions and the series are not correlated with geography.

The petals have fallen off the open flowers of all collections examined. The flowers vary in size, from 1–3 mm. across but only reach 2–3 mm. when the fruit has begun to develop (BSIP 1144).

Because the various characters vary fairly independently of each other and are each and every one connected by intermediate stages I think all these collections must be placed in a single species.

White (in 'Taxonomy and Geography', 1962 p. 79 *et seq.*) has coined the useful and appropriate term ochlopecies (Gr. oklos—an irregular crowd, a mob; also 'trouble', 'annoyance') for species showing a complex reticulate pattern of variation of this kind and in which the morphological disjunctions are insufficient for us to recognise taxonomic categories. In the *Buchanania arborescens* group analysed above morphological differentiation has proceeded further to produce distinct local forms which can be given taxonomic status. In other words evolution has gone further in the *Buchanania arborescens* group than in *Schizomeria serrata*.

Several species of *Schizomeria* have been described which all fit our material. At Kew I have examined authentic material of the following species of this group.

S. serrata: Hochreutiner 103 (isotype); also two recent collections from same tree (VII a 12 at Bogor); Soepadmo 10, 23.xi.59 (sheet also at Lae); Rastini 164, 14.iii.60.

S. floribunda: Ledermann 9763 (isotype), Ledermann 9664.

S. pulleana: Lam 1474 (isotype).

S. brassii: Brass 713 (isotype).

S. whitei: Kajewski 1336 (isotype) 1135.

The characters on which these species have been differentiated are mainly those demonstrated above to vary more or less independently and continuously. The collections from the Solomons cover the whole range of morphological variation of all these species. I have also examined twenty-one collections from New Guinea and the Moluccas; they all appear similar. Now that abundant material is available I do not think any of these species can be maintained, the formerly perceived disjunctions break down.

I conclude that the wide-ranging lowland *Schizomeria* of Sahul-land is probably best regarded as one polymorphic species for which the earliest name is *S. serrata* Hochr. and that *S. floribunda*, *S. pulleana*, *S. brassii*, and *S. whitei* must be reduced to synonymy now. In all probability when material can be traced *S. katastega* Mattf. (J. Arn. Arb. 20, 434, 1939), *S. tegens* Mattf. (loc. cit.) and *S. homaliiformis* Kan. et Hat. (Bot. Mag. Tokyo, 56, 109, 1942) they will also prove synonymous.

Two further observations must be made: —

(a) *S. pulleana* is said to differ from *S. floribunda* in various of the features demonstrated inconstant above but also in possessing longer and irregularly 3-lobed petals. However as the petals are early caducous in *Schizomeria* this character cannot be considered satisfactory or adequate to uphold a species.

(b) *S. serrata*: the type and the figure in Ic. Bog. 3, t. 228, 68–70, 1907 have big lanceolate leaves about three times as long as broad whereas *S. floribunda* usually has ovate leaves about twice as long as broad. The difference is so striking that I at first was inclined to keep the species separate, but BSIP 1397, 1455, 2891, 3565 and 4731 have lanceolate leaves, although rather smaller than the type of *S. serrata*. Finally however I viewed Rastini 164 from the type tree of *S. serrata* and this has both shapes of leaves on a single specimen. The flowers of this tree are only 2–3 mm. across on the specimens although Hochreutiner states them to be 7–8 mm. diam. The biggest dried fruit is 15 × 12 mm., about the same size as that of *S. floribunda*. Thus the material, but not his description, falls within the range of all the other species in the group. I take it he must have viewed and described living specimens.

Schizomeria serrata material examined at Kew and/or Lae, loci from west to east; in addition to authentic material listed above.

MOLUCCAS

Solea bb 28867.

Morotai *Kostermans* 996, 1081, 1084, 1205, 1278.

Ambon *Robinson* 603, *Teysmann* s.n. (cult. in Hort. Bog.)

NEW GUINEA

West W. New Guinea Div. BW 4472, 5781, 7604
Hollandia Div. BW 7995
Biak *Dijk* 914

East Morobe Distr. NGF 3145, 8445, 19045
Sepik *Ledermann* 9664

Papua Sorong *Pleyte* 996
Sogeri NGF 4200
Garitar *Brass* 713
Misima Isl. *Brass* 27534, 27653
Oriomo R. *Brass* 5804

BISMARCKS

New Britain NGF 1893

SOLOMONS (BSIP series unless indicated otherwise)

Bougainville *Voyce* B3, D8; *Waterhouse* K 733

Choiseul 4050, 5269, 5270

Rob Roy 5343, 5356

New Georgia Islands Baga 1328, 2891 Gizo 5613 Kolombangara 821, 1397, 1455 New Georgia 3140, 3789, 4731, 4765 Vangunu 155, 893, 976, 1225

Santa Ysabel 2748, 2764, 3565, *Brass* 3428

Guadalcanal Tina 1105, 1144, Rere 308, 313, 3383

III. Euphorbiaceae

Endospermum Bentham

Endospermum medullosum L. S. Smith Proc. R. Soc. Queensl. 58, 53, 1947.

Endospermum malaccense Muell. Arg.* Flora 47, 469, 1864.

The common lowland Solomons tree *A'asa* (Kwara'ae) has been called *E. medullosum* from Walker's early collections (BSIP 97, 304), determined at Brisbane, onwards. It is a perfect match for the abundant collections at Lae, including the type and other sheets cited by Smith. The species is distinctive in forest and herbarium.

I have examined at Kew the type of *E. malaccense* (Griffith 4721) and Maingay 1392 which also is cited in the 'Pflanzenreich' account, as well as many old and recent western Malesian gatherings. *E. medullosum* is extremely similar to this species and sterile trees are indistinguishable. Smith makes it clear that he saw no western Malesian material when he described his species. There is a slight yet consistent difference in the inflorescence and flower stalk, which can be summarised as a key:

Male and female inflorescences paniculate; branches often themselves branching;; branch systems usually at least 2.5 cm. long; flowers and fruits sessile, or on very short stalks 1 mm. long.

— *E. medullosum*

Male and female inflorescences spikes or narrow panicles; branches simple, to 2.5 cm. long. Flowers and fruits on distinct stalks c. 10 mm. long.

— *E. malaccense*

* Airy Shaw (Kew Bull. 14, 395, 1960) considers it highly probable that the correct name for this species is *E. diadenum* (Miq). Airy Shaw, and I agree with him.

On the basis of these differences I propose that provisionally the two species are kept distinct. When more fertile gatherings come to hand from the region of "Wallacea" between western and eastern Malesia it may be found that, as in so many other cases, we have just one widespread variable species.

Collections of E. medullosum, and state of material examined, from Solomons (all BSIP series): —

Shortland	5744 (fr.)
Wagina	5470 (very young inflorescence)
New Georgia Islands	Baga 4202 (seedling) Kolomban- gara 1431 (fr.) New Georgia 1978 (fr.) 2543 (fr.)
Santa Ysabel	2724, 2202 (fr.)
Guadalcanal	1169 (very young inflorescence)
Malaita	3451 (very young inflorescence)

IV. Guttiferae

Calophyllum Linnaeus

A. Big Coriaceous Leaves Species

C. kajewskii A. C. Smith J. Arn. Arb. 22, 353, 1941.

C. solomonense A. C. Smith loc. cit., 346.

We have in the Solomons a big-leafed, big-fruited *Calophyllum* which is a common tree of lowland rain-forest. This note is to establish its identity and also that of a much less common species.

C. kajewskii is based on Kajewski 2024, a sterile branch with a single detached fruit. Waterhouse 201 is also cited by Smith; the sheet seen was sterile but the description stated 'orang-like fruit'. Smith states 'the foliage closely resembles that of *C. inophyllum*', but the species is unique in the region with its extremely large fruit reaching 5-6 cm. diameter.

C. solomonense is based on Kajewski 2469. Brass 3447 was also seen. Like *C. kajewskii* the foliage 'bears a close resemblance to *C. inophyllum*, it differs obviously in the greatly contracted inflorescence' (Smith).

The two species are not at all clearly distinguished in Smith's latin descriptions. I have examined all the sheets Smith saw (except Waterhouse 201), kindly lent me at Lae by the Brisbane herbarium and at Cambridge by the Singapore herbarium, and our own extensive collections from the Solomons. I am able to distinguish the species on the following diagnostic characters.

C. kajewskii

Twigs and petioles commonly blue-black, or sometimes golden, glaucous. Leaf blade obovate or ovate, rarely broadly ovate, 4 × 11 to 9 × 19 cm. (ratio 2.7-2.1), secondary veins coarser than in

C. solomonense, raised on both surfaces (felt by finger tips), 60–80° to midrib. Flowers in racemes to 7 cm. long up to 10 per raceme. Fruit globose 5–6 cm. across at maturity. Very big timber tree with coarsely fissured bark. Kwara'ae name *Ba'ula*. Common throughout Solomons, also in Bismarcks and with two collections from northwest New Guinea.

C. solomonense

Twigs and petioles always golden. Leaf blade oblong, 7 × 16 to 8 × 28 cm. (ratio 2.3–3.5). Secondary veins finer than in *C. kajewskii*, not or scarcely raised on upper surface (not felt by finger tips), slightly raised but not prominent below, 80–90° to midrib. Flowers unknown. Fruits single or paired, on 5 mm. pedicels and a 10 mm. peduncle; only 2 cm. across at maturity. Smaller (our collections and *pace* Kajewski 2469), and much less common tree than *C. kajewskii*, with smooth, slightly fissured bark. When bark is cut superficial phellem comes away to reveal red phelloderm and its own inner surface which is yellow (BSIP 2580, 2791); no other Solomons *Calophyllum* does this. Branches more or less pendent with leaf bases overlapping, like *Inocarpus fagiferus*, (BSIP 2580). Kwara'ae confused by this tree and call it *Gwaragwaro* (*C. vitiense*) or *Oleole* (*C. paludosum*).

The leaf differences between these two species are subtle and I am unable to place one sterile collection (BSIP 1940) in one species or the other, and the 20 ft. tall young tree BSIP 1925 from under *C. kajewskii* BSIP 1921 has very solomonense-like leaves.

In passing I observe that Smith apparently made a mistake when he described *C. solomonense*. He says that on Brass 3447 'the fruits appear to be solitary in the leaf axils, in the type (Kajewski 2469) . . . (they) are . . . on short racemes' whereas in the Brisbane sheets it is the other way round, the fruits are solitary in the type and racemose in the Brass collection.

Collections examined (BSIP series unless otherwise stated)

Calophyllum kajewskii

SOLOMONS

Bougainville Tonelai Hbr. NGF 13029 Buin *Kajewski* 2024 type.

Mono 4178

Choiseul 5268a

Rob Roy 5363

New Georgia Islands Baga 1290, 1321, 3065, 4207 Gizo 5610

Kolombangara 818, 1407, 4092 Rendova 1899, 1921, 1925

New Georgia 1941, 3111 Gatukai 318, 1248b.

Santa Ysabel 2722, 2738, *Brass* 3447

Guadalcanal 2790

Malaita 3415, 3846

San Cristobal 4213, 4345

BISMARCKS

New Britain NGF 24, 1827, 7007, 10914, 10922, 17048

New Ireland NGF 12352

Umbo NGF 9623

NEW GUINEA

NW. Hollandia Res. Tam. BW 764, 1641

Calophyllum solomonense

SOLOMONS

Santa Ysabel 2580, Brass 3447

Guadalcanal 2794, 3317, *Kajewski* 2469 type

C. kajewskii or *solomonense*

New Georgia 1940

It remains to demonstrate that these recently described Solomons' species are distinct from the earlier described big-leaved *Calophyllums* of the Bismarcks and New Guinea. None of the latter is known at all well. Each was described from only a few collections and in some cases flowers or fruits or both were not known. Recent collections at Lae are sterile. Nevertheless there are distinctive features for each species, which I enumerate below and which enable me to place the collections at Lae with some confidence and to consider them different from *C. kajewskii* and *C. solomonense*, as well as from each other.

C. peekelii Lauterbach, Bot. Jahrb. 58, 11, 1923.

Cited specimens: BISMARCKS: New Ireland: Namatanai, *Peekel* 132, fruits (but lost); Namarodu, *Peekel* 781, flowers. NEW GUINEA: Kei Islands: *Warburg* 20041, sterile.

To these I add: BISMARCKS: Admiralty Islands: Los Negros Isl. NGF 536, sterile; St. Matthias Group, Mussau Isl. W 293 (*A. C. Richardson*), sterile.

The fruit shape and size are only known from *Peekel's* manuscript flora of the Bismarcks p. 1233.

Diagnostic characters. Leaf blade 32×11 cm.; flowers big, 2 cm. across; fruit big, oval almost round, 3.6×4.7 to 4.7×5.7 cm. (once 8.5×7.0 cm.).

Two sterile collections from the Papua Gulf, Kikori R. NGF 4551, and Oriomo R. NGF 10410, are of very similar leaf and provisionally can go here too, although fertile collections are of course essential for final judgement, as is true also of the Kei Islands collections (above). The field description of NGF 10410 says 'fruit axillary, globular, somewhat pointed at apex 3 in. diam' and this is strong circumstantial evidence that the species is *C. peekelii* as such big fruits are unique. Both collections are of a swamp tree with stilt roots. Mr. Womersley tells me this species is locally common.

C. macrophyllum Scheffer Nat. Tijd. N.I. 32 (2) 405, 1873.

Lauterbach (loc. cit.) says this is probably identical with *C. peekelii*. I have seen the type at Leiden (Teysmann, s.n., Herb. Bog. 7574, Isl. Gebeh), a single huge lanceolate leaf 45 × 10 cm. quite unlike that of any other *Calophyllum* I have ever seen, and certainly different from *C. peekelii*.

C. euryphyllum Lauterbach, loc. cit. 14

Cited specimens. NEW GUINEA: Sepik River at Lagerberg, *Hollrung* 761, sterile.

To this I add NEW GUINEA: Sterile: Sepik River nr. Yellow River NGF 3920; Sekoli nr. Hollandia BW 8141; Oregon Trail BW 12032; Meos Waar Isl. 1255; nr. Manokwari BW 4352. Flowering: Hollandia BW 4797. Fruiting: Hollandia BW 4827. MOLUCCAS: Sterile: Morotai, Tobelo, Totodokoe bb. 33.771.

Diagnostic characters. Leaf blade broadly ovate, 8 × 11 to 10 × 16 cm., rounded at base and apex; secondary veins almost invisible on upper surface, faint and rounded not angular on lower surface. Flowers (in bud) 1–3–4, in 5 cm. racemes, clustered in 2–3 s in leaf axils; pedicel 1 cm. Fruits globular 28 mm. across. A species of northern New Guinea;

C. sil Lauterbach loc. cit. 14

Cited specimen. NEW GUINEA SW: South coast by Gelieb village: *Branderhorst* 179 fruits, TYPE.

No material seen.

Diagnostic characters. Leaf blade obovate, 3.5 × 7 to 5 × 10 cm. Few flowered 5 cm. inflorescence. Fruit spherical 10–12 mm. unripe.

B. Other Species1. **C. vitiense** Turrill J. Linn. Soc. Bot. 43, 17, 1915.

A big timber tree described from Fiji which reaches its northern limit in the Solomons. This species is characterised by its long, slender, blue-black petiole, lanceolate leaf, racemose inflorescence, usually with peduncle to 5 cm. and pedicels 2 cm., and ellipsoidal seed 2.5 cm. long.

Collections seen:

SOLOMONS (BSIP series unless stated otherwise)

Bougainville NGF 2873, *Kajewski* 2020

Choiseul 5271

New Georgia Islands Baga 1377, 2812 Kolombangara 836, 1410, 2099 Rendova 1880 1911 New Georgia 1977, 2154 Vangunu 429, 899, 967, 1260 Gatukai 1249

Santa Ysabel 2186, 2420

Guadalcanal 648, 1120, 1123, *Kajewski* 2657

SANTA CRUZ

Tevai 1570

Vanikoro 1596, 1706

2. *C. cerasiferum*, *C. paludosum*, *C. soulattri*.

These are the small-tree Calophyllums of the Solomons. They seldom attain 5 ft. girth and are usually only 2–3 ft. They are more easily distinguished in forest than herbarium and some collections I cannot place. In the forest the Kwara'ae can uncannily tell *Kaumanu* (*C. cerasiferum*) from *Oleole* (the others) although the species often grow together. I have not been able fully to analyse the bole and bark characters they use.

All three species have small, usually umbellate, inflorescences, often much reduced in the first two; flower buds are tiny (2–3 mm.), and peduncles slender; fruits are small, globose to subellipsoid, and do not exceed 15 mm. long. The leaves are chartaceous and the secondary veins close.

The species have a wide habitat range from the lowlands to mountain ridges, and from swamps to dry land. I am unable to correlate this physiological diversity with morphological variation. *C. kajewskii* has a similar range and is equally indivisible; physiological evolution has not yet been matched by morphological.

C. cerasiferum Vesque *Epharmosis* 2, 10, 1889.

Diagnostic characters. Bole with flying buttresses; exudate from cut bark clear golden yellow (except BSIP 2388 — opaque white). Leaves small, ovate-elliptic, 5 × 2.5 to 10 × 4 cm. (ratio 2 to 2.5) with midrib slightly raised and broadly channelled on upper surface and rather clearly cut raised veins prominent on both surfaces, distant, 25–30 per cm. Sometimes in high mountains. Kwara'ae name: *Kaumanu*.

The Solomons' collections are a reasonable match for *C. cerasiferum* of Fiji in leaf shape, size and details of venation. The type, Seemann 49, (isotype at K!) has most but not all the midribs raised and channelled above. In both Fijian and Solomons' material the inflorescence may be a short raceme with the flowers clustered at two points along the main axis (Vaisewa 18, BSIP 1497). The vernacular name in Fiji is *Damanu*, cognate with the Kwara'ae name*.

Closely related to *C. congestiflorum* A. C. Smith and *C. pauciflorum* A. C. Smith of highland New Guinea which, however, have consistently smaller and rounder leaves with the midrib above always sunken rather than raised on the upper surface, and the secondary veins more distant and less clear-cut.

*Dr. B. C. Stone tells me this name and cognate versions are wide spread through the Pacific for Calophyllum species, e.g. *Kamani Kamanu* (Hawaii), *Tamanu* (Samoa, Tahiti).

Collections seen, and habitat

SOLOMONS (BSIP series)

Choiseul 5278 (ridgetop 50 ft.) 5399 (hillside 100 ft)

New Georgia Islands Kolombangara 852 (lowland), 2100 (ridgetop 2700 ft.), New Georgia 2013 (swamp), Vangunu 1207 (crater rim 2400 ft.)

Santa Ysabel 2388 (summit ridge, Mt. Sasari 3600 ft.)

Malaita 70 (littoral swamp)

FIJI *Seemann* 49 (type), *Horne* 732 *Vaiwesa* 18, *Bola* 11.

In addition the following collections appear intermediate with *C. paludosum*:

New Georgia Islands Baga 2837 (lowland), 2912 (valley bottom, lowland).

Malaita 70 (littoral swamp-forest), 3458 (periodically flooded lowland).

C. paludosum C. T. White J. Arn. Arb. 31, 98–9, 1950.

Diagnostic characters. Buttresses absent. Exudate from cut bark opaque cream-yellow (except NGF 12351-clear). Leaves ovate-lanceolate 7×2 to 10×3 cm. (ratio 3.5 to 3.3), veins clear-cut, visible on both surfaces close, c. 40 per cm. (50 on BSIP 316), drying brown. Kwara'ae names: *Oleole* (Kwai dialect) *Kaumanubala* (Auki dialect). Distinguished in herbarium from *C. cerasiferum* with difficulty, the leaves are on the whole narrower, the veins closer, less clearly cut and less prominent; and it has not yet been found in high mountains.

Clearly distinct (*pace* C. T. White) from *C. pulcherrimum* Wall., the sheets of which at Singapore (labelled by Henderson & Wyatt Smith, see Gard. Bull. Sing., 15, 1956), all have smaller, more ovate leaves with more distant veins, much more delicate twigs and long racemose inflorescences with bigger flowers, (isotype, Cuming 1077, ! at K).

C. neo-ebudicum Guill. is also well distinguished by its open racemose inflorescences 6 cm. long and big flowers 10 mm. across, although in leaf it is identical, (isotype, Kajewski 705, ! at K). Kajewski 642 from Santa Cruz Islands, Vanikoro has a small raceme 3 cm. long, and flower buds of intermediate size: in morphology as in locality it is intermediate.

Collections seen, and habitat:

BISMARCKS

Mussau *A. C. Richardson* W 294 (over coral-limestone)

New Ireland NGF 12351 (well drained ground, sea-level).

SOLOMONS (BSIP series)

Shortland 5746 (hillside 100 ft.)

Choiseul 5278 (ridgetop 50 ft.)

Rob Roy 5340 (ridgetop 100 ft.)

New Georgia Islands Baga 1330 (lowland ridgetop) Kolomban-
gara 1497 (ridgetop 700 ft.) 2101 (ridgetop 2700 ft.) New
Georgia 192 (swamp) 4759 (hillside 240 ft.) Vangunu 944
(ridgetop) Gatukai 316 (coastal swamp)

Santa Ysabel 2769 (ultrabasic ridge)

Malaita 3469 (ridge 400 ft.), 3549 (lowland hillside)

San Cristobal 4373 (narrow rocky ridge 1500 ft)

C. soulattri Burm. Fl. Ind. 2, 121, 1768; Henderson & Wyatt-
Smith Gard. Bull, Sing., 25, 319, 1956.

C. kiong Lauterbach et Schumann. Fl. Deutsch. Schutzgeb.
Südsee 450, 1901; Ltb. Bot. Jahrb. 58, 11, 1923.

Mr. J. S. Womersley has long suspected that *C. kiong* is the
same as *C. soulattri*. *C. kiong* was described from collections made
on Sattelberg 20–30 miles north east of Lae. The locus has un-
fortunately not been revisited despite its relative accessibility,
but there is a common *Calophyllum* around the Huon gulf, well
represented in Lae herbarium. It is common in the foothills of
the ranges immediately to the north of Lae which adjoin Sattel-
berg. It fits the description of *C. kiong*, and matches one of our
Solomons' species, notably in leaf shape, size and venation and
the umbelliform inflorescences. I have examined the sheets at
Singapore determined as *C. soulattri* by Henderson and Wyatt-
Smith and find them a good match with the species round Lae;
inter alia umbelliform inflorescences are uncommon in *Calophyl-
llum*. The main difference is that the New Guinea-Solomons'
collections sometimes have smaller leaves; this cannot, I consider,
be maintained as a specific difference, especially as there is a
continuous range of variation in leaf size. I therefore propose to
reduce *C. kiong* to synonymy with *C. soulattri*.

Diagnostic characters. Buttresses absent. Exudate from cut
bark, opaque, cream-yellow. Big ovate-oblong leaf blade, broadest
near base, 9 × 4 to 20 × 7 cm. or rarely 28 × 9 cm. (ratio 2.25–
2.7–3.1); drying grey-green; veins faint, very close together. c. 50
(40) per cm. Kwara'ae names: *Oleole* (Kwai dialect), *Kaumanubala*
(Auki dialect). Sometimes confusable with *C. paludosum*; distinct
in the bigger leaves with closer, fainter veins, drying pale grey-
green rather than brown.

Collections seen, and habitat:

NEW GUINEA

West

Tami R: BW 2712

Mt. Krabo: BW 10752

East

Lae environs NGF 3293 (coastal), 11919 (Atzera Range).

Bulolo (300–400 ft.) NGF 7543, 10144, 12239, 17025
Womersley s.n., 5/6/61.

Wau NGF 1463 (ridge 3,500 ft.)

Papua

Oriomo R. NGF 2723, 13196.

Sogeri Plateau (2,000 ft.) *Schodde* 3131, NGF 2829.

SOLOMONS (BSIP series unless indicated).

Choiseul 3959 (ridge 200 ft.), 5399 (hillside 100 ft.).

New Georgia Islands Baga 1360 (swamp) Gizo 5602 (ridge 200 ft.) Kolombangara 817 (lowland plain) 1485 (ridge 100 ft.) Rendova 1856, 1857 (ridge 300 ft.) 1912 (ridge 150 ft.) New Georgia 2041 (riverbank) 2520, 2521, 2523, 2524 (ridge 600–750 ft.), *Waterhouse* 309 (damp country).

Santa Ysabel 2703 (ridge).

Guadalcanal 3388 (ridge 200 ft.), 3833 (low ridge).

3. ***Calophyllum* sp.** BSIP 424, from New Georgia Islands, Vangunu. A small tree of lowland forest, unique and distinctive in its tiny lanceolate leaves only 3 cm. long. I demur from describing it as a new species with only one collection and the flowers unknown. [*But see the following paragraph which was added in proof.*]

IV **Guttiferae**, *Calophyllum* sp. BSIP 424

The note that this represents a new species was based on the BSIP sheet. In sorting through the set now deposited at SING I have just noticed that the sheet there of BSIP 424 has much bigger leaves. In fact the collection is none other than *Calophyllum cerasiferum*.

V. **Myrtaceae****New combinations in *Eugenia***

I take the broad view shared by many other botanists that *Syzygium* is not generically distinct from *Eugenia* and make the following transfers.

Eugenia cincta (Merr. et Perry) Whitmore **comb. nov.**

Type: Brass 3344.

Syzygium cinctum (Merr. et Perry)

J. Arn. Arb. 23, 272, 1942, basionym.

Eugenia myriadena (Merr. et Perry) Whitmore **comb. nov.**

Type: Kajewski 2713.

Syzygium myriadenum Merr. et Perry

J. Arn. Arb. 23, 293, 1942, basionym.

Eugenia onesima (Merr. et Perry) Whitmore **comb. nov.**

Type: Kajewski 2043.

Syzygium onesimum Merr. et Perry

J. Arn. Arb. 23, 296, 1942, basionym.

VI. Sapindaceae

A. *Pometia* J. et G. Forster

The abundant collections we now have of this common Solomons' timber tree fully support Jacobs' contention (Reinwardtia 6, 140, 1962) that in the Solomons *Pometia* is taxonomically homogeneous. The fertile and some sterile collections all run down in his key to *forma pinnata*. Some sterile collections have a glabrous midrib above and cannot be keyed out, namely BSIP 5913, 5916, 5918.

The New Guinea foresters, notwithstanding Jacobs' treatment, still find it useful to distinguish three species of *Pometia* (see van Royen, 1964, 'Manual of the Forest Trees of Papua & New Guinea' 2, 35-42) which they distinguish on a number of morphological characters and which differ in their ecology and bole form (hence commercial value).

On their criteria all the Solomons' collections are *P. pinnata* Forst. except one BSIP 2694, from Santa Ysabel, Tatamba, which is *P. tomentosa* T. et B.

I propose that in the Solomons we follow the New Guinea foresters for this genus, which contains one of our most important timber species. The group seems comparable to the *Buchanania arborescens* group, a widespread polymorphic species with variously distinct local forms; rather than to the ochlospecies *Schizomeria serrata*, which cannot be taxonomically subdivided.

Collections examined (all BSIP series).

SOLOMONS

Shortland 5913, 5914, 5915, 5916, 5918, 5920, 5924, 5925, 5927, 5928.

New Georgia Islands Baga 2882, Gizo 5608, Kolombangara 804, 1483.

Choiseul 5667.

Rob Roy 5416.

Santa Ysabel 2694, 3626.

Guadalcanal 1073, 2775.

Malaita 3456.

San Cristobal 4260, 4324.

SANTA CRUZ

Vanikoro 1722 (with edible fruit but *forma pinnata* nevertheless).

B. *Tristiropsis* Radlkofer

Tristiropsis acutangula Radlk. Sitz. Ber. K. (Bayer.) Ak. Wiss. M.-Ph. Kl. (Cl.) Münch. 20, 248, 1890; listed also in Durand. Ind. Gen. 1887.

T. obtusangula Radlk. loc cit.

T. dentata Radlk. Denkschr. K. Ak. Wiss. M.-N. Kl. Wien 89, 572, 1913.

This note is prepared after consultation with Dr. Leenhouts who is revising the whole family Sapindaceae, and is published now to provide a sound name for an important Solomons' species.

The nine or so species described in this genus are very difficult to tell apart and have very slight differences. From the Solomons are *T. acutangula* Radlk. based on a fruiting collection, Guppy 272, from Oima (should be Oema) in the Shortland Islands; and *T. dentata* Radlk. based on two sterile collections, one a juvenile, from Popoco, a small island and village in Kieta Bay, Bougainville, about fifty miles north of Oema.

We have found a *Tristiropsis* which is a common tree of the coral-strand — on Baga (BSIP 4211, 4417), where considerable numbers have been felled for timber, on Kolombangara in the New Georgia Islands, and as a relict tree on the coastal coral of north central Guadalcanal within Honiara town (BSIP 4421). The species has a patchy distribution, we have not seen the species anywhere else despite the abundant and highly distinctive seedlings which make it easy to spot and we know for certain that it does not grow in northern Malaita where no one has seen it and there is no local name for it; tree climber Susui went to Malaita and round the villages to check this for me.

My collections are a good match for Guppy's from Oema (type at Kew!) and can be referred to *T. acutangula*.

Two other species have been described from the Pacific. *T. obtusangula* from the Marianas, differing in the obtuse rather than acute-angled fruits and *T. dentata* from Bougainville differing in having toothed leaflets. Dr. Leenhouts and I examined at Leiden (on loan from Paris) the type of the former. It is a good match on leaf with my collections and has two flattish detached fruits which appear simply to be young, not yet fully developed. *T. dentata* is almost certainly merely a juvenile plant, for the seedlings of my collections BSIP 4211 have serrate leaves.

It is not possible to maintain these three Pacific Island species as distinct, and as *T. acutangula* has the most complete type specimen it seems the best name to adopt for this important Solomons' timber species.

VII. Verbenaceae

Gmelina Linnaeus

G. moluccana (Bl.) Backer in Heyne, Nutt. Pl. 4, 118, 1917.

G. salomonensis Bakh. J. Arn. Arb. 16, 72-3, 1935.

There is a common *Gmelina* found through the Solomons. It is a big tree of disturbed lowland-forest and is well known locally as it is the best canoe timber in the archipelago. We have made

many collections of this species. There are two fairly distinct varieties which have different ranges. Thus:

(1) Leaves densely velvety below, rather thick in texture; inflorescence axes, stems and petioles densely fulvous tomentose all over; fruit sometimes cylindrical; central and eastern Solomons. *Collections seen* (all BSIP series unless indicated):

Santa Ysabel 2487, 4072, 2301 *Brass* 3309.

Guadalcanal 59*, 649.

Malaita 3501.

San Cristobal 4255; *Brass* 2860*.

(2) Leaves glabrous below except for a few hairs on veins, rather thin in texture; inflorescence axes, stems and petioles partly glabrous partly fulvous tomentose but thinly so; fruit always conical; western Solomons (except 257).

Collections seen (all BSIP series):

San Cristobal 257*.

Shortlands Fauro 3949, 5708.

New Georgia Islands: Baga 1870, 5573 Gizo 5603 Kolombangara 819, 851. Rendova 1854 New Georgia 169*, 3709.

The starred numbers are at BRIS and L; the others (i.e. the recent part of the BSIP series) at K, L, LAE, US, and SING.

The hairiness and texture of the leaves apparently does not depend on their maturity, all leaves on every collection are similar to one another. Nevertheless I prefer not to give these differences specific status as in their essential parts these taxa are the same.

The hairy leaved eastern form is a good match for *G. moluccana* (Bl.) Backer, abundantly represented at Leiden and Lae from New Britain, all over New Guinea and the Moluccas, much of which was determined by Moldenke, and including Teysmann 1859, 5031 from Ambon cited by Backer (loc. cit.). All the sheets seen have coriaceous leaves, most of them velvety hairy but a few glabrous or glabrescent below (e.g. NGF 1854, 4580, 5870, 8213). There is none of the other form in Lae or Leiden. As with the Solomons' material there is no suggestion that texture or degree of hairiness changes much on ageing.

G. salomonensis Bakh. was described on the basis of a single collection, Brass 3309, from Santa Ysabel, Tiratona. Bakhuizen stated that it is intermediate and possibly a hybrid between *G. moluccana* and *G. macrophylla* (R. Br.) Benth., which is properly called *G. dalrympleana* (F. Muell.) H. J. Lam (Verb. Malay. Arch. 223, 1919). I have examined an isotype at Leiden which fits the

hairy-leaved typical *G. moluccana* of the eastern Solomons, although the leaves are rather larger, slightly thinner and less hairy than is usual.

White (J. Arn. Arb. 21, 113, 1950) annotating Walker's Solomons' collections also noted how close *G. salomonensis* is to *G. moluccana*. On the other hand *G. dalrympleana* in Moldenke's sense is a very distinct entity as I show below. It has not been found yet east of mainland New Guinea and none of the Solomons' collections come near to it, including, in my opinion, the type of *G. salomonensis*.

In my opinion *G. salomonensis* must be considered synonymous with *G. moluccana*, which occurs in the archipelago in its typical form in the eastern islands and in a glabrous form in the western islands. The glabrous form may be Moldenke's *G. salomonensis* forma *glabrescens* (Résumé of Verbenaceae etc. 204, 1959) from Bougainville of which I have been unable to trace description or material.

Gmelina in New Guinea

The next question is, what is *G. dalrympleana*? I have seen material of three closely related published species of *Gmelina* from New Guinea. They may be distinguished thus:—

Leaves densely velvety hairy below, without conspicuous glands; inflorescence axes stout

Flowers sessile, partially covered by large triangular bracts c. 12 mm. long; inflorescence a simple spike;

. . . *G. sessilis* White et Francis in Lane Poole Rep. For. Resources Terr. Papua & New Guinea 136, 1925 and more fully in Proc. R. S. Queensland 38, 257-8, 1927.

Flowers stalked not covered, bracts smaller lanceolate; inflorescence usually branched paniculate; *G. moluccana* (Bl.) Backer

Leaves glabrous and shiny below with a pair of conspicuous glands at base of midrib; inflorescence axes slender

. . . *G. dalrympleana* (F. Muell.) H. J. Lam.

The difference between *G. sessilis* and *G. moluccana* is slight and not absolute; for instance the Lae sheet of NGF 10883 has simple spikes, and the Leiden sheet branching ones, and both sheets have big foliaceous bracts partially enclosing the flower. The position is further complicated by *G. papuana* Bakh. (J. Arn. Arb. 10, 71, 1949). I have not been able to find the type and only cited sheet (Papua, Iawarere, 695, 25.xi.25) of this. Clearly as Bakhuisen himself states and from his description and photograph it is very close to *G. moluccana*. These three species are all close and more or less intergrading; *G. moluccana* is the first one published. *G. dalrympleana* by contrast appears to be distinct.

The following collections fit these species; a star indicates the sheet was determined by Moldenke. L: at Leiden, otherwise at Lae.

G. sessilis:

NEW GUINEA

East

Dobodura NGF 2005*

Aitape NGF 1221.

Papua

Milne Bay NGF 1345*.

BISMARCKS

New Britain Talasea NGF 10883.

G. moluccana:

(numerous sheets at Lae & Leiden, including many seen by Moldenke and some by Backer).

G. dalrympleana:

NEW GUINEA

West

Merauke: *Van Royen* 4891.

Salawati Isl. BW 1343.

Jalan Kp. Keliki *Anta* 250 (L).Animanharin *Anta* 179 (L).Okaba *Branderhorst* 23 (L) (cited by Backer 1921).

East

Sepik, Green R. NGF 9375*.

Morobe NGF 2922.

Papua

N., between Ambasi & Devatutu Villages *Hoogland* 3405*.

Robinson Bay 3422.

Darn Isl. *Brass* 6319 (L).Tarara *Brass* 3539 (L).Lake Daviumbu *Brass* 7666 (L).Oroimo R. NGF 10374, *Brass* 5753 (L).Normanby Isl. NGF 8680* (L), *Brass* 25388.Milne Bay NGF 1298* (L), *Brass* 21719*,
21915*.Fergusson Isl. *Brass* 27281.Modewa Bay *Brass* 28910.

MOLUCCAS

Aroe Isl. *Buwalda* 5431*.

QUEENSLAND

Kajewski 146 (L); *Mueller* s.n. (Cape York) (L).

Notes on the Systematy of Solomon Islands' Plants and some of their New Guinea Relatives, VIII and IX

By

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VIII Apocynaceae

A. *Allowoodsonia* Markgraf

*Allowoodsonia**whitmorei Mgf.n.gen. et sp.

Arbor 6–12 m. alta, radicibus tabularibus instructa, cortice fusco, laevi oblecta. Folia opposita, chartacea, glabra, breviter (8 mm.) petiolata, elliptica, apice breviter caudata, 13–18 cm. longa, 5–7 cm. lata; nervi secundarii arcuati, 6–7 in utroque latere. Inflorescentiae axillares, glabrae, pauciflorae, pedunculo 1–1.5 mm. longo, simplici, in parte superiore bracteis minimis ornato, a basi ad apicem flore altero post alterum florentes. Pedicellus gracilis, 1.5 cm. longus, 0.5 mm. latus. Calycis lobi 5, ovato-lanceolati, usque ad basin liberi, 4 mm. longi, 2 mm. lati, in marginibus brevissime ciliati, intus in latere tecto uniglandulosi. Corollae albae tubus extus glaber, 10–12 mm. longus, 3 mm. latus, a medio ad apicem ad 4 mm. ampliatus, intus longepilosus, fauce non calloso; lobi 5 sinistrorsum tegentes, lanceolati, paulum obliqui, margine tecto magis arcuato et basi subauriculato, 15 mm. longi, 4 mm. lati, extus glabri, intus longe-pilosi. Stamina 5, medio tubo inserta, filamenta brevissima, antherae sagittiformes, capiti stigmatico agglutinatae, thecae exteriores 4 mm., interiores 1 mm. longae, connectivum in apiculum pilosum, 0.5 mm. longum, faucem attingens prolongatum. Caput stigmaticum subglobosum, quinquangulare, apice in appendices 2 erectas, brevissimas, pilosas attenuatum; stylus 5 mm. longus; ovarium glabrum, biloculare, apocarpum, 1 mm. altum, oblongum, disco anulari quinquelobo circumdatum, ovula in utroque carpello ad 8. Fructus apocarpus, mericarpia horizontaliter divergentia, cylindrica acuminata, hinc inde inflata, glabra, coriacea, complura semina gerentia, 12 mm. crassa, usque ad 28 cm. longa. Semina applanata, oblique oblongo-lanceolata, 5 cm. longa, 1 cm. lata, glabra, non comata. Embryo rectus, radícula 6 mm. longa, 1 mm. lata, cotyledones cordato-lanceolati, 34 mm. longi, 8 mm. lati.

SOLOMONS: Guadalcanal: BSIP 3313, NE at Rere R., c. 3 miles inland, primary forest in valley bottom. Tree H. 20 ft., G. 1 ft. Bole straight, bark grey, smooth. Slash: wood soft, white;

* Dedicated to the late Prof. Dr. R. E. Woodson Jr. of St. Louis, Missouri, who with great success explored the systematics of Apocynaceae.

bark soft, brown, exudate whitish-cream, clear, sticky but free flowing. Flowers white. Fruits brown, 0.5 in. across, long; two joined, about 5 in. Fl. 19.xi.63-Z. Lipangeto (holotype of the genus, in BSIP).

Shortland: BSIP 5774, SE at Hisie R., valley bottom, well drained primary forest. Tree, H. 40 ft., G. 3 ft. Bole straight, buttresses thick, spreading, to 2 ft. Bark surface dark brown, smooth. Slash: wood hard, yellow, bark soft, brown and yellow. Exudate opaque, sticky and free flowing. Flowers white. Fruits brown, 11 in long. Fr. 30.iv.64, Whitmore's Collectors.

Santa Ysabel: BSIP 2632, Allardyce Hbr, coastal swamp. Small tree, fruits long and brown. Fr.11.vii.63, J. Sore, W. Masu'u, Z. Lipangeto.

This genus, belonging to the tribe *Echitideae* with anthers enclosed and sticking to the stigma head, represents an Asiatic counterpart to the tropical-American (and west-African) genus *Malouetia*, which has similar fruits and also seeds without a hair tuft. The large cotyledons call in mind those of *Tabernaemontanoideae*.

B. *Alstonia* R. Brown

Alstonia vitiensis Seem. var. *whitmorei* Mgf.n.v.

Arbor usque ad 15 m. alta. Ramuli glabri, teretes. Folia opposita, glabra; petiolus 2-6 mm. longus, basi intus glandulosus; lamina tenuiter chartacea, lanceolato-elliptica, apice acuta, basi cuneata et in petiolum decurrens, 15-25 cm. longa, 5-11 cm. lata; nervi secundarii ad 16 in utroque latere, conspicui, obliqui, in ipsum marginem decurrentes. Inflorescentiae foliis vix breviores, glabrae, multiflorae, e bracteis minimis triangularibus axis principalis ramuli oppositi, subpleiochasiales oriundi, bracteis minimis scariosis ornati; bracteolae duae minimae scariosae calyci approximatae. Calycis lobi glabri, obtusi, orbiculari-ovati, eglandulosi, 1.5 mm. longi et lati. Corollae albae, odoratissimae, tubus claviformis, 3 mm. longus, infra faucem constrictum 1 mm. latus, extus glaber, intus infra stamina et in ipsa fauce longe pilosus; lobi lineares, obtusi, 6 mm. longi, 1 mm. lati, glabri, dextrorsum tegentes, in basi tegente subauriculati. Antherae breviter ovoideae, infra faucem subsessiles, 1 mm. longae. Stigma conicum, verrucosum, anulo basali angusto circumdatum, antheras attingens. Stylus 1 mm. longus. Ovarium apocarpum, cylindraceum, glabrum, 1 mm. altum, 0.6 mm. latum, multiovulatum; discus nullus. Mericarpia (immatura) ad 40 cm. longa, 3 mm. lata, laevia, glabra, teretia.

SOLOMONS: Guadalcanal: BSIP 605, Gold Ridge, alt. 2000 ft., ridge forest. Several-stemmed small tree, 30 ft. tall. Flowers white, highly fragrant. — Fl.13.x.1962 — T. C. Whitmore, (holotype of the variety, in BSIP).

Santa Ysabel: BSIP 2463, nr. Maringe Lagoon, long western ridge of Mt. Sasari, ridge forest, alt. 2000 ft. Small tree, H. 30 ft., G. 9 in. Fruits green, unripe, leaves bright green. Fr.28.x.1963
T. C. Whitmore. BSIP 2433, Maringe Lagoon, Molau village, alt. 2200 ft., secondary forest; tree, H. 40 ft., G. 1 ft. Crown conical, tiered, the old fruits pendent from every tier; bole smooth, bark grey; slash: wood yellow, bark coarsely granular; vivid sulphureous yellow at cambium, paler outwards, with fawn flecks; no exudate, but cut twigs with sticky white exudate; flowers yellow in bud, with white lobes when open. — Fl.27.x.1963, T. C. Whitmore.

S. E. Choiseul: BSIP 2985, ultrabasic outcrop across bay from Ruruvai, sea level, inside edge of mangrove. Tree, H. 15 ft., flowers white, scented; white exudate from twigs. Fl.27.ii.1964, T. C. Whitmore. BSIP 4015, Easternmost Choiseul, ultrabasic hill on coast opposite Bembalama Island. Forest with much Casuarina and thick leaf litter layer. Tree, G. 1 ft. Flowers white. Fl.3.iii.1964, T. C. Whitmore.

SANTA CRUZ: Vanikoro: BSIP 1653, E. side Saboe Bay, ridge forest, alt. c. 500 ft. Tree, H. 50 ft., bole smooth, fawn; flowers yellow-green in bud; cut twigs exuding white sap. Fl.1.iv.1963, T. C. Whitmore. BSIP 1630, S. coast at Emwa, ridge forest, alt. c. 1000 ft., soil deep, red sticky clay under a mull-type humus layer. Small tree to 20 ft., flowers white, fruits green. Fl.8.iv.1963, T. C. Whitmore.

This Solomon's taxon belongs to the polymorphous Polynesian group of *A. plumosa* Lab., mentioned by Monachino in his monograph (Pac. Sc. 3, 143, 1949, point 4, second paragraph), and especially to his "dubious form in the Solomon Islands" (171), which (172) "in general appearance is markedly like" his var. *novo-ebudica* from the New Hebrides, but also "to the glabrous-leaved series from Fiji".

C. Carruthersia Seemann

Carruthersia mollis Mgf.n.sp.

Frutex alte scandens. Ramuli juveniles teretes, setis brevibus patulis molliter fusco-velutini. Folia chartacea, supra laxe hirsuta, subtus molliter fusco-velutina, in marginibus ciliata; petiolus 1-1.5 cm. longus; lamina firme chartacea, ovata, apice acuminata, basi cordata, ad 9 cm. longa, 5 cm. lata; nervi secundarii utrinsecus 6-8. Inflorescentiae axillares, trichasiales, molliter fusco-velutinas 5 cm. longae et latae, bracteis et bracteolis minimis, supra glabris. subtus velutinae ornatae. Pedicelli 6-8 mm. longi. Calycis lobi late ovati, 1 mm. alti et lati, extus breviter setosi, intus glabri et multiglandulosi. Corollae tubus ruber, 9 mm. longus, 2 mm. latus, supra calycem paulo ampliatus et inde usque ad faucem extus breviter setosus, intus longiuscule pilosus; faux pilis longioribus clausus; lobi rosei, dextrorsum tegentes, valde obliqui.

securiformes, pars erecta 7 mm. longa a basi angustiore ad 5 mm. dilatata, pars lateralis obtusa, 3 mm. lata, 3 mm. longa (cum apice partis erectae, ex qua oritur, 8 mm. longa). Antherae oblongae, breviter acuminatae, caudis basalibus incurvis, glabrae, 15 mm. longae, 0.5 mm. latae, filamentis 0.5 mm. longis, glabris 1 mm. supra basin tubi insertae. Ovarium glabrum, apocarpum, carpella subglobosa, 0.3 mm. alta, cum 2 squamis disci obtusis alternantia. Ovula pauca, biseriata. Stylus 1.5 mm. longus, capite stigmatico 1.5 mm. longo, fusiformi-incrassato coronatus. Fructus desunt.

SOLOMONS: Santa Ysabel: BSIP 2749, Bogotu, forest on gentle sloping ridge-side west of Parega village; deep, sticky, orang clay soil overlying ultrabasic rock. Woody climber, flowering at 50 ft., corolla tube red, limbs pink. Fl.6.xi.63 T. C. Whitmore, (holotype in BSIP).

In most characters corresponding well to *C. brassii* Merr. et Perry, and to *C. latifolia* Gillespie, but both are essentially glabrous, and have an outside glabrous corolla tube; their filaments are hairy; they differ slightly too in the measurements of leaves, flowers and flower parts.

D. *Kentrochosia* Ltb. et K. Schum. and *Kopsia* Blume

The vegetative parts and flowers of *Kopsia flavida* Bl., the fruit of which is unknown, completely agree with those of *Kentrochosia monocarpa* K. Schum. (cf. Markgraf in Bot. Jahrb. 61, 196, 1928). All the years over no indigenous *Kopsia* has been discovered in New Guinea and surrounding countries. Thus it becomes obvious that both names refer to the same species. As moreover another species with a minor lateral excrescence of the fruit has now been found in Borneo (*Kopsia lapidilecta* v.d. Slessen in Blumea 10, 137, 1960), the genus *Kentrochosia* should best be united with *Kopsia*.

E. *Ochrosia* Jussieu

Ochrosia sciadophylla Mgf.n.sp.

Arbor 9–12 m. alta. Ramuli glabri, angulosi. Folia ternatim vel quaternatim verticillata; petiolus 2–4 cm. longus, intra basin multi-glandulosus; lamina firme chartacea, glabra, oblongo-elliptica, apice obtuse acuminata, in petiolum cuneato-decurrens, 12–25 cm. longa, 3.5–6 cm. lata; nervi secundarii arcuati, sed e costa rectangulariter orti, 18–25 paria, paucis abbreviatis tenuioribus interiectis. Inflorescentiae glabrae, axillares, pauciflorae; pedunculus communis 2–3 cm. longus, erectus, pedunculi ultimi 2–5 mm. longi floribus subsessilibus glomeratis coronati; bracteae et bracteolae triangulares minimae. Lobi calycis ovati, obtusi, glaberrimi, 1.5 mm. longi, 1 mm. lati, intus eglandulosi. Corollae albae, glabrae, gracilis tubus 2 mm. longus, 1 mm. latus, etiam

intus glaber, lobi glabri, oblongi, 5 mm. longi, 1 mm. lati, sinistrorsum tegentes, obtusi. Antherae infra faucem sessiles, glabrae, breviter ovatae, 1 mm. longae. Stigma glabrum, cylindrico-conicum, collo basali cinctum, antheras vix attingens. Ovarium apocarpum, biloculare, ovoideum, in utroque loculo biovulatum. Mericarpia viridia, oblique ovata, 5 cm. longa, 2.5 cm. crassa, in rostrum apicale 1 cm. longum recurvum attenuata exocarpium chartaceum, nitidulum, mesocarpium suberosum, vix evolutum, endocarpium lignosum, compactum, nonnisi prope marginem in costulas latiores et inpaucos fibros tenues dissolutum, intus laeve et nitidulum. Pars basalis laterum carpelli ad 15 mm. longitudinis et 7 mm. latitudinis concreta; dissepimentum coriaceum, in utroque eius latere unum semen valde applanatum, oblique ovatum, 2 cm. longum, 1.5 cm. latum, prope basin ad 1 cm. erosum, ala 3 mm. lata cinctum gerens.

SOLOMONS: New Georgia: BSIP 3700, NW at Vaimbu River; well drained primary forest on hill side, alt. 350 ft. Tree, H. 80 ft., G. 4 ft.; bole straight, bark surface light brown, smooth; slash: wood hard, yellow, bark hard, yellow; white, opaque, sticky, free-flowing exudate; flowers white, scented; fruits green. Fl. and fr. 19.iii.1964, Whitmore's Collectors (holotype in BSIP). BSIP 3182, NW at Viambu River, hillside 400 ft., well drained primary forest. Tree, H. 40 ft., G. 3 ft.; bole straight, buttresses absent, bark surface dark brown, fissured; slash: wood hard, light brown, bark hard, fawn inside, brown outside; fruits green, Fr.30.iv.1964, Cowmeadow's Collectors. BSIP 3734, N. coast near Hovoro, ridge top, 564 ft., well drained primary forest. Tree, H. 38 ft., G. 2 ft.; buttresses thick, steep, spreading, bark surface dark brown, scaly; slash: wood soft, yellow, bark soft, flecked yellow; flowers yellow, scented, fruits green. Fr.21.v.1964, Whitmore's Collectors. BSIP 2529, Viru R., Viru Hbr., flat land, volcanic rock, alt. 200 ft., Camptosperma forest, red clay loam. Small understory pole; G. 2 ft. 13.viii.63, A. W. Cowmeadow & R. Teona. BSIP 1950, Roviana Lagoon, nr. Nusahope village, small stream in lowland forest. Tree, H. 30 ft., open, deep crown, flowers white, fruits green, Fl. & fr.19.ix.1963, T. C. Whitmore.

This taxon belongs to a small group of distantly-nerved species with cuneate leaf base, like *O. ficifolia* (Sp. Moore) Mgf. in New Guinea. It is distinguished by its long-petioled and long-bladed, many-nerved leaves, short inflorescences, by a thick endcarp, containing only one seed at either side of the false septum.

F. *Pagiantha* Markgraf

Pagiantha koroana Mgf. var. *salomonensis* Mgf.n.v.

Arbor ad 18 m. alta, radicibus tabularibus instructa, cortice fusca, squamosa et verrucosa obtecta. Ramuli crassiusculi, glabri, subquadranguli. Folia opposita, coriacea, glabra, petiolus 5–10 mm. longus, in axilla stipula una cyathiformi 5 mm. longa praeditus; lamina elliptica, obtusa, usque ad 25 cm. longa, 16 cm. lata, nervi secundarii arcuati, 10–12 in utroque latere. Inflorescentiae axillares, trichasiales, pedunculi crassiusculi, angulosi, bractee et bracteolae triangulares, 3 mm. longae, semiamplectentes, pedicelli 5 mm. longi, crassiusculi. Lobi calycis orbiculares, glabri, minute ciliati intus pluriglandulosi, 6 mm. longi. Corollae albae, odoratae, tubus crassiusculus, 20 mm. longus, 5 mm. latus, glaber; lobi in alabastrum globosum, 8 mm. latum inflexi, glabri, sinistrorsum tegentes, oblique ovati, in basi tegente auriculati, 10 mm. longi, 7 mm. lati. Stamina in medio tubo subsessilia, antherae oblongae, 4 mm. longae, 1 mm. latae, apice breviter apiculatae. Caput stigmaticum crassum, verrucosum, oblongum, 2 mm. longum, 1 mm. latum, apice breviter biapiculatum, antheras non attingens. Stylus crassus, brevissimus, 0.5 mm. longus. Ovarium apocarpum, biloculare, 2 mm. altum, 2.5 mm. latum, glabrum, carnosum, angulosum, multiovulatum. Fructus apocarpi; mericarpia (plerumque unum solum maturans) subglobosa, breviter acuminata, recurvata, fusca, verrucosa, carnosum, usque ad 15 cm. crassa, pulpa rubra impleta. Semina numerosa, oblonga, longitudinaliter unisulcata et in superficie multirimsa, ad 12 mm. longa et 6 mm. lata. Testa tenuis, albumen corneum. Embryo rectus, longitudinalis, sulco oppositus et in latere sulci concavus, radícula 5 mm. longa, 1 mm. crassa, cotyledones triangulari-ovati, 4 mm. longi, 3 mm. lati.

SOLOMONS: New Georgia: BSIP 3195, NW at Hehebere R., near Hovoro, valley bottom, 300 ft. above sea level, well drained primary forest. Tree, H. 60 ft., G. 8 ft. Bole straight. Buttresses thick, steep to 7 ft. Bark surface light brown, scaly and warty. Slash: wood hard, light brown, bark soft and fawn. Exudate white, opaque, sticky in free-flowing drops. Flowers white, scented. Fruits brown, 3 × 1.5 in. ovoid. Fl. 4.v.64.A.W. Cowmeadow, (holotype of the variety, in BSIP). BSIP 3129, NW at Vaimbu R., well drained primary forest on hillside, alt. 320 ft. Tree, H. 60 ft., G. 3 ft. Bole straight. Bark surface light brown, fissured. Slash: wood hard, light brown, bark hard, fawn. White, opaque, sticky, free-flowing exudate. Flowers green in bud, unscented. Fl. 24.iii.64. A. W. Cowmeadow. Kolombangara S.W.: BSIP 1193, Tree, up to 40 ft., overall with widely spreading branches. Flowers white, sweetly scented. Fruits rarely paired, grey brown. Fl. 26.xi.62, Womersley and Whitmore.

Santa Ysabel: BSIP 4103, Bogotu Peninsula, near Koloajoa village. Disturbed forest. Tree, H. 30 ft. Flowers white. Fruits grey-green, paired. Young fl. and fr. 23.iii.64, T. C. Whitmore. BSIP 2183, N.W. coast, Bagi R., 1 mile S. of Allardyce Hbr. Low-lying, periodically swamped forest near shore. Tree, H. 60 ft., G. 5 ft. Crown rounded, dense with large leaves. Bole orange-fawn, coarsely rugose with large lenticels. Low, thick, rounded buttresses. Slash: wood fine grained, orange, bark granular, fawn. Copious slightly sticky white, milky latex. Fruits very curious, some paired, ovate to kidney-shaped, brown warty surface, to 7 in. long. Ultimately dehiscent longitudinally. Seeds in a central red mass which is probably floral tissue; the pericarp very very thick; persistent exuding latex. Fr. 15.x.63, T. C. Whitmore.

The genus *Pagiantha* is distributed from India to Polynesia, but in isolated species areas. (cf. Markgraf in Notizbl. Berl.-Dahl 12, 549, 1935 and Bull. Bish. Mus. 141, 129-130, 1936). This new variety of the Fijian *P. koroana* differs mainly by being larger in all vegetative parts, and by presenting elliptic leaves with rounded base instead of obovate ones. Moreover, the corolla lobes seem to remain shorter, and the stigma head does not reach the anthers. The fruit of the species is here described for the first time.

IX. Gnetaceae

By this collection, our knowledge of the genus *Gnetum* in the Solomon Islands has been considerably enhanced. As yet it was unknown that e.g. the climbing *Gnetum latifolium* Bl. occurred there at all. Now its presence is proved by numerous good samples. It is represented chiefly by the common f. *latifolium*, not by f. *brachypodium* Mgf. so frequent in the Philippine Islands, and once by var. *laxifrutescens* (Elm.) Mgf., whose area previously extended from the Philippine Islands to the Bismarck archipelago. In this Solomon Islands collection, there has been found also var. *latifolium* f. *longipes* Mgf., to which, however, no geographical value can be attributed, as it occurs here and there in the whole area of the species.

The numerous samples of the tree *Gnetum gnemon* L. offer some interesting features. The typical variety of this species, var. *gnemon*, centres in eastern Malesia, from Palawan, Sulu, Celebes and Sumba eastward, though it is often cultivated in other parts. At any rate, its area is accompanied by some low-growing and small-seeded varieties. Four varieties thrive in western Malesia, from Celebes through Borneo and the Malay Peninsula in to

Assam and Burma; one other, var. *silvestre* Parl. has the same range as var. *gnemon*, from the Philippine Islands and Celebes through the Moluccas and New Guinea to the Fiji Islands. It appears from Whitmore's collections that this variety hybridizes with var. *gnemon* in the Solomon Islands. Of course it may do so elsewhere, but previously we have never had enough material from a single region to make a comparison.

In order to distinguish the two varieties and the intermediate specimens, one can find out several graded characters: height of the plant, length of the fertile part of the inflorescences in anthesis, the same of female plants with ripe seeds, length of their internodes, size of ripe seeds, shape of ripe seeds, number of male flowers in one middle bracteate collar of male plants. The specimens of the present collection are arranged in a scheme according to these steps in Table 1 which shows as a first general result that var. *silvestre* seems to be the more frequent one; moreover it is often expressively called frequent by the collectors. As earlier collections have shown too, it proves to be the prevailing variety in the rain — forests east of New Guinea. None of the Solomons' specimens reaches the mean height of true var. *gnemon*. Even in those which come nearest to var. *gnemon*, the characters taken into consideration hold its lowermost level. The same predominance of var. *silvestre* appears also in the intermediate specimens; most of them incline more to var. *silvestre* than to var. *gnemon*. This trend may be understood in the easiest way by assuming that var. *silvestre*, prevailing in quantity, will prevail also in morphological characters over the interbreeding var. *gnemon*. This interpretation of the intermediates as being of hybrid origin, is favoured too by the fact that the respective characters appear in them in almost any combination. Only the lengths of the inflorescences show a certain parallelism to the lengths of their internodes. Of our scheme, the first three collections, BSIP 1875, 3942, 3448 may still be reckoned under true var. *gnemon*, and the last seven under var. *silvestre*, namely BSIP 2202, 5319, 2799, 4008, 3435, 5653, 3680.

All the specimens cited in these notes were examined on loan from the Forest Herbarium, Honiara (BSIP). Replicates are at K, L, LAE, SING and US; the last two sets are however incomplete.

TABLE 1

The two common *Gnetum gnemon* varieties in Solomons and their intermediates.
Hybridisation is suspected. See text

BSIP No.	average <i>v. gnemon</i>	1875	3942	3448	2989	5444	2519	1155	2708	5250	826	5635	4079	3061	1167	2202	5319	2799	4008	3435	5653	3680	average <i>v. silvestre</i>	BSIP No.
sex	♂ & ♀	♂	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♂	♂	♂	♂	♂	♂	♀	♀	♂ & ♀	sex
stage	adult	open fl.	adult	unripe seeds	unripe seeds	adult	fl. & ripe seeds	unripe seeds	open fl.	ripe seeds	ripe seeds	ripe seeds	adult	unripe seeds	young	young	open fl.	young	adult	young	ripe seeds	fl.	adult	stage
plant ht. m.	8-20	3	9	6	3	4.8	shrub	12	treelet	under 4.5	6	tree	treelet	tree	treelet	treelet	3	treelet	4.5	under 1.5	tree	7.5	8-12	plant ht. m.
inflorescence lengths	in flower cm.	2-5	=	=	=	=	2	=	2.8	=	=	=	=	=	1.5	broken	1.7	1.5	1.2	1.5	=	2.5	♂ 1.5-2 ♀ 2-3	in flower cm.
	with ripe seeds cm.	6-8	=	7-8	7	7	8	5	3	=	4	broken	4	4	2	=	=	=	=	=	4	=	2-5	with ripe seeds cm.
	internodes cm.	♂ 1-2 ♀ 2-5	0.5	6-7	5-8	8-10	6-7	fl. 2 ripe 6	4-5	3-4	3-4	1-2	2-3	3	1-2	0.1	0	0.2	0	0	0.1	2-3	1-2	fl. 0-1 ripe 2	internodes mm.
seed size mm.	20-25 ×10-15	=	25×15	20×11	14×8	16×10	17×8	15×12	=	15×8	20×10	15×11	15×10	15×10	=	=	=	=	=	=	15×11	=	8-12 ×8	seed size mm.
seed shape	blunt	=	blunt	blunt	round with tip	pointed	pointed	pointed	=	pointed	pointed	round with tip	pointed	round with tip	=	=	=	=	=	=	round with tip	round	pointed	seed shape
approx. no. ♂ fl.	80	60	=	=	=	=	=	=	=	=	=	=	=	=	60	50	50	30	30	25	=	=	40	approx. no. ♂ fl.
conclusion		true <i>v. gnemon</i>				intermediate between <i>v. gnemon</i> and <i>v. silvestre</i>										true <i>v. silvestre</i>				conclusion				

Notes on the Systematy of Solomon Islands' Plants and some of their New Guinea Relatives, X.

by

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X. Sapotaceae

The Sapotaceae of the Solomon Islands are in general not very well known, and material of one of its most interesting genera, *Chelonespermum*, was so scrappy that for a long time it remained a rather doubtful one. In the large collections by T. C. Whitmore from many parts of the Solomons this genus turns out to be well represented and seems to be sufficiently distinct to keep it separate from *Burckella*.

Apart from the specimens in *Chelonespermum*, two new species in *Burckella* and *Palaquium* are found, descriptions of which will be given below. In addition we will add some remarks on *Chelonespermum*.

The sheets examined were all at LAE; there are replicates at BSIP, K, L, SING and US. The last two series are incomplete.

A. *Burckella* Pierre

***Burckella sorei* Royen n.sp.** Fig. 1

Arbor magna. Ramuli subcrassi, foliis, bracteis et flores apice conferta, dense pallide brunneo-sericei, glabrescentes. Folia apice ramulorum conferta, pseudo-verticillata, oblongo-elliptica, 10–14 × 4–6 cm., apice obtuse acuminata, basi rotundata vel late cuneata interdum obliqua, nervi secundarii 17–22 pares, arcuatim conjuncti, tertiarii reticulati; utrinque glabra. Petiolus 2.2–4 cm. longus, glaber, supra late canaliculatus. Flores fasciculi; pedicelli 3–6 mm. longi, dense ferrugineo-sericei. Sepala 4, ovata, 2–2.5 × 1–1.5 mm., subacuta, dorsa subcarinata, extus disperse sericea, apice ferrugineo-plumulosa, intus glabra. Corolla 8-lobata, glabra sed apice plumulosa (ultimo glabrata?). Stamina 15, filamenta pilosa, antherae pilosa apice solis. Ovarium 4-loculare, glabrum. Fructus obovoideo-ellipsoideum, usque ad 7.5 × 3.8 cm., 1-spermus, glaber. Semen usque ad 5 × 2.8 cm., cicatrice testam $\frac{3}{4}$ parte includente irregulariter bullata.

Tree up to 33 m. with dense crown. Buttresses steep and broad, up to 2.4 m. Bole fluted. Bark surface dark, dull brown, closely fissured, in part with elongate, loose scales. Cut inner bark orange-brown or pink, with copious white exudate. Wood orange-yellow or pink-brown. Branchlets relatively slender, densely pale brown, sericeous, ultimately glabrous. Leaves conferted at tip of flushes,

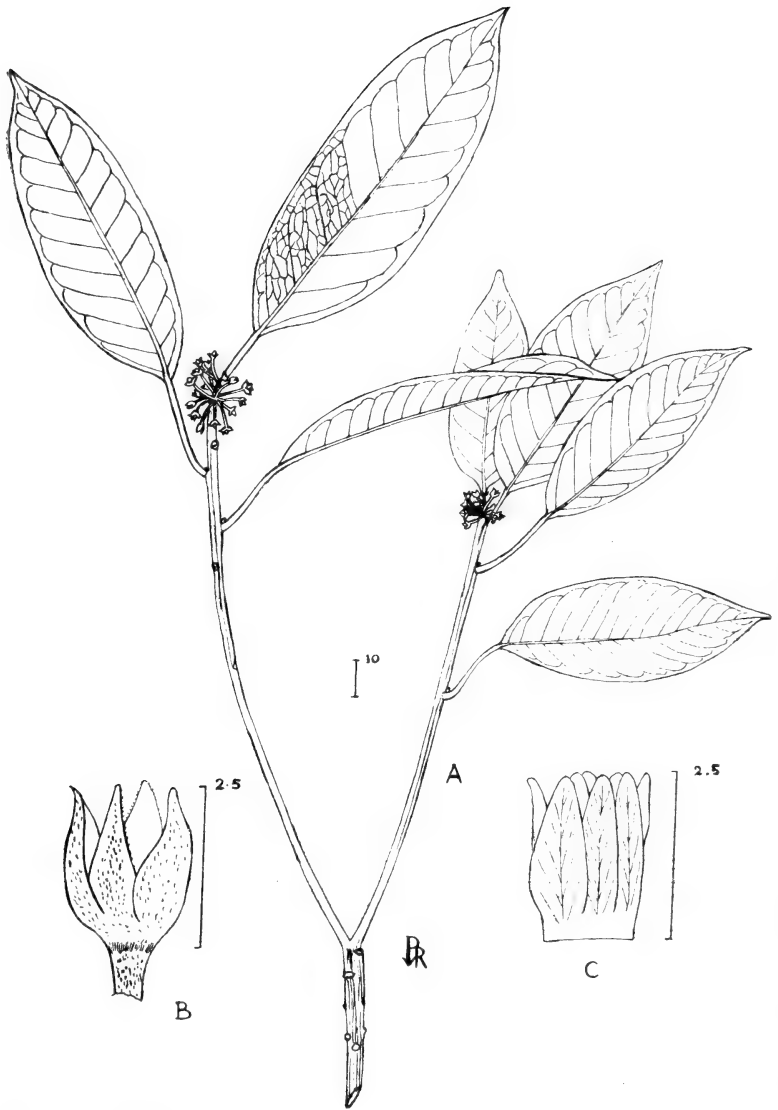


Fig. 1. *Burckella sorei*.

Whitmore BSIP 2771. A Habit, B Calyx, C Corolla. All sizes in mm.

sometimes seemingly whorled, limb oblong-elliptic, 10–14 by 4–6 cm., short obtusely acuminate at tip, rounded to broadly cuneate at base and sometimes asymmetric; midrib narrowly crested above, rounded below, lateral nerves 17–22 on either side of midrib, inconspicuous above, distinct below, archingly joined, nervation widely reticulate, hardly visible above, conspicuous below; glabrous on either side; Petiole 2.2–4 cm., broadly grooved in the apical part, flat in lower parts, glabrous. Flowers closely bundled at tip of branchlets; pedicels 3–6 mm. long, densely ferruginous, silky. Sepals 4, ovate, 2–2.5 by 1–1.5 mm., subacute, slightly crested on outside, scattered silky hairy on inside, with a plumule of rusty hairs at tip, glabrous on inside, the 2 inner sepals with membranous margins. Corolla-tube c. 1 mm. long, glabrous, lobes 8, ovate, 2–3 by 1–1.2 mm., obtuse, plumose at tip (ultimately glabrous?). Stamens 15, c. 1 mm. long, filaments hairy, anthers hairy at tip only. Ovary 4-celled, glabrous, style c. 1 mm. long, glabrous. Fruits obovoid-ellipsoid, up to 7.5 by 3.8 cm., subacute at tip, glabrous, 1-seeded; pericarp fleshy. Seed up to 5 by 2.8 cm., scar covering $\frac{3}{4}$ of entire seed, roughly knobby.

SOLOMONS: Guadalcanal: BSIP 2771, Rere R. c. 3 miles inland, T. C. Whitmore, Nov., flowers, Holotype in SING.

Santa Ysabel: BSIP 2477, Garona, a few miles W. of Maringe Lagoon, T. C. Whitmore Oct., fruits.

A lowland rain-forest species.

The flowers are known in the bud stage only and details particularly those of the stamens and ovary, are incomplete.

This species, which by its 8 corolla-lobes belongs to *Burckella*, could not be matched against any of the known *Burckella* species, not even against the very variable *Burckella obovata* Pierre, from which it differs by the larger number of lateral nerves coupled with smaller leaves. The calyx of *B. sorei* is much smaller than that of *B. obovata*, but the flowers being young, this detail might not be reliable.

The species is named in honour of Mr. J. Sore, a tree-climber working for the Forestry Department B.S.I.P., and living on Guadalcanal at Bambasu village in Longgulenggu near the Rere R. where the type material was collected.

Kwara'ae names: *Faigona*, *Kona*.

B. *Chelonespermum* Hemsley

This genus was described by Hemsley (Ann. Bot. 6, 205, 1892) based mainly on the peculiar seeds that separate it immediately from the closely related genus *Burckella*. Of the four species described only *C. majus* had leaves (though fragmentary) and fruits, while *C. fijense* was based on leaves and seeds only. The other two species, *C. minus* and *C. unguiculatum* are based on

seeds only. In 1959 I described a new species (Nova Guinea N.S. 10, 140) *C. banikiense*, from Banika Island, in the Russells, of which at that time no fruits were known. The reason to place this species in *Chelonespermum* and implicitly the maintaining of that genus against *Burckella* was the number of corolla-lobes in *Chelonespermum*. In *Burckella* this is 8, in *Chelonespermum* 4, rarely 5. Additional to this, though the differences are overlapping, are the number of cells in the ovary, viz. 1-4 in *Chelonespermum*, (3-) 4-8 in *Burckella*.

Though these differences are small, they are not smaller than is recognised in many other groups in the Sapotaceae, for instance *Madhuca* and *Burckella* 4, *Palaquium* 6 sepals, though in both *Madhuca*, *Burckella* and *Palaquium* occasionally 5 sepals are found.

It is doubtful whether the fruits, and more in particular the seeds ultimately can be used as sufficiently different to keep the genera apart, emphasizing only their close relationship. In *Burckella* the scar, representing that part of the seed with which it is attached to the placenta, is usually smooth, without any appendages, while those of *Chelonespermum* have a most intricate system of crests, knobs and protuberances. However, in *Burckella magusun*, described by myself in 1959 (l.c.) the scar is very irregularly grooved and knobby, and the same applies to *Burckella sorei* described in this paper.

In *C. banikiense*, material of which turned up several times in Whitmore's collection, the seeds show the same type of scar as in the two *Burckella*'s mentioned in the previous paragraph. To complete the description given in 1959, that of the fruits and seeds follows here.

C. banikiense. Fig. 2. Amended description. Fruits globose, narrowed at base, up to 3.5 cm. across, pericarp fleshy-woody, glabrous; 1-seeded. Testa of seed narrow, brown, glossy, scar covering about $\frac{3}{4}$ of entire seed, knobby; seeds ellipsoid, c. 2 by 1.2 by 1 cm. obtuse at either end.

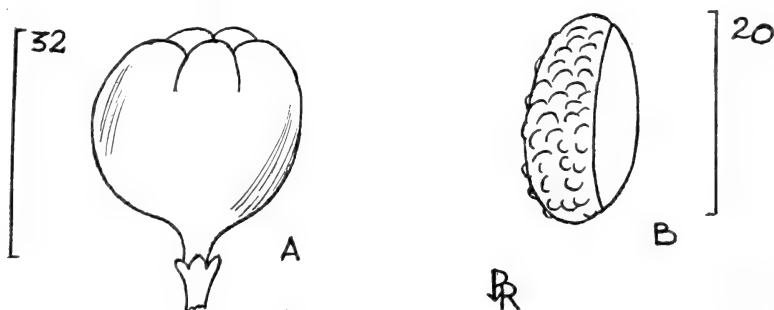


Fig. 2. *Chelonespermum banikiense*.

Whitmore BSIP 1512. A Fruit. B Seed. All sizes in mm.

SOLOMONS: New Georgia Islands: Kolombangara: BSIP 1512, W. coast, Sandfly Hbr. T. C. Whitmore fruits, Febr. Baga BSIP 2849, Whitmore's Collectors, fruits, Jan. BSIP 3008, Whitmore's Collectors, fruits, Febr.

Shortland: BSIP 5876, N. at 1 mile west of Kupola R., Whitmore's Collectors, flowers, May.

Kwara'ae names: *Faigona*, *Kona*.

C. *Palaquium Blanco*

***Palaquium masuui* Royen n.sp.** Fig 3.

Arbor magna. Ramuli ferrugineo-sericei, glabrescentes; stipulae lanceolato-subulatae, acutae, dense ferrugineo-pilosae. Folia apice ramulorum subconferta, obovata, 6–15 × 4–7 cm., apice obtuse-acuminata, basi cuneata, supra glabra basi excepta, subtus glabra; nervi secundarii utroque latere 11–15, sursum evanescentes, tertiarum transversi. Petiolus 2–4 cm. longus. Pedicellus 2–2.8 cm. longus, dense ferrugineo-pilosus. Sepala 6, extus ferrugineo-pilosus, intus pilosus in parte apicali solis. Corolla intus glabra, tubus extus ferrugineo-sericea, lobi sericei in linea mediana. Stamina c. 15, filamenta glabra, antherae extus ferrugineo-pilosum. Ovario 6-loculare, hemi-globosum vel late ovoideum, ferrugineo-sericeum, stylus glaber. Fructus ignotus.

Tree up to 21 m., d.b.h. 45 cm. Buttresses up to 2.4 m. Bark surface dark brown, smooth, with close, fine superficial fissures. Cut inner bark red or orange-brown, fibrous, with sticky white exudate. Sapwood pink or orange-fawn, heartwood dark dull brown or red. Branchlets rusty sericeous, ultimately glabrous. Stipules lanceolate-subulate, 2–3 mm. long, densely rusty hairy. Leaves (sub-) crowded at tip of branchlets, limb obovate, 6–14 by 4–7 cm., obtusely acuminate at tip, cuneate at base and decurrent along upper side of petiole, midrib shallowly grooved above and longitudinally crested, prominent and rounded below, lateral nerves 7–9 on either side of midrib, diminishing until inconspicuous along margin, prominulous and grooved above, prominent below, nervation transverse, slender; glabrous except above, greyish hairy at the extreme base. Petiole 2–4 cm. long, grooved above, rounded below but crested in basal part, densely rusty or greyish silky, becoming glabrous. Flowers in 2–4 flowered, axillary clusters or solitary; pedicels angular, 2–2.8 cm. long, densely appressed, rusty hairy. Sepals 6, outer 3 ovate-triangular, 3–4 by 3–3.5 mm., obtuse or obtusely acuminate, inner 3 more lanceolate-ovate, 3.5–5 by 3–3.5 mm., rounded, crested, all sepals appressed rusty hairy on outside, sparsely hairy on inside in apical part only, inner sepals plumose at tip and glabrous along the membranous margins.

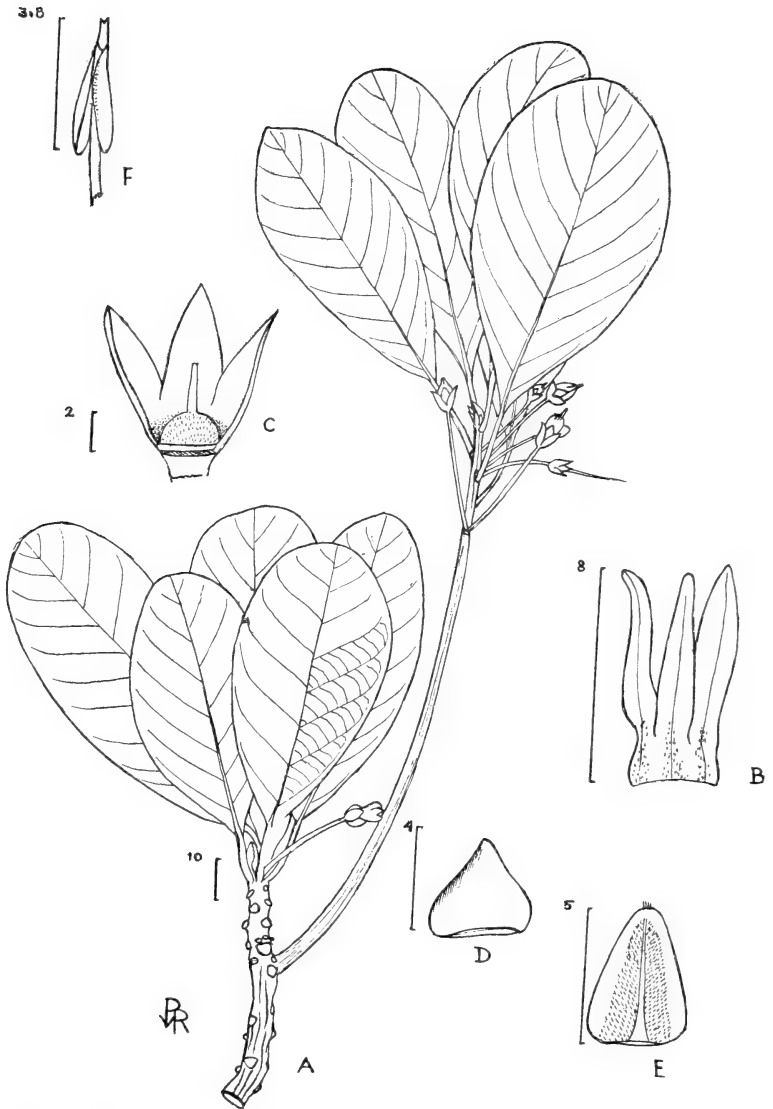


Fig. 3. *Palaquium masuui*.

Whitmore BSIP 1638. A Habit. B Corolla outside. C Ovary with part of corolla. D Outer sepal. E Inner sepal. F Anther. All sizes in mm.

Corolla-tube 2–3 mm. long, lobes 6, elliptic or oblong-elliptic, 5–6 by 2.5–3 mm., rounded or truncate at tip; corolla on outside appressed rusty hairy on tube and along part of midrib or corolla-lobes, glabrous on inside. Stamens c. 15, c. 6 mm. long, filaments c. 4.5 mm. long, glabrous, anthers c. 2.5 mm., connective prolonged, truncate or bifid at tip, appressed rusty hairy on outside. Ovary 6-celled, hemiglobose or broadly ovoid, 2–3.5 mm. across, appressedly rusty hairy, style up to 15 mm. long, glabrous. Fruits not known.

SANTA CRUZ: Vanikoro: BSIP 1638, E. side of Saboe Bay, T. C. Whitmore April, holotype in SING. BSIP 1814, ridge near Peou, T. C. Whitmore, May.

A species of primary or old secondary lowland rain forest.

This species is related to *Palaquium neo-ebudicum* Guillaumin, from the New Hebrides. It differs from that species by its appressed pubescence of branchlets, petioles and pedicels, by its smaller number of lateral nerves, by the pubescence of the sepals which are hairy on outside and only so on inside in the apical part, while those of *P. neo-ebudicum* are glabrous on the outside. Also the corolla has a pubescence on outside, that of *P. neo-ebudicum* being glabrous.

This species is named in honour of Mr. W. Masu'u, a tree-climber from Totonga Village, Longgolenggu, Guadalcanal, who worked for the Forestry Department, B.S.I.P., between 1962 and 1964.

The Tree-ferns of Malaya

by

R. E. HOLTUM

AND

BETTY MOLESWORTH ALLEN

Introduction (R.E.H.)

Preparation of the account of the tree-fern family (Cyatheaceae) in *Flora Malesiana* (Series II, Vol. 1, part 2, 1963) involved a study of all the species which have been named throughout the Malayan region, some 350 names in all. This led to the discovery that a good many species had been re-named, sometimes more than once, by different authors; in such cases, the earliest name has to be used. For this reason, the names of some species described in *Ferns of Malaya* (1954) have to be changed. An example is *Cyathea kingii*, named in 1883 from a Malayan specimen, which is found to be indistinguishable from *Cyathea lurida*, originally described from a Java specimen in 1828. Two more names were later given to specimens from Sumatra, but they are not distinct from *C. kingii*, the variability of which is shown by more ample collections made in Malaya. Besides changes made for this reason, two more are due to the discovery that names used in *Ferns of Malaya* were mis-applied; and three species have to be added to the list. The changes are as follows.

Ferns of Malaya		Flora Malesiana
<i>Cyathea brunonis</i>	p. 117 =	<i>C. moluccana</i> R. Br. p. 143
<i>C. latebrosa</i> var <i>indusiata</i>	p. 121 =	<i>C. hymenodes</i> Mett. p. 89
<i>C. obtusata</i>	p. 121 =	<i>C. borneensis</i> Copel. p. 110
<i>C. burbidgei</i>	p. 124 =	<i>C. trichodesma</i> (Scort.) Copel. p. 150
<i>C. ampla</i>	p. 125 =	<i>C. polypoda</i> Bak. p. 151
<i>C. kingii</i>	p. 126 =	<i>C. lurida</i> (Bl.) Copel. p. 121.

Misapplications. The true *C. burbidgei* (Bak.) Copel. and the true *C. ampla* Copel. are both species of Sarawak which do not occur in Malaya, and the names were wrongly applied to Malayan ferns in *Ferns of Malaya*. The Malayan specimens misnamed *C. burbidgei* were found to be identical with the type-specimen of *C. trichodesma* at the British Museum (Natural History); this species had been overlooked when *Ferns of Malaya* was being written. The Malayan specimens misnamed *C. ampla* are only distinct from *C. polypoda* in their broader leaflets, and are now included in that species (true *C. ampla* has indusiate sori).

Additional species are *C. incisoserrata* Copel., *C. sumatrana* Bak., and *C. alleniae* Holttum.

In *Flora Malesiana* are new keys for the identification of species. But as these keys cover 191 species, mostly not in Malaya, they

are unnecessarily complex for local use. A simplified key is therefore here provided, covering only the species known to be native in Malaya.

The final part of the present paper consists of a summary by Mrs. Allen of her observations, made over many years, on the local occurrence of the individual species in Malaya. These notes will be of great value to local field botanists. They will also be of historic interest, as unfortunately species have been exterminated in some localities by felling of the forest in which they once grew, and more areas of forest will suffer the same fate, as more land is taken over for other use. In addition to this information on local occurrence of species within Malaya, a summary of their known distribution outside Malaya is given; this is taken from *Flora Malesiana*, and is based on a study of specimens preserved in many herbaria in various parts of the world.

Key for identification of tree-ferns in Malaya

Note. In this key, the word *pinnules*, unless otherwise stated, refers to the larger pinnules of middle pinnae; upper pinnae are always smaller, and lower ones more or less reduced.

1. Scales at base of stipe dark, shining (except in *C. excavata*), with paler fragile edges which are often abraded when fronds are old.
2. Pinnules lobed almost to costa throughout; an indusium always present (sometimes very small and hidden by sorus); lower surfaces of rachises rarely very dark; little difference in size between sterile and fertile pinnules.
3. Pinna-rachis bearing some hairs on lower surface, at least distally; indusium a little wider than base of sorus, at least on costular side.
4. Pinna-rachis rather densely hairy throughout on lower surface; indusium very fragile, completely covering young sorus, breaking at maturity and leaving an irregular shallow cup
1. *C. sumatrana*.
4. Pinna-rachis hairy towards apex only on lower surface; indusium rather firm and disc-shaped or only on costular side of receptacle.
5. Indusium forming a disc round receptacle (sometimes asymmetric); stipe-scales to 4 mm. wide 2. *C. hymenodes*.
5. Indusium only on costular side of receptacle; stipe-scales to 1 or 1½ mm. wide.
6. Lower pinnae usually much reduced; larger scales on costae not setiferous; pinnules to 10 cm. long
3. *C. borneensis*.
6. Lower pinnae not much reduced; larger scales on costae setiferous; pinnules to 14–15 cm. long 4. *C. alleniae*.
3. Pinna-rachis lacking hairs on lower surface; indusium either completely covering young sorus, or quite covered by sorus.
7. Indusium completely covering young sorus, breaking later; no bullate scales on costae and costules 5. *C. excavata*.
7. Indusium very small, covered by sporangia; bullate scales abundant on costae and costules.
8. Pinnules of well-grown plants commonly 2½ cm. wide, sometimes to 3½ cm., with several basal pairs of segments separately attached to costa; largest segments deeply lobed near bases; costules 4½–5½ mm. apart 6. *C. incisoserrata*.
8. Pinnules of well-grown plants rarely to 2 cm. wide; at most one basal segment almost free; segments not deeply lobed; costules usually 3–3½ mm. apart 7. *C. latebrosa*.

2. Pinnules rarely lobed more than $\frac{1}{2}$ way to costa, or if lobed nearly to costa the fertile segments much narrower than sterile; no indusium; lower surfaces of rachises always dark, often very dark.
9. Greatly reduced pinnae, separate from the rest, on basal part of stipe 8. *C. recommitata*.
9. No greatly reduced pinnae at base of stipe.
 10. Sterile pinnules lobed almost to costa throughout, bearing bullate scales on lower surfaces of costules; lobes of fertile pinnules greatly contracted 9. *C. lurida*.
 10. Sterile pinnules not lobed nearly to costa, with no bullate scales beneath; lobes of fertile pinnules not greatly contracted.
 11. Pinnules borne on very short stalks and lobed $\frac{1}{2}$ way to costa or more; sori on lowest veins not near costule, those on higher veins progressively nearer to it, the arrangement thus an inverted V; basal basicopic vein of each group often from costa, not from costule 10. *C. gigantea*.
 11. Pinnules borne on stalks 2–4 mm. long, lobed less than $\frac{1}{2}$ way to costa; sori on all veins about equidistant from costule; basal basicopic vein of a group attached to costule above base of costule 11. *C. glabra*.
1. Scales at base of stipe thinner, usually pale, edges not of different texture but bearing many short oblique dark setae.
12. Most segments of pinnules quite free as tertiary leaflets; sori apparently indusiate, actually covered by overlapping scales 12. *C. tripinnata*.
12. Most segments of pinnules not free; sori indusiate in nos 13 & 14, in other species exindusiate, never covered by overlapping scales.
13. Fronds simply pinnate; pinnae entire or \pm crenate; indusium conspicuous, covering young sorus (disappearing later) 13. *C. moluccana*.
13. Fronds with deeply lobed or pinnate pinnae.
 14. Pinnae deeply lobed, or almost pinnate near base 14. *C. alternans*.
 14. Pinnae fully pinnate or almost so throughout; no indusia.
 15. Pinnules lobed almost to costa throughout; stipe and lower surfaces glaucous, stipe strongly spiny 15. *C. contaminans*.
 15. Pinnules not lobed nearly to costa; lower surfaces not glaucous, stipe not strongly spiny.
 16. Long spreading hairs present on lower surfaces of pinna-rachis, costules and veins 16. *C. trichodesma*.*
 16. No long spreading hairs on lower surfaces.
 17. Largest pinnules with a free segment at base; pinnules on stalks to 4 mm. or more long; texture firm 17. *C. polypoda*.
 17. Largest pinnules lacking a free segment at base, sessile or nearly so; texture thinner.
 18. Sori on 3–4 pairs of basal veins of each group only, not on distal veins, at maturity confluent 18. *C. obscura*.
 18. Sori on almost all veins, not confluent at maturity 19. *C. squamulata*.

* A plant intermediate between *C. trichodesma* and *C. alternans*, probably a hybrid, has been found near Ampang Reservoir, Kuala Lumpur (see Flora Malesiana p. 150).

Notes on the distribution of the Malayan Tree-ferns (B.M.A.).*Cyathea sumatrana* Baker

General distribution: Sumatra and the Malay Peninsula, between 500—1500m.

One sterile specimen has been found in Malaya, in 1957 (M.A. 3447). It was growing at an altitude of about 500m in Selangor in tall forest on the upper side of the Ginting Sempak road, near the 19 9/10 milestone. The fern was in a sandy patch which was in the middle of a flat, wide but shallow stream. Although it was not in the water it must frequently be inundated, and perhaps had been washed down from a higher altitude, for no others were found in the vicinity, either in the stream-bed or in the forest, where there was comparatively little floor covering. Some young plants which appear to be this species were found alongside the Kinta and Ulu Piah rivers in Perak at about 170m in altitude. No adults were found although the area was searched, and so they should be looked for further upstream.

The Selangor specimen had a very short trunk, not more than 30cm tall and the fronds when living, were soft in texture and bluish-green and dull above. The stipes, rachises and costae were almost black above but pale below and there were distinct excavations at the stipe bases.

C. hymenodes Mett. (syn. *C. latebrosa* var *indusiata* Holtt.)

General distribution: Sumatra and the Malay Peninsula, 700-2200m.

This is not a common Malayan fern for so far has been found only in Pahang and Johore in mountain areas, but of course may turn up on other hills, especially on the Main Range. It grows in the shade of tall dark forests often where the ground is sloping and the soil loose and damp, sometimes by streams but more often well above them.

It is not uncommon at Fraser's Hill but is easily overlooked as it resembles *C. latebrosa*. One of the places it occurs frequently is on the forest slopes on the north side, below Victory and Cecily bungalows, near and below the main contour path. It has also been found on the quartz ridge at the beginning of the path above Pahang bungalow, and in the forest about half-way to Pine Tree Hill. At Cameron Highlands where it seems to be more local, it has been collected near the junction of the Terla and Telom rivers at about 1200m, and on Gunong Batu Brinchang where specimens were collected at an altitude of 2200m; the plant was growing on steep but wet ground and had a trunk of nearly 250cm in height. An interesting habitat was in an area of recently cleared forest, where only a few saplings and shrubs remained; near some well established young plants of *C. excavata* were a few adult *C. hymenodes* in full sun. One had a trunk of about 1m in height, and the fronds were shiny and tough. Although it was too early then (1962) to know whether they were really established, it would be interesting now to

have further observations. The area is in a peaty ridge near Walkerburn cottage (now Che Foo) and above Brinchang village, on a woodcutters' path a few metres from the road.

In Johore *C. hymenodes* was collected from the summit of Gunong Muntahak. Fronds are usually dark green above and the trunk is slender and not more than about 350cm in height.

C. borneensis Copel. (syn. *C. obtusata* Rosenst.)

General distribution: from Mergui southwards, and Peninsula Thailand; Malayan peninsula and Sarawak, in lowland forest to 1200m.

In Malaya this species has been collected from between 100-1200m from Perak, Pahang and Selangor, but not very much is known about its distribution and is possibly more widespread than we know. It is a forest species not tolerating much sunlight and therefore may have been more common when it was first collected in Perak last century, for specimens do not seem to have turned up again until 1957. In an area which many years ago was milled but not cleared, where there was tall secondary growth mixed amongst the taller trees, *C. borneensis* was found to be common. In 1962 this place (on the slopes of Bujang Melaka mountain) was completely cleared for rural development, but on more remote places on the mountain it may still exist. It has also been found in several places in the Tapah Hills Forest Reserve on the foothills of the Main Range in Perak, and although apparently absent from wide areas is common enough where it does occur. In Pahang it grows in more or less undisturbed tall forest below Fraser's Hill on the north side at about 1200m, sometimes together with *C. hymenodes*. In Selangor it occurs sporadically in the tall forest by the side of the Sungei Berok above Kepong Forest Research Institute; in the forest surrounding the Ampang Reservoir, alongside streams, and in the Ginting Sempak it was once collected by a streamside in the forest above the road at 300m.

The fern is nearly always near water and always in gloomy places. When living, the fronds are usually very dark green above and pale below, and one Pahang specimen had a trunk of nearly 5m in height with a circumference of only 30cm.

C. alleniae Holttum

General distribution: Malayan Peninsula, between 1100-1200m.

So far known only from the Kuala Terla area in the Cameron Highlands district of Pahang. The original plant was growing in a band of forest above the Terla river, near the junction of the Terla and Telom rivers. No others were found here, but a few hundred metres further on by the main road towards Blue Valley Estate, several patches of young plants (some fertile) were found, and about 16m above the Telom river, under a light forest canopy and on steeply sloping ground, others were seen. Some had trunks to 2m in height and all had pale green fronds. Several miles away,

near a tributary of the Telom more plants were found, but none so tall as the type which had a trunk about 4m tall, with small crowns of fronds from near the base of the trunk. The species apparently tolerates a great deal of light but not exposure to wind, favouring forest edges and open places which are sheltered, or in light forest and not on streamsides, but often growing well above where the humidity would be more or less constant. Without more field work it is difficult to be sure of its proper habitat, adapting itself as it does to disturbed forest. The pinnules break off very easily but the stipe base does not (in most species of *Cyathea* this is easily detached from the trunk by a tug).

C. excavata Holttum

General distribution: Malay Peninsula; again known only from the Cameron Highlands district of Pahang, from about 1170 to 1900m.

This is a very distinctive species and occurs in many areas around the hill station environs. It is common in open places alongside streams where the forest has been cleared but where a few small trees, shrubs and tall grasses line the banks, and seems to be increasing by the sides of shaded streams near bungalows where the banks undergo periodic cleaning. These two habitats are no doubt artificial ones, and as Dr. Holttum states this species was originally found in primary forest, and it is still to be found on the more or less undisturbed forest slopes of mountains such as Jasar, Ruil and Brinchang by small streams or on flat wettish ground. It also occurs in the forests below Cameron Highlands near the Terla and Telom rivers. Apparently it will grow when away from water for in a cleared area on the slopes of a peaty ridge (see under *C. hymenodes*) *C. excavata* was quite common, yet there was no stream near enough to influence it.

It is easily distinguished from *C. contaminans* which is the common tree-fern of the open places at Cameron Highlands, by its soft fronds and completely smooth stipes.

C. incisoserrata Copel. (syn. *Alsophila latebrosa* var. *ornata* Ridley*)

General distribution: Sarawak and the Malay Peninsula; from the lowlands to 1400m or more.

This has been found in Penang, Perak, Pahang and Johore, and is a tall species growing on forest edges or in clearings within the forest, requiring light and sun. On Penang Hill it was growing at about 650m altitude, and in Perak was quite common on forest edges both on the lower slopes of Bujang Melaka and the foothills behind Gopeng. At Fraser's Hill it grows commonly on the edges of tall forest which borders Girdle Road, the trunks being as tall as *C. contaminans* with which it grows, but it differs by the more

* See H. N. Ridley: The Ferns of Malay Peninsula — J. Mal. Br. R. As. Soc. IV, 8: 1926.

lacy appearance of the fronds and the non-glaucous stipe bases. In Selangor it is quite conspicuous in sunny places on the forest edges at Ampang Reservoir: here the fronds are yellowish. In Johore it was found at Tanjong Kupang (Ridley) and on the forest edge between Mersing and Endau.

This is a species which is possibly increasing with the changing face of our forests, for it obviously tolerates much sun and seems equally happy in damp or dry ground; also plants become fertile at an early age.

C. latebrosa (Wall. ex Hook.) Copel.

General distribution: Hainan, Indochina and Thailand; Malaya, Sumatra, Borneo.

In Singapore and Malaya, throughout the lowlands and up to 2000m. This is the species most frequently seen on roadside ditches where there is shade; on the floor of old rubber estates; on streamsides in secondary growth; in swamp forests and is one of the few *Cyathea* species to be recorded from the bases of limestone outcrops. In the hill stations it is a common fern in both forest and rather open places, the highest being at 2000m on Gunong Batu Brinchang in Pahang. It is usually a small species with a slender trunk and soft fronds.

C. recommutata Copel.

General distribution: Central and S. Sumatra, Malay Peninsula & Borneo.

In Malaya it has been found between 600-1500m in Perak on Maxwell's Hill; in Pahang at Fraser's Hill and on Gunong Tahan; in one or two places on the mountain ridges in Selangor, and on Mt. Ophir in Johore. *C. recommutata* does not seem to be a common fern, apparently requiring a special environment. It has been found on peaty ground, on quartzite ridges and in short mossy forest, sometimes in association with *C. lurida*, but always in the shade. Previously it was collected from Bujang Melaka in Perak, but does not seem to be there now. It is a small dark tree-fern, easily distinguished by the very small pinnae on the stipe bases.

C. lurida (Bl.) Copel. (syn. *C. kingii* (Clarke) Copel.)

General distribution: Sumatra, Malay Peninsula, West Java and the Philippines (Mindoro only).

This species is found in Malaya between 1250-2220m in Perak and Pahang, on some of the higher hills. It is most easily seen in Perak near the summit of Gunong Hijau above Maxwell's Hill, and at Cameron Highlands and Fraser's Hill in Pahang, the highest altitude recorded being near the summit of Brinchang in mossy forest. Although a fern of the forest shade it seems to persist for some years on forest edges in rather open places, and is very common on the quartzite ridges around Fraser's Hill. It is nearly always trunkless, occasionally short ones are seen; this, together with the long stipes, drooping laminae and contracted fertile pinnae make it easy to recognise.

C. gigantea (Wall. ex Hook.) Holttum

General distribution: Ceylon and S. India, N. E. India to Burma, Thailand and Annam, Malaya, Central Sumatra and W. Java.

In Malaya found only on Langkawi Is. (Kedah), Penang and Upper Perak from sealevel to about 350m, in rather open places. In Langkawi it was collected from Gunong Raya, and in Penang on the east and north eastern slopes of the hill, but as much of this area has now been cleared it may not still be there. In Perak it was found recently (1960) growing on flat banks of the Plus river, towards Legap on the outskirts of light forest, and some, being close to the riverside were quite exposed. Another species (not fertile) was nearly always growing with it. Neither species was common. In the field *C. gigantea* has a similar appearance to *C. glabra*; the differences are given in the key.

C. glabra (Bl.) Copel.

General distribution: Sumatra, Malaya, Borneo and W. Java. In Malaya it occurs in forest from sealevel to 1700m and has been collected from most states except Penang. On Kedah Peak it grows in light forest at about 860m; in Perak on the higher parts of Maxwell's Hill and near Ipoh on the edges of the rocky lowland forest bordering the Kinta river at more or less sealevel, and at 270m near a quartz outcrop on sloping dry ground. It does not seem to be common in the lowland swampy forests here, as it is further south. In Selangor and Pahang it grows under tall forest on sloping ground near the tops of ridges on the Main Range, but not near streams. It is common at both Cameron Highlands and Fraser's Hill. In Singapore it still occurs in Mandai forest but is now rare.

C. tripinnata Copel.

General distribution: Malaya, N. Borneo, W. Java, Amboyna, Philippines.

In Malaya found only on Pulau Tioman at Bukit Telang and Sedagong at 270m. This species should be looked for on the mountains near the east coast of the Peninsula (see Holttum, Ferns of Malaya p. 120). On Mt. Kinabalu where it is fairly common locally, it is quite distinctive with its attractive lacy fronds. It is a tall tree-fern.

C. moluccana R. Br. (syn. *C. brunonis* (J. Sm.) Wall. ex Hook.)

General distribution: Central Sumatra, Malaya, Lingga, Borneo (excluding S. & S.W.), South and (?) Central Celebes, Moluccas (Ceram, Amboyna).

It has been found throughout the Malay Peninsula except from perhaps Perlis, from sealevel to 1300m. Although a common lowland and foothill fern of disturbed forest and short secondary growth, it appears to be absent from wide areas. It is very common on Penang Hill; on the lower (drier) slopes of Maxwell's Hill, on forest edges; and on the roadsides to both Cameron Highlands and Fraser's Hill, becoming rarer about 650m (one young plant was

found on a ridge near F. H. at 1300m). As it not only tolerates, but appears to thrive in short second growth, especially when near streams, it may be on the increase in many areas. *C. moluccana* is easily recognised by its simply pinnate fronds; it is nearly always trunkless, but in old plants in tall foothill forest, trunks may be seen up to 50cm. This species probably hybridises with *C. alternans*.

C. alternans (Wall. ex Hook.) Presl

General distribution: Sumatra, Malay Peninsula, Sarawak and N. Borneo.

In Malaya this species occurs in most States from Penang and Kelantan to Johore, from the lowlands to 1430m, but is often very local and thus may be overlooked. It is possible that it is more common than is known at present. It is certainly not uncommon on Penang Hill and in parts of Perak, and often grows in association with *C. moluccana* on forest edges, but is much rarer than this species, sometimes only solitary plants being found. In Perak *C. alternans* has been seen several times growing together with a *Pleocnemia* sp. (which was always infertile). Mature specimens on Penang Hill at about 650m had trunks 2-3m in height, but this does not seem to be commonly seen now, for young, trunkless plants are usually encountered, and these in shaded places in tall secondary growth. Tall and mature specimens which have also been seen in Perak, Pahang and Selangor, appear to be quite happy in full sun, on forest edges, and with one exception were not near streams, yet young specimens frequently are. Observation for nearly ten years on two plants suggests that they are slow growing, but young ones are definitely increasing in undisturbed secondary growth. At Fraser's Hill there is a mature plant with a trunk about 45cm high growing on the forest edge, on the lower side of Girdle Road which is just over 1300m, and a young trunkless one was seen on the summit of Peninjau near the wireless station. Fronds vary tremendously in the pinnae shape and lobing, and on the Gap road in Selangor, in one of the Agricultural plots at about 700m, are some tall specimens with curiously shaped pinnae.

C. contaminans (Wall. ex Hook.) Copel.

General distribution: Throughout Malaysia; from the Malay Peninsula northwards to the latitude of Mergui.

In Malaya this species is almost as widespread as *C. latebrosa* and certainly the commonest species of the hills. It grows in abundance on forest edges, on streamsides in cleared valleys and on mountain slopes in open places, and tolerates a great deal of sun and exposure, and is not a fern of the forest understory. This is our tallest species and adapts itself easily to new habitats, and has fairly recently been recorded from about sealevel, on riversides in flat areas (near Taiping, behind the town; on the banksides of the Sungei Raia where it emerges into the Kinta Valley). It would thus appear to be on the increase in the lowlands. It has been collected from as high as 2000m on Gunong Batu Brinchang in Pahang.

C. trichodesma (Scort.) Copel. (syn. *C. burbidgei* of Ferns of Malaya, not (Bak.)).

General distribution: Central part of the Malay Peninsula, Sarawak, N. Borneo in lowland and hilly forest (to 1500m in Borneo).

So far it has been found in Perak, Pahang, Selangor and Negri Sembilan, up to 430m. It seems rather rare, except in Selangor where it is common locally. In Perak it grows in rocky forest (near the edges and thus in a fair amount of light) on the Kampar side of Bujang Melaka mountain, facing west, yet apparently not on the Chenderiang side which is of a more northern aspect. In Selangor it has been found on the edges of light forest below the Gap, usually in damp places; in the forest above Kepong and Sungei Buloh and at Ampang Reservoir near streams. This species with its softly hairy olive-green fronds is easily recognised in the field.

Two adult plants found at Ampang Reservoir may be hybrids having *C. trichodesma* as one of the parents. More observation is needed; the plants were on the lower (left hand side) side of the contour path past the lake at about 60m above the stream, and on very steep ground. *C. trichodesma* and four other species were growing fairly near.

C. polypoda Bak.

General distribution: Malay Peninsula, Sarawak, N. Borneo and the Philippines (Panay, Mindanao).

C. polypoda has been found only in Perak and Johore, with an uncertain record from Pahang, between 1100-1300m and is a species, so far we know, of restricted distribution. In Perak it is common where it grows on the upper slopes and summit of Gunong Kledang, a small mountain near Ipoh, where there were many tall specimens. Below a forest ridge above Lake Chenderoh, several small infertile plants were found, but were undoubtedly this species. In Pahang in the Telom Valley below Cameron Highlands at about 930m. one small infertile plant was seen and the adults should be looked for on the small isolated peaks around there (below Mt. Penelope). This is a distinctive species with shiny deep green fronds and pinnules cut into large segments. Apparently it prefers a dryish ridge or steeply sloping ground in mid-mountain forest, but not near streams.

C. obscura (Scort.) Copel.

General distribution: Sumatra and the Malay Peninsula, in forest between 900-2000m.

This has been collected from Penang, Perak, Pahang and Selangor, and is a common species of the higher forest slopes of Maxwell's Hill, Cameron Highlands and Fraser's Hill and on other hills in the Main Range in Selangor. It is a fern of the heavy forest,

not necessarily near streams, but usually in dampish places, yet it will survive on forest edges where clearing has exposed the plants. The fern is a large one with trunks to about 3-4m; fronds are deep green above (yellowish and contracted when in exposed places) and rather thick and brittle. The long paraphyses which are amongst the sporangia in the sori are very easily seen.

C. squamulata (Bl.) Copel.

General distribution: Sumatra, Malaya, W. Java, Borneo and the Sulu Archipelago.

To be found in lowland forest to at least 300m, but more field work is needed in Malaya for us to know its present day distribution and habitat. The fern was locally common on the lower part of Penang Hill, but appears to be rare there now; there is one record from Perak, growing in light secondary growth by an old rubber estate towards the base of Maxwell's Hill; in Selangor it was found (again one plant) on the edge of secondary growth where there was a Resam (*Gleichenia* sp.) thicket. In the past it has been collected quite often in Johore and in Singapore and in the latter place it is still found in several localities: Nee Soon and Mandai forests and in light growth near the base of Bukit Timah.

Almost certainly the original habitat of this fern in Malaya was moist lowland forest (see Holttum, *Ferns of Malaya* p. 123), but with so much of this now destroyed, it seems to be, today, more frequent in dryer and lighter places in secondary growth.

Notes on the distribution of *Nepenthes* Species in Singapore

by

SALLY GREEN.*

Species found in Singapore.

N. gracilis Korth, *N. rafflesiana* Jack and *N. ampullaria* Jack are all common; *N. hookeriana* Lindl. and *N. trichocarpa* Miq. both occur rarely and singly. In the past *N. reinwardtiana* Miq. and *N. phyllamphora* Willd. were recorded from the Island. Quite recently a few plants were found with a superficial resemblance to *N. mirabilis* Druce, with which *N. phyllamphora* is now merged, but differing from it in important ways, such as the shape of the peristome, the venation of the lamina and the lid, and the number and complexity of the glands under the lid. The Singapore plant cannot be *N. mirabilis*, and since it occurs singly it is probably a hybrid.

Hybrids.

So far as is known, all species of *Nepenthes* can be crossed, producing offspring of great vigour and fertility, which can be used in further crosses; as was done in nineteenth century Europe, where nepenthes breeding had some of the appeal of orchid breeding to-day. Many new varieties were formed; some were beautiful and most sold for high prices. Although gardens hybrids are produced so readily it appears that there is no proved case of a natural hybrid occurring, though taxonomists agree that they probably do. The three possible hybrids in Singapore are *N. hookeriana*, *N. trichocarpa*, and the plant resembling *N. mirabilis*, all of which are rare and generally grow singly. *N. hookeriana* is widely thought to be the hybrid of *N. ampullaria* and *N. rafflesiana*, having some characters of each, and the right geographical and local distribution. The nineteenth century horticulturalists knew *N. hookeriana*, and esteemed it highly; they used it in their crosses, but unfortunately they did not determine its status. *N. trichocarpa* has been accepted as a good species with an odd geographical distribution: Sibolga in N. W. Sumatra, and the Singapore, S. Johore region (Danser, 1928). In the herbarium of the Singapore Botanic Garden however Holttum has classed it as hybrid of *N. ampullaria* and *N. gracilis*, and the appearance of the plant and its occurrence, in Singapore, make this very probable. The third possible hybrid resembles *N. trichocarpa* even more than it resembles *N. mirabilis*; and it is perhaps a cross of *N. trichocarpa* with *N. gracilis*. All of the three possible hybrids are very vigorous and pleasant to cultivate, producing plenty of good-sized pitchers under a fairly wide range of external conditions; unfortunately this is not true of the three good species.

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Distribution of *Nepenthes* species in Singapore. (See Map).

Nepenthes has an ancillary food supply in the prey caught and digested in its pitchers, and it might be expected that it would grow on peculiarly infertile soil. This is indeed so. Singapore soils are of volcanic, sedimentary or alluvial origin, and *Nepenthes* is recorded from the first two of these but not from the richer alluvium. Thus *N. gracilis* is found on the sedimentary outcrop at Ponggol Point, but not further inland, and there are many old records of *Nepenthes* growing on the granite at Changi, but none from the alluvial Tampines region just inland from this. At first sight the Tampines scrubland is very similar to that in which *Nepenthes* grows on volcanic and sedimentary soils, and some of the same plants associated with *Nepenthes* in such sites, can be found there; these include *Melastoma malabathricum* and *Dicranopteris linearis*, which are both abundant. Others however are absent; *Lycopodium cernuum*, a constant associate of *Nepenthes*, is most rare, and *Dillenia suffruticosa* is represented only by occasional unhealthy-looking plants. Evidently the region is unsuitable for *Nepenthes* only in its soil. The Tanah Merah cliff in the alluvial region, which bears *Nepenthes*, appears to be an exception, but in fact it is not so; the *Nepenthes* grow on exposed ancient rock below the alluvial level.

In the sedimentary and volcanic regions all the local *Nepenthes* spp. can be found growing together, though their relative frequencies vary. Typical habitats are:—

1. Coastal cliffs. e.g. Tanah Merah, Labrador, Tanjong Gul. Pulau Tekukor.

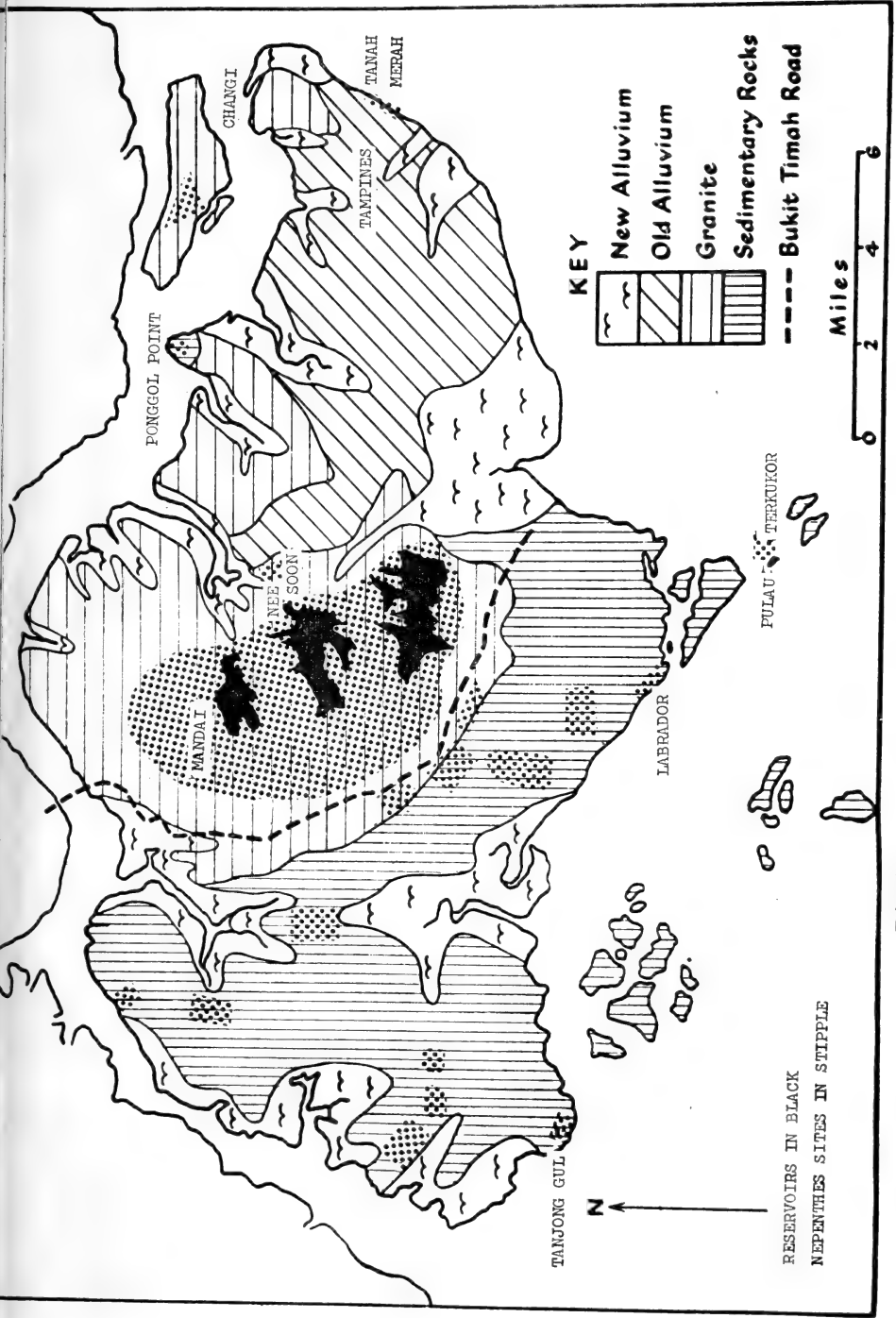
There is no record of clearing or burning of the cliff vegetation, so that it may be primary. The *Nepenthes* found here are often very large indeed, flowering and fruiting abundantly, and with many pitchers. *N. rafflesiana* predominates.

2. Roadside cuttings.

This is a habitat resembling the coastal cliffs in many ways, though the cuttings are usually less exposed than the cliffs, and many of them are of course quite recent. The *Nepenthes* are often very numerous, though smaller than the cliff plants. Flowers, fruits and seedlings are numerous. *N. gracilis* predominates.

3. Regenerating waste ground.

In Singapore there are many areas which have been cleared, farmed and abandoned after the soil is exhausted. Exposure to high insolation, leaching and erosion lowers the fertility still more. Their history, if they are undisturbed, is of a slow change from sandy wastes to secondary forests; Holttum (1954), Gilliland (1958) and others have recorded the stages. It is not known at what stage in the succession the *Nepenthes* plants first appear, but they are not among the pioneers. In the scrub stage — Holttum's "Adinandra Belukar" — all the local species are common climbing in the bushes. All flower and fruit and there



Distribution of *Nepenthes* on Singapore Island.

are many seedlings. *N. gracilis* predominates. By the time the succession has reached forest conditions the relative frequency of the species has changed; *N. rafflesiana* is now rare, *N. gracilis* is less common and *N. ampullaria* predominates. This is the situation where the forest is comparatively open and the trees of no great height; it can be seen at present around the margins of Pierce and MacRitchie Reservoirs. With the growth of the trees the height of the *Nepenthes* has increased; they can be seen among the branches 30 ft. or more above the ground. Seedling plants, chiefly *N. ampullaria*, can be found, usually along rides where these are lower than the forest level, so that there are sloping banks rather like miniature cliffs on which the small plants grow. In denser forests such as that bordering Mandai Road the relative frequency of the species changes again; here *N. ampullaria* is very plentiful, but the other two species are quite rare. There are no flowers but *N. ampullaria* proliferates from shoots on prostrate stems. Its dense clumps of ground pitchers are extraordinarily numerous, but on the few plants of the other species pitchers are rare. The plants are old; that and the absence of flowers and seeding suggests that they are the last survivors from an earlier stage of regeneration. This is the end of the *Nepenthes* period in the re-development of forest; the plants are absent from well-established secondary forest, as they are from primary Dipterocarp forest.

4. Peat swamp. Nee Soon.

Singapore has one small peat swamp at Nee Soon in which *Nepenthes* is plentiful. All the local species grow on the banks of the broad cutting leading to the swamp, with some hybrids; seedlings, particularly of *N. ampullaria*, are abundant. In the swamp itself there is no *N. ampullaria*; *N. gracilis* is common, small plants apparently growing on detritus floating on the water, and larger ones growing from islands formed round the bases of *Ploiarium* trees, where *N. rafflesiana* is also found. The island plants are in no way stunted — they are in fact very fine. Both species flower and fruit.

It appears that the ecological needs of the three common Singapore species of *Nepenthes* are somewhat different. The sites on the cliffs, cuttings and waste ground can perhaps be considered together as a continuum, with the cliffs at one end of the scale and secondary forest at the other; on such a scale shade, soil water content, fertility and pH increase together, maximum temperature, diurnal temperature range and evaporating capacity of the air decrease; with available water still further reduced on the cliffs by salt spray. From the distribution it is clear that the more exposed, less fertile end of the continuum is best suited to *N. rafflesiana*, the shadier, moister, more fertile end to *N.*

ampullaria; while *N. gracilis* finds optimum conditions between the extremes. The differences are not great; there is, for instance, a very fine female plant of *N. ampullaria* growing on the Tanjong Gul cliff, and fruiting abundantly; however this is an exception, and its seedlings do not survive. The Nee Soon peat swamp ranges from a cutting in secondary forest through increasingly acid, infertile, physiologically dry conditions to the wet centre. The *Nepenthes* distribution follows a predictable pattern, with all species growing in the cutting, *N. ampullaria* predominant at the forest edges, and *N. gracilis* alone with one or two plants of *N. rafflesiana* in the standing water at the centre. Anderson (1963) in a study of the coastal peat swamps of Sarawak records a similar distribution. After zoning the bogs into Phasic Communities 1 — 6, P.C. 6 being the climax, he found *N. ampullaria* occasional in P.C.s 1 and 2, *N. gracilis* frequent in P.C. 4 and surviving though stunted in P.C. 6, and *N. rafflesiana* rare in P.C.s 3 and 4 but frequent in P.C. 6. In peat swamp as well as belukar *N. rafflesiana* favours the most infertile conditions, *N. ampullaria* the least.



Plate 1. *N. ampullaria* Jack.

Ground, stem and leaf pitchers. Water Catchment Nature Reserve, Singapore.

Some Ecological Factors affecting Distribution.

An exhaustive account of the ecology of the local *Nepenthes* cannot be attempted here, but a general description of some of the important points may help in understanding distribution. All the Singapore species grow on the same or very nearly the same sites, only their relative frequency varies; so that their ecological needs can all be considered together. These are met not only in the belukar and cliff habitats, which are clearly rather similar, but also in the peat swamp. In Borneo the same species grow in peat swamps and also in the heath forests, which have some resemblance ecologically to the Singapore belukar. The two kinds of habitats have in common acid, highly infertile soil, which is widely recognised as being a necessity, perhaps the prime edaphic one, for the growth of *Nepenthes*. Indeed in 1914 Barrowcliff proposed using the plants as an index of soil poverty. Macfarlane (1922) thought that a well-aerated soil was also essential, and cultured his plants accordingly; but this can hardly be so for the peat swamp plants, which prosper as well as the belukar ones. Aeration is evidently not important. Available water is low in the peat swamps, the belukar has spells of aridity, and as well, *Nepenthes* is particularly abundant on slopes and cliffs, from which the water drains quickly. Anatomically the plants show signs of xerophytic adaptation, which fit them to survive on a dry soil, though this may not be essential.

Cultivating *Nepenthes*, even in a suitable soil, is somewhat difficult because their growth is much affected by climatic factors. Holttum (1938) pointed out that the micro-climate changes during the upward growth of climbing plants; so that adaptive changes in their responses to external conditions are to be expected. These are not very evident in *Nepenthes* until the flowering stage: although the plants do show very considerable changes in morphology during their growth, their response to climatic factors appears to be relatively constant.

The Seed and Seedling.

About 10,000 seeds are produced from one inflorescence of *N. gracilis*. The seeds are remarkably light, and are winged, so that they can be dispersed by the wind over long distances. Each of the two filamentous wings is hollow, so that the seeds are buoyant; they can be carried for short distances by rainwater rills. Wastage is obviously high by either method of dispersal, but the seeds are so numerous that some must find their way to suitable habitats. Garrard (1955) estimated the viability of *N. gracilis* as 8.3 per cent but counts made by the author gave 79 per cent and 63 per cent; Stern (1917) mentions differences in fertility in seeds from different parts which may account for the discrepancy, and probably viability does not limit distribution. The seeds germinate in the light, and within limits increasing the light shortens the time required. This is a fortnight to three weeks after sowing for most of the seeds, but for others it is very much longer; as late as six or seven months after sowing it is still possible for seeds to

germinate. This variation may have some survival value, since the seedlings emerge into different climatic conditions, some more suitable than others. The seedling is very small. From the first it is adapted to life on infertile soil, since the leaves, though markedly different from those of any adult plant, all bear tiny pitchers. These are functional with digestive glands in the cavities. The attractive glands, which are so numerous and so complex in adult pitchers, are restricted in the primary leaves to the rudimentary rim under the mouth. Development is slow; a tiny rosette of leaves is formed, and the plant remains in this form for the next two or three years, with successive leaves gradually getting larger, and successive pitchers slowly changing towards their adult form. The seedling is quickly killed by desiccation, either by wind or by strong sunlight, and this even in damp soil, which perhaps sufficiently explains the absence of *Nepenthes* from the pioneering plants on bare ground. The seedling root is a very meagre one, and often does not appear until after the cotyledons; wind can uproot the small plants, as well as dry them. If the humidity is high the seedlings survive even in a seemingly dry soil, though it is not clear how this is achieved. A bunch of long, tough root hairs appears outside the seed case even before the tip of the root shows, but these are not enough for anchorage and they are doubtfully enough for absorption. Stern (1917) suggested that the seed coat was important, supplying water by capillary action along its furrows. Macfarlane (1908) thought that minute glands scattered all over the surface of the cotyledons and leaves absorbed moisture directly from the air, though not all authors agree with him. The problem is intriguing, but to understand distribution it is perhaps enough to note that the seedlings are adapted for life where the humidity is high, the air is still, there is some shade, and not over-much dependence on soil water. In such situations they are found—at the base of bushes, in nooks on banks and along forest rides. However, there is another limitation; in shade — by no means sufficient to cause etiolation — no pitcher is formed, but only a large lamina. It is unlikely that the seedlings can survive this deprivation for long.

The mature Plant.

The need for humidity, and a rather limited light tolerance, dominate the life of the older plant as they do that of the seedling; though as the plant matures some protective adaptations develop. The cuticle thickens, the young leaf, exposed in the seedling, is shielded in the older plant, the rudiment of the pitcher — the most vulnerable part — is wrapped in hairs. But exposed leaves still curl' pitchers wither, actual burnt patches appear. Nevertheless the plants, once established, survive quite adverse conditions, sometimes even fire. No doubt sheer size plays a part; a patch of strong sunlight kills the whole of a seedling, but only one or two leaves of a large plant. Also the root system becomes extensive, and once the rhizome is formed new growth can come from that. The effect of light can be seen most clearly if the growth of pitchers is watched.

Where shade is too deep pitchers and tendrils do not develop on stem or rosette leaves, laminae become large and thin. If exposure is not high enough for burning, but still too high, both pitchers and their laminae are small; some leaves, notably in *N. rafflesiana*, show twisting of the lamina as well as of the tendril, bringing the pitcher away from exposure. The species all react in this way until climbing is some way advanced; after that there are differences which may be related to their slightly different habitats. Singapore has among its three common species one that is simple, and two that are highly specialised in quite different ways. The simple species, *N. gracilis*, normally has a pitcher on every leaf, borne on the end of a tendril which can coil round supports. The pitchers are tubular and not very large; the wings are never wide, and may be absent. On leaves at the base of the plant, the pitcher mouth opens inwards, towards the stem; on the upper parts it opens outwards. This twisting round of the upper pitchers appears to be normal in the development of *Nepenthes*, since it occurs in most species. In the simpler species, like *N. gracilis*, it is a gradual process with intermediate stages; it involves no change in the shape of the pitcher beyond a slight narrowing of the base, and no change either in the response to light. Matters are quite otherwise with

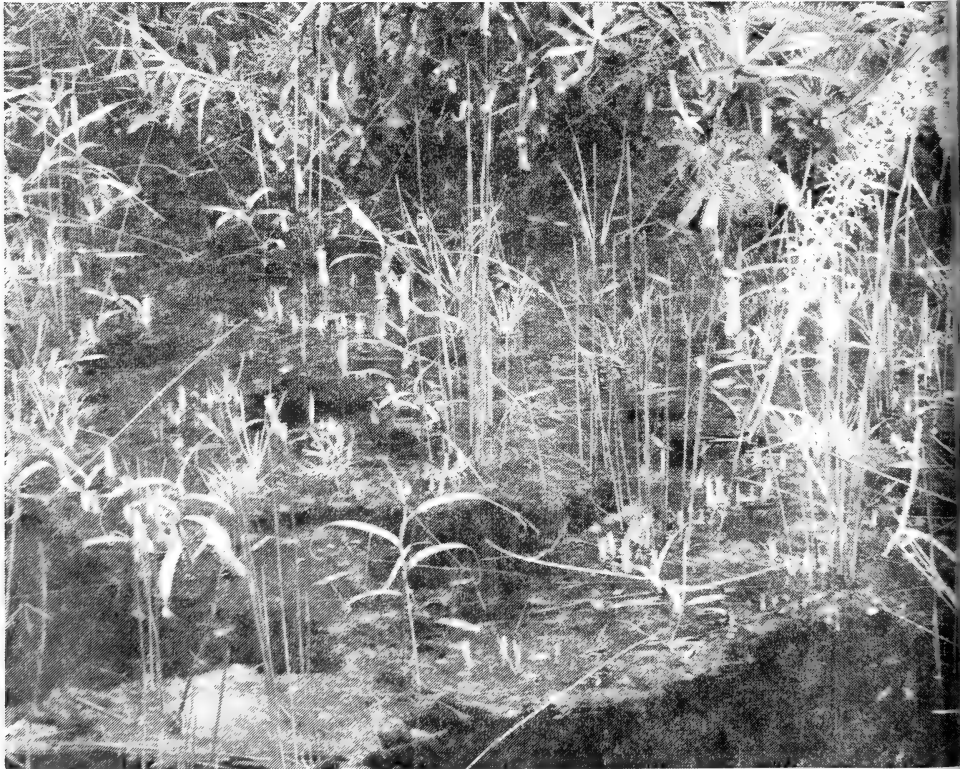


Plate 2. *N. gracilis* Korth.

Growing on the surface of the freshwater peat swamp forest, Nee Soon area of the Water Catchment Nature Reserve, Singapore.

the more specialised species; not only is the change in direction of the pitcher opening quite sudden, between one leaf and the next, but there may be a dramatic change in the shape of the pitchers. *N. rafflesiana* is such a species. An altogether stouter plant than *N. gracilis*, it has correspondingly larger pitchers. The lower ones are broad-based with widely reaching wings; usually they sit on the ground, joined by straight tendrils to their laminae — which may be two feet or more above their level. The upper pitchers are wingless, with the base so narrowed and curved that they have been described as cornucopias. There are clearly biological advantages in this form; not only is wind resistance lessened, but so also is the volume of digestive fluid in the base which has to be supported, while the trapping area round the mouth remains wide. The two types of pitcher respond differently to light. In conditions of under or over-exposure pitchers or tendrils develop on neither; but where exposure is right, the tendril of the lower pitchers grows rapidly downwards, carrying the pitcher away from the light — which is normally of course towards the base of the plant. The tendril of the upper pitchers grows outwards in an arc, and normally coils round a support before the pitcher grows too big for this to be possible. The lower pitchers wither very easily; they cannot survive even that amount of exposure which, when applied to the lamina, stimulated their development. The upper pitchers are



Plate 3. *N. rafflesiana* Jack.
On the sea cliffs of Pulau Terkukor, Singapore.

more resistant, though still less hardy than their laminas. The upper and lower leaves are adapted to different conditions in fact; as much in their tropistic responses as in the different shape and hardness of their pitchers. Evidently making the best of two worlds is a feature of *Nepenthes* organisation; *N. rafflesiana* — and most other species too — can catch not only running insects on the ground, but — with the mouths of the upper pitchers opening invitingly outwards — flying insects as well, though the catch of flying insects is in fact small. *N. ampullaria* is specialised in a different fashion; each

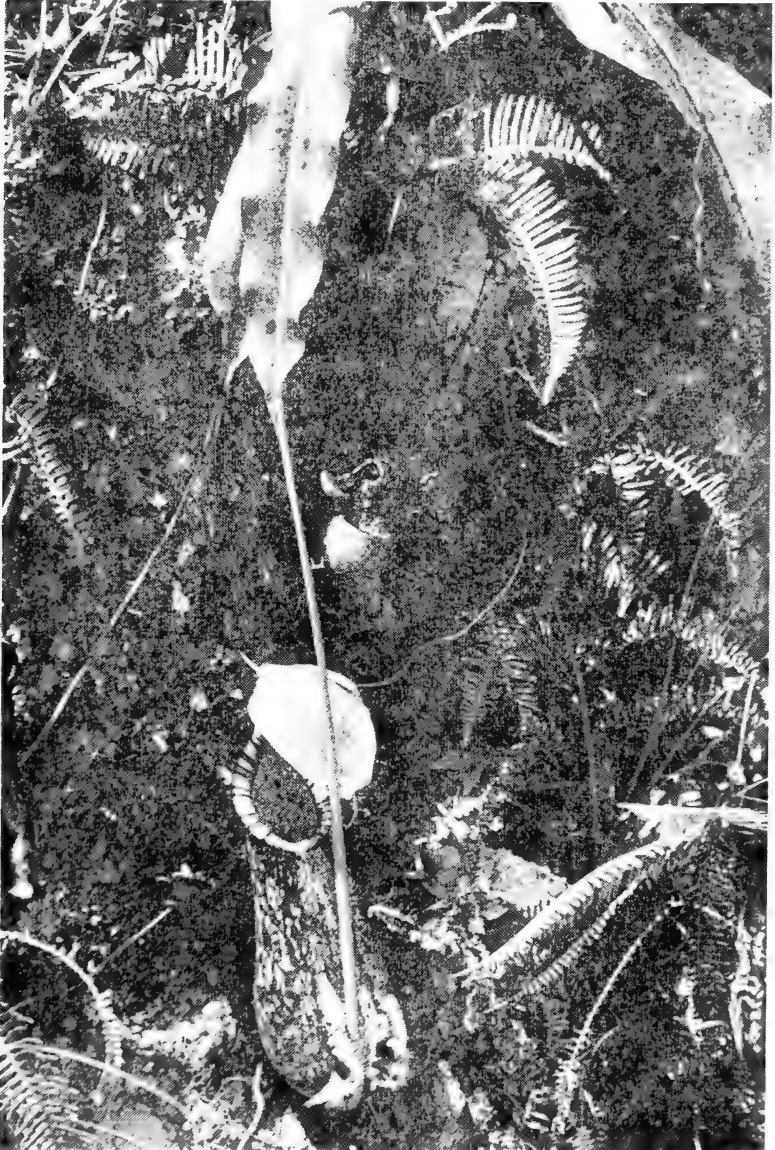


Plate 4. *N. rafflesiana* Jack.
Ground Pitcher.

leaf on the lower part of the growing stem bears a pitcher on a short tendril which does not coil, but on the upper leaves, although there is a coiling tendril, the pitcher does not develop. There is no record of a pitcher of *N. ampullaria* in which the mouth opens outwards. As the lower leaves and their pitchers die, they are not replaced. Instead ground pitchers appear at the base of the plants, borne on short shoots from prostrate stems and rhizomes. Each shoot bears a tight rosette of pitchers, in which the rudimentary laminas and tendrils serve only to bring the pitchers into position. In forest conditions the ground pitchers cover large areas of forest floor, half hidden in fallen leaves; they must be a most efficient trap. Similar pitchers can appear on the brown, seemingly lifeless stems that climb high in the trees. In effect, *N. ampullaria* bears two kinds of leaves, one photosynthetic and climbing, the other absorbtive. Perhaps this is a biological advantage, since its distribution is wider than that of the other local species, not only locally but geographically, and it can grow at higher altitudes. The ground pitchers are borne in quite dense shade, which is sometimes provided on open ground by the bushy growth of this remarkably adaptable plant. Many species of *Nepenthes*, including all the Singapore ones except *N. rafflesiana*, can produce clumps of ground pitchers from the mature plants. The pitchers have the same form as those from the leaves on the lower part of the stem; as in *N. ampullaria* their laminas and tendrils are so reduced as to be scarcely discernible. These ground pitchers are a remarkable development; all other leaves of the plants show enlarged laminas when they are grown in shade, and pitchers are not produced.

Cultivators of *Nepenthes* in private or botanic gardens are sometimes troubled by a scarcity of pitchers. This can be due, not only to too much or too little shade, but also to too rich a soil (Smythies 1963). Such pitcherless plants sometimes flower and seed normally. Evidently carnivory is not obligatory, at least for older plants, though it may well be for early stages, since *Nepenthes*, growing naturally, is usually excluded from habitats with rich soils.

The Flower

The inflorescences are terminal, though growth continues from lateral shoots. The climbing habit has the effect of bringing the flowers out into the open, to the advantage of both pollination and seed dispersal. They appear only where they can be fully exposed, so that they protrude from the tops and sides of trees, and a foot or more over the tops of bushes; and it seems that no degree of exposure can be too high. A different micro-climate indeed from that of preceding stages! A few leaves project along with the inflorescences, and these are pitcherless — according to Stern, because of diversion of food to the inflorescence. But this is to neglect the function of the pitchers in procuring food, and it

is perhaps more probable that the pitchers fail through over-exposure. Few flowers remain unfertilised, but it is uncertain how fertilisation is accomplished. The surfaces of the tepals are dotted with large glands, which secrete so much nectar that it fills the base of the spoonshaped tepals; nevertheless the flowers are seldom visited by insects, not even by ants. Because of the dioecious habit, and the floral structure, a pollinating insect would need to be large and winged. The writer once had the good fortune to watch a bee absorbed in drinking the nectar, which it did while straddling the stamen column with its body. Such insects are well-fitted to be pollinators, but there is no other report of their visiting the flowers. Pollination is probably mainly by wind. Dr. Pallot, lately of the Botany Department, University of Singapore, points out that the pollen grains, though joined together in tetrads, are small enough for this to be possible.

Conclusion.

Nepenthes distribution in Singapore appears to be rather narrowly limited to the most infertile areas which can also provide suitable climatic conditions. The plants are in fact fairly widespread, but this reflects rather the prevalence of man-made waste ground than any abundance of natural sites, of which only the cliffs and perhaps Nee Soon swamp give any picture. The *Nepenthes* population must have been quite small before cultivation began on Singapore Island; and must become so again as one site after another is taken over for industrial and other development.

All things considered, it cannot be said that *Nepenthes* is ideally adapted to the dryland conditions in which it grows in Singapore, especially in the early stages. The leisurely growth, the meagre root, and the readiness with which the small plants — and the older pitchers — dry out, all suggest an origin in a different habitat. It is tempting to see this in the peat swamps, home of many insectivorous plants; and to suggest that the ancestral *Nepenthes* invaded the dry land where it found a suitable soil and tolerable climate. However, for the Singapore species in the existing lowland swamps in Sarawak light is insufficient; Anderson describes them as appearing to climb only where there is an opening in the tree canopy, and only the climbing plants can reproduce. The ancestral home of *Nepenthes*, as so much else concerning these unusual plants, must remain problematic.

Acknowledgements

I have to thank the late Professor H. B. Gilliland, of the University of Singapore, Mr. B. S. Smythies and Dr. J. A. R. Anderson, both of the Forestry Department, Sarawak, and Mr. H. M. Burkill, Director of Singapore Botanic Gardens, for their help, and my husband, for the photographs.

REFERENCES

ANDERSON, J. A. R. The Flora of the Peat Swamp Forests of Sarawak and Brunei.

Gard. Bull., Sing. 20, 2. 1963.

BARROWCLIFF, M. Malayan Rubber and Coconut Soils.

Trans 3rd. Internat. Cong. Trop. Agric. 2, 1914.

DANSER, B. H. The *Nepenthaceae* of the Netherlands Indies.

Bull. Jard. bot. Buit. ser. 3, 9, 1928.

GARRARD, A. The Germination and Longevity of Seeds in an equatorial Climate.

Gard. Bull., Sing. 14, 2. 1955.

GILLILAND, H.B. Plant Communities on Singapore Island.

Gard. Bull., Sing. 17, 1958.

HOLTTUM, R.E. *Adinandra Belukar*. A succession of Vegetation from bare ground on Singapore Island.

Mal. Journ. Trop. Geog. 3. 1954.

HOLTTUM, R. E. (through Richards) The Ecology of Tropical Pteridophytes in Verdoorn's *Manual of Pteridology*. The Hague 1938.

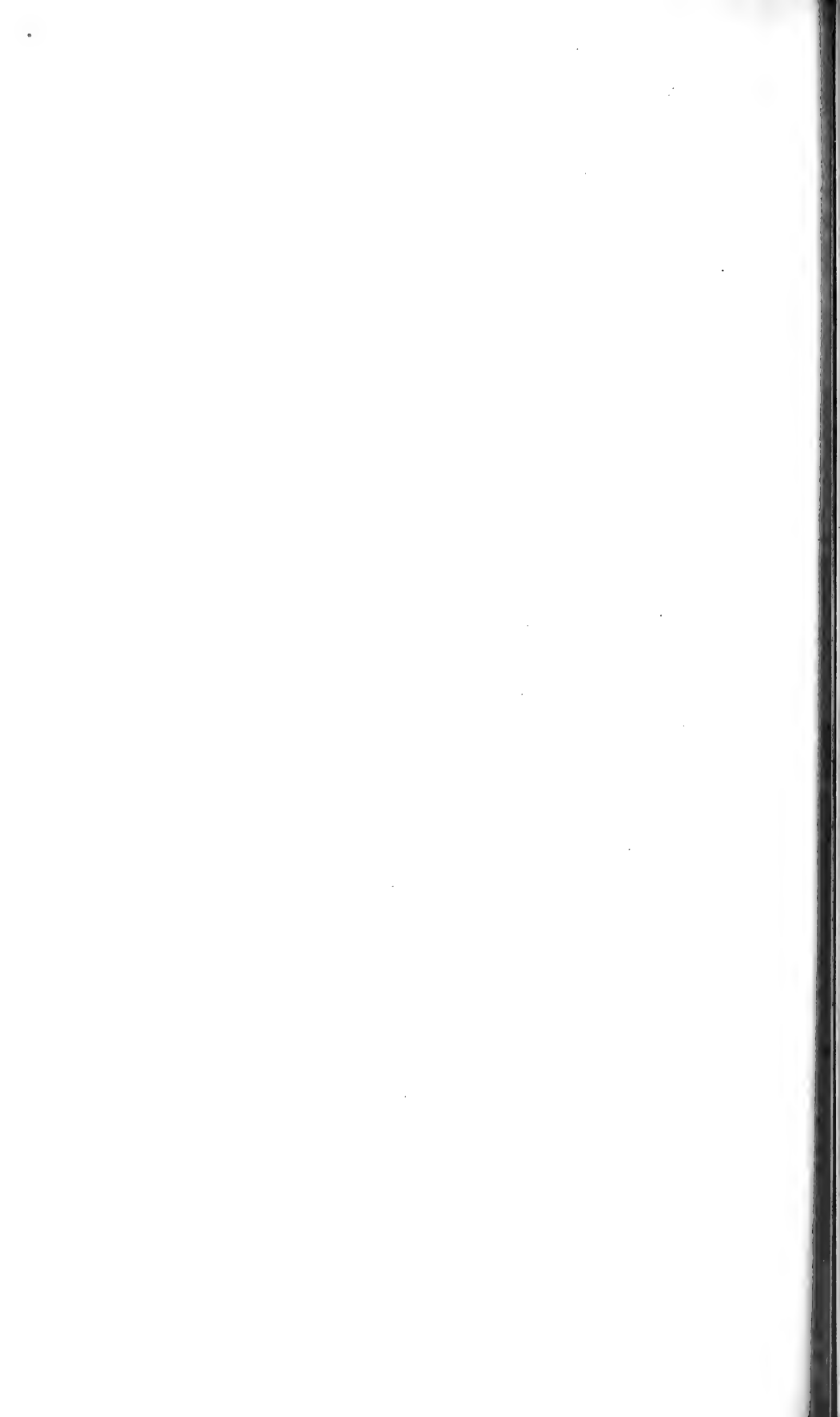
MACFARLANE, J. M. *Nepenthaceae*. *Das Pflanzenreich*. Leipzig 1908.

MACFARLANE, J. M. *Nepenthaceae*. *Standard Cyclop. Hort.* New Ed. 4 1922.

RICHARDS P. W. *The Tropical Rain Forest*. O.U.P. 1952.

STERN, K. Beitrage zur Kenntnis der *Nepenthaceen*. *Flora*, 109. 1917.

SMYTHIES, B. E. *The Distribution and Ecology of Pitcher-plants (Nepenthes) in Sarawak*. Symposium on Ecological Research in Humid Tropics Vegetation, Kuching, Sarawak, July 1963. UNESCO Science Co-operation office for South-east Asia, 1965.



ISAAC HENRY BURKILL 1870 - 1965

by

R. E. HOLTUM

Volume XVII, part 3, of this *Bulletin* was published on May 18th 1960, to commemorate the 90th birthday of Isaac Henry Burkill, Director of Gardens, Straits Settlements, from 1912 to 1925. Mr. Burkill died on March 8th 1965, thus having almost attained the age of 95 years. In 1960 Dr. H. Santapau gave details of Mr. Burkill's early life and of his service in India before he came to Singapore, and Dr. C. X. Furtado and I collaborated in an account of his work in Singapore. The following is to be regarded as supplementing these earlier statements.

Mr. Burkill's early work as assistant in the University Herbarium at Cambridge had trained him as a field botanist in the careful recording of much detailed observation, especially regarding the relations between flowers and insects. His work at Kew had first introduced him to tropical floras and then to an interest in useful tropical plants. In India he was officially engaged in collecting information about useful plants, and during his many travels for this purpose he took every opportunity to extend to Indian plants his investigations of floral biology. He also began the detailed study of wild and cultivated species of *Dioscorea* (true yams) which he continued almost to the end of his long life. Thus he came to Singapore with considerable experience as a field botanist, with an extensive knowledge of the plants of tropical Asia, especially those of use to man, and with a particular interest in yams and in floral biology.

Burkill arrived at Singapore several months after the retirement of H. N. Ridley, that dynamic and erratic pioneer genius who accomplished so much in 23 years, during which period the plantation rubber industry was established, largely as a result of his experiments with the *Hevea* trees in Singapore. Ridley was always in a hurry and often uncritically careless about details. Thus Burkill found much reorganization necessary in every aspect of the work of the Botanic Gardens. In his efforts to achieve reorganization he was hampered by lack of trained assistants, especially during the period of World War I; he was also hampered by a failure of the senior civil servants of his day to understand the significance and needs of the work of the Botanic Gardens. But despite these difficulties he did achieve important developments which had a great influence both on the Gardens Department and, through his published work, on many people throughout the world who have been concerned with useful tropical plants.

During the period between Ridley's departure and Burkill's arrival, J. W. Anderson, Assistant Curator, prepared and had printed a catalogue of the plants in cultivation in the Gardens. This contained too many errors to satisfy Burkill's critical examination, but it showed the need for carefully compiled records of the plants which had been introduced and of their behaviour in cultivation. Burkill therefore had prepared a complete series of extracts from the plant introduction books, thus obtaining a list of all names under which plants had been introduced, with their sources and the date of each record. He also had herbarium specimens prepared of plants in cultivation, and himself checked their names, attempting thus to compile a complete record of the actual state of the Gardens for comparison with the introduction records. This survey included all the useful plants which has been introduced into the Economic Garden (now the site of the Faculties of Arts and Science of the University of Singapore). He also reorganized the labelling of plants (especially trees, shrubs and palms) and every week checked the painted labels before they were put out. He thus trained Malay youths to have a knowledge of botanical plant names and also to recognize the plants which bore them and to know their places in the Gardens. Among these Malays was a very promising young man named Mohamed Nur.

The herbarium, and field work for collecting new specimens, also needed reorganization. Ridley's methods had been casual, and in some cases resulted in confusions of labelling. Burkill therefore devised a new system of field labels, based on his Indian experience, and trained his staff in the importance of labelling all specimens at the time of collections. Needing a new assistant in the herbarium, he promoted Mohamed Nur, who subsequently made such a great contribution to this aspect of the Gardens' work. Burkill collected specimens during his travels wherever possible, and also arranged for other members of the staff to do so, sending duplicates to Kew, where they were available to Ridley, who was preparing his *Flora of the Malay Peninsula*. As the successive volumes of this *Flora* appeared, the herbarium was re-arranged, and Burkill took the opportunity of making a careful survey of the extent of botanical exploration of the various parts of the Peninsula (*Gard. Bull.* 4: 113–202, 1927). He also made careful analyses of the floras of two restricted localities in which he had himself made extensive collections, namely Fraser's Hill (with R. E. Holttum, *Gard. Bull.* 3: 19–110, 1923) and Taiping (with M. R. Henderson, *Gard. Bull.* 3: 303–458, 1925); these accounts give an indication of his critically detailed treatment of his data, and also the wide scope of his thought.

He made a special effort to secure herbarium specimens of wild and cultivated yams, and also cultivated living plants whenever possible, to observe their growth both above and below ground. He cultivated many yams from other parts of the world, notably a collection from Tahiti. He had collected local names for yams in

India, and continued this practice in Malaya; he searched a very wide range of literature for other recorded vernacular names, the final list being more than 1500. His published commentary on the list throws light on the migrations of man and on the history of the use of yams as food; it also points out the value of such records in linguistic studies.

On the subject of floral biology, Burkill was not able to publish much, apart from studies of various Malayan orchids in cultivation; these included the very remarkable *Plocoglottis lowii*. It was however clear to anyone accompanying him in the field (as I did on several occasions during the years 1922–25) how deep was his interest in such matters and how wide his knowledge.

Throughout his service in Singapore, Burkill was in close contact with the Forest Department, and from 1918, when Dr. F. W. Foxworthy was appointed to establish a Forest Research service, this contact became closer, as Foxworthy needed frequently to consult the Singapore Herbarium. Mr. G. E. S. Cubitt, head of the Forest Department, hearing of Burkill's accumulated records of useful plants and their history in culture in Singapore, and knowing also his work in connection with the preparation of Watt's *Dictionary of the Commercial Products of India*, suggested to the Governor of the Straits Settlements that Burkill should spend the years following his retirement in compiling such a dictionary for Malaya. This proposal was approved, and in his last two years of service Burkill spent as much time as he could in collecting data for the Dictionary in various part of Malaya. In this work he was assisted by Mohamed Haniff of Penang. They collected especially information about local medical uses of plants, and in so doing also collected a large amount of information on local plant-name. The results of this work were published in *Gard. Bull.*, 6 (2), 1930.

It had been suggested that the Dictionary would be completed in the three years following Burkill's retirement. But he spent the whole of those years searching literature, at Kew and elsewhere, and accumulated a card-index which he told me contained 36,000 entries; only then did he begin the writing. The work was finally published in 1935, ten years after its commencement. It is the most comprehensive account of useful tropical plants, and of the history of their use by man, that has yet been published. Naturally, it is now not up to date in many matters, but as a basis of fact about the past it will always be of great value.

This great work accomplished, Burkill reverted to his interest in yams, and (in collaboration with Sir David Prain) completed the text of a great monograph on the oriental species of *Dioscorea* (*Annals of the Royal Botanic Garden, Calcutta*, 14, 1936–38). He extended his studies to African yams, and devoted much time also to basic studies on the anatomy and morphology of *Dioscorea* and the other genera of the yam family. At the age of 81 he completed an account of the family Dioscoreaceae for *Flora Malesiana*. Finally, at the age of 90, he completed a remarkable survey of the whole family, treating it from many viewpoints (*Journ. Linn. Soc. Bot.* 56: 319–412, 1960).

The historical studies on which the Dictionary was based, and those on the dispersal and uses of yams, led Burkill to a general interest in the history of food plants and so to a wide reading of literature on early human history and pre-history. In his usual way he accumulated a large number of reference slips dealing with all aspects of this subject, and used them in preparing his Hooker Lecture to the Linnean Society in 1951 on "Habits of Man and the origins of the cultivated plants of the Old World". He had thoughts of expanding this study into a book, but was obliged to give up the idea.

About 1950 Burkill was asked if he would write something on the history of botany in India, a subject on which he had already a wide knowledge. He set about the work with his usual thoroughness, and went to much trouble in searching for biographical details from many sources. His last visit to Kew was in connection with this work, which was interrupted by a serious illness, after which he received much help from his wife in bringing this final labour to a conclusion. It was published, as "Chapters on the History of Botany in India", in the *Journal of the Bombay Natural History Society*, from 1953 to 1963, and is now re-published in book form by the Botanical Survey of India.

ISAAC HENRY BURKILL 1870 - 1965

A Bibliography

by

H. M. BURKILL, *filius*

The following lists are by way of supplementing the notes published in the *Gardens' Bulletin, Singapore* 18 (3), 1960, and in this issue on the life of I. H. Burkill. His published papers total over 7,700 printed pages. Burkillian taxa number 2 genera, 7 sections, 233 species, 78 varieties and 72 new combinations. The extent of his collaboration with his friend and colleague, Sir David Prain can be seen from these lists. Joint publications amount to 768 printed pages, the first in 1904 and the last in 1938, and 113 new species and 55 new varieties.

I am indebted to Dr. C. G. G. J. van Steenis, Director, and Mr. L. Vogelgang, Librarian, of the Rijksherbarium, Leiden, to Dr. R. E. Holttum of Kew, and to Father H. Santapau, Director of the Botanical Survey of India, who have helped me with additions and corrections.

I. PUBLICATIONS

1892

Gloucestershire Rubi. *J. Bot.*, **30**, 1892: 376.

1893

The Flora of Gloucestershire, Reports of *Cheltenham Nat. Sci. Soc.*, 1893, 57–67. [Being the substance of a lecture.]
Reprinted in *Cheltenham Examiner*, 10 and 17 May, 1893.

Observations on the Flora of the pollard willows near Cambridge.
Proc. Camb. Phil. Soc., **8**, 1893: 82–91. (J. C. Willis and I.H.B.)

Notes on the plants distributed by the Cambridge dustcarts.
Proc. Camb. Phil. Soc., **8**, 1893: 91–94.

1894

Botanical notes from north Cardiganshire.
J. Bot., **1894**: 1–7. (I.H.B. and J. C. Willis.)

On the fertilisation of some species of *Medicago* L. in England.
Proc. Camb. Phil. Soc., **8**, 1894: 141–52.

1895

On some variation in the number of stamens and carpels.
J. Linn. Soc. Lond., **Bot.**, **31**, 1895: 216–45.

Flowers and Insects in Great Britain. I.
Ann. Bot., **9**, 1895: 227–73. (J. C. Willis and I.H.B.)

1896

On a collection of plants from New Britain (Neu Pommern).
Proc. Camb. Phil. Soc., **9**, 1896: 91–98.

Teratological observations on *Parnassia palustris*, L.
J. Bot., **1896**: 1–4

1897

Fertilisation of spring flowers on the Yorkshire coast.
J. Bot., **1897**: 92–99; 138–45; 184–9.

List of the known plants occurring in British Central Africa.
In JOHNSTON: *British Central Africa*, London, 1897, Bot. App., II: 233–84.

1898

Changes in the sex of willows.
Ann. Bot., **12**, 1898: 557.

[Abstract of a paper read to the British Association for the Advancement of Science, Section K, meeting of 1898 — vide 1899.]

Pittosporum spathaceum.
Hook. Ic. Pl., **26** (3), 1898: t.2561.

1899

Changes in the sex of willows.
Rep. 68 Meeting Brit. Ass. Adv. Sci., 1898. 1065–6 (Abstract).

Botany [of Gloucestershire].
In BEACON C.W.: *Gloucester Court Guide and County Blue Book*, 1899: 156–82.

‘*Limacia monilifera*.

Hook. Ic. Pl., **26** (4), 1899: t. 2585.

On *Pelargonium rapaceum*, Jacq.

Ann. Bot., **13**, 1899: 181–2.

Acanthaceae.

In THISELTON-DYER: *Flora of Tropical Africa*, **5**: 1–44.

Notes on plants collected in the Aconcagua valleys by Phillip GOSSE.

In FITZGERALD, E.A.: *The Highest Andes*, London 1899, *Botany*, pp. 361–79.

Cupuliferae: Betuleae.

In FORBES, F.B. & W.B. HEMSLEY: *An enumeration of all the plants known from China Proper, Formosa, Hainan, Corea, The Luchu Archipelago and the Island of Hongkong, together with their distribution and synonymy*.

J. Linn. Soc. Lond., **Bot. 26**, 1899: 496–500.

Cupuliferae: Coryleae.

In FORBES, F.B. & W.B. HEMSLEY: *op. cit.*

J. Linn. Soc. Lond., **Bot. 26**, 1899: 501–5.

Salicaceae.

In FORBES, F.B. & W.B. HEMSLEY: *op. cit.*

J. Linn. Soc. Lond., **Bot. 26**, 1899: 526–38.

On some African Labiatae with alternate leaves.

J. Linn. Soc. Lond., **Bot. 34**, 1899: 268–76.

(I.H.B. and C.H. Wright.)

1900

Trifolium pratense var. *parviflorum*.

Proc. Camb. Phil. Soc., **11**, 1900: 29–31. (Reprinted in *J. Bot.*, **1901**: 235–6.)

Dolicholobium acuminatum.

Hook. Ic. Pl., **27** (2), 1900: t. 2630.

1901

The ovary of *Parnassia palustris*, Linn.

Ann. Bot., **15**, 1901: 187–92.

Ground-nut, or pea-nut (*Arachis hypogaea*, Linn.).

Kew Bull., **1901**: 175–200.

The Flora of Vavau, one of the Tonga Islands.

J. Linn. Soc. Lond., **Bot. 35**, 1901: 20–65. (With a short account of its vegetation by C. S. Crosby.)

Report on two botanical collections from Mt. Roraima, Introduction.

Trans. Linn. Soc. Lond., **II, 6**, 1901: 1–17.

The phanerogamic flora of the Clova Mountains in special relation to flower biology.

Trans. Bot. Soc. Edin., **66**, 1901: 109–25.

(J. C. Willis and I.H.B.)

1902

On the variation of the flower of *Ranunculus arvensis*.

J. As. Soc. Beng., **71**, 1902: 93–120.

Paspalum dilatatum, an American fodder grass.

Kew Bull., **1902**: 1–4.

Ginseng in China (*Aralia quinquefolia*).

Kew Bull. **1902**: 4–11.

Aleurites cordata, Steud. Tung Oil or Chinese Wood Oil.

Commercial Circ. No. 2 of 1902-3, Calcutta, 1902. [Issued by the office of the Reporter on Economic Products to the Government of India.]

Annual Report of the Industrial Section of the Indian Museum for the year 1901-1902; 34 pp., Calcutta.

1903

Irregular casings of the Faggot Worm.

Proc. As. Soc. Beng., 1903: 97-98.

The diffusion process of extracting Sugar from Sugar Cane.

Agric. Ledger 1903, **10 (8)**: 193-213. Calcutta, 1903.

Flowers and Insects in Great Britain. II. Observations on the natural orders Dipsacaceae, Plumbaginaceae, Compositae, Umbelliferae, and Cornaceae, made in the Clova Mountains.

Ann. Bot. **17**, 1903: 313-49. (J. C. Willis and I.H.B.)

Flowers and Insects in Great Britain. III. Observations on the most specialised flowers of the Clova Mountains.

Ann. Bot. **17**, 1903: 539-70. (J. C. Willis and I.H.B.)

Notes on anthophilous insect fauna of the Clova Mountains.

Ann. Scot. Nat. His., 1903: 29-37, 99-103.

(J. C. Willis and I.H.B.)

Report and Programme, 1903. Collections for the Indian Museum, Calcutta, and the Imperial Institute, London. Calcutta, 1903, 34 pp.

Annual Report of the Industrial Section of the Indian Museum for the year 1902-1903; 40 pp., Calcutta.

1904

A note upon the use of *Marsdenia* in the Rajmahal Hills.

Agric. Ledger 1904, **11 (8)**: 113-14. Calcutta, 1904.

The Tapioca plant: its history, cultivation and uses. A review of existing information.

Agric. Ledger 1904, **11 (10)**: 123-48. Calcutta, 1904.

Annatto Dye. A review of existing information.

Agric. Ledger 1904, **11 (12)**: 177-87. Calcutta, 1904.

Notes on the anthophilous insect fauna of the Clova Mountains. II.

Ann. Scot. Nat. His., **1904**: 166-8.

(J. C. Willis and I.H.B.)

A report on cotton in Burma.

Calcutta, 1904. [Issued from the office of the Reporter on Economic Products to the Government of India.]

On *Dioscorea burmanica*—a new species from Burma—and two allied species.

J. As. Soc. Beng. II, **73**, 1904: 183-7.

(D. Prain and I.H.B.)

The Central Factory System, with reference especially to countries growing sugar cane.

Agric. Ledger 1903, **11 (12)**: 245-60. Calcutta, 1904.

(I.H.B. and J. Weinberg).

On *Dioscorea deltoidea*, Wall., *Dioscorea quinqueloba*, Thunb., and their allies.

J. As. Soc. Beng., II, **73 Suppl.**, 1904: 1-11.

(D. Prain and I.H.B.)

1905

Frankincense, Myrrh and Bdellium.

Note No. 157 of the Reporter on Economic Products to the Government of India. Calcutta, 1905. 12 pp.

The collection and composition of the dye-stuff Kamala.

Agric. Ledger 1905, No. 4: 49–70. Calcutta, 1905.

1906

A treatment for hydrophobia.

Ind. For., 32, 1906: 27.

A parasite upon a parasite—a *Viscum*, apparently *V. articulatum*, Burm., on *Loranthus vestitus*, Wall., on *Quercus incana* Roxb.

J. As. Soc. Beng., n.s., 2, 1906: 299–301.

On *Swertia angustifolia*, Ham., and its allies.

J. As. Soc. Beng., n.s., 2, 1906: 363–81.

Gentianacearum species asiaticus novas descripsit.

J. As. Soc. Beng., n.s., 2, 1906: 309–27.

Notes on the pollination of flowers in India. I. The pollination of *Thunbergia grandiflora*, Roxb., in Calcutta.

J. As. Soc. Beng., n.s., 2, 1906: 511–14

Notes on the pollination of flowers in India, II. The pollination of *Corchorus* in Bengal and Assam.

J. As. Soc. Beng., n.s., 2, 1906: 515–20.

Notes on the pollination of flowers in India, III.

The mechanism of six flowers of the northwest Himalaya.

J. As. Soc. Beng., n.s., 2, 1906: 521–5.

The fertilisation of *Pieris*.

Nature, July 26, 1906.

Bambarra ground-nut (*Voandzeia subterranea*, Thou.)

Kew Bull., 1906: 68–70.

Goa Beans in India.

Agric. Ledger 1906, 13 (4): 51–64. Calcutta, 1906.

Gossypium obtusifolium, Roxb.

Mem. Dep. Agr. India, Bot. ser., 1906, 1 (4): 1–10.

Swertiam novam japonicam ex affinitate Swertiae tetrapterae.

J. As. Soc. Beng., n.s., 2, 1906: 329.

(S. Le M. Moore and I.H.B.)

Annual Report of the Industrial Section of the Indian Museum for the year 1905–1906; 39 pp., Calcutta.

1907

Alpine Notes from Sikkim.

Kew Bull., 1907: 92–94.

A note on *Swertia tongluensis* and on a new variety of *Swertia purpurascens*.

J. As. Soc. Beng., n.s., 3, 1907: 33–35.

On *Gentiana coronata*, Royle.

J. As. Soc. Beng., n.s., 3, 1907: 149–68.

A fish trap from northern Arakan.

J. As. Soc. Beng., n.s., 3, 1907: 441–2.

- Notes on the pollination of flowers in India, IV. On Cotton in Behar.
J. As. Soc. Beng., n.s., 3, 1907: 517–26.
- Anguillicarpus*—a new genus of Cruciferae.
J. As. Soc. Beng., n.s., 3, 1907: 559–61.
- A variety of *Ducrosia anethifolia*, Boiss., from Baluchistan.
J. As. Soc. Beng., n.s., 3, 1907: 563–4.
- A note on *Impatiens balsamina*, Linn., as a dye plant.
J. As. Soc. Beng., n.s., 3, 1907: 565–6.
- An abnormal branch of the mango (*Mangifera indica*, Linn.).
J. As. Soc. Beng., n.s., 3, 1907: 427–32.
 (I.H.B. and G. C. Bose.)
- On three varieties of *Corchorus capsuaris*, Linn., which are eaten.
J. As. Soc. Beng., n.s., 3, 1907: 633–8.
 (I.H.B. and R.S. Finlow.)
- Annual Report of the Industrial Section of the Indian Museum for the year 1906–1907; 22 pp., Calcutta.

1908

- Notes on the pollination of flowers in India, V. Some autumn observations in the Sikkim Himalaya.
J. As. Soc. Beng., n.s., 4, 1908: 179–95.
- Notes on the pollination of flowers in India, VI. The spring flora in the Simla Hills.
J. As. Soc. Beng., n.s., 4, 1908: 197–231.
- The Indian Doum (*Hyphaene*) Palm.
J. Bomb. Nat. Hist. Soc. 18, 1908: 929–30.
- A review of information on Burmese peas and beans so far collected in the office of the Reporter on Economic Products to the Government of India. Calcutta, 1908.
- Dioscorearum novarum descriptiones quaedam.*
J. As. Soc. Beng., n.s., 4, 1908: 447–57.
 (D. Prain and I.H.B.)
- Melchior Treub. [A biographic note on the occasion of his election to honorary membership of the As. Soc. Beng.]
Proc. As. Soc. Beng., 1908: lxxxviii—lxxxix.
- Rai Ram Brahma Sanyal Bahadur. [Obituary.]
Proc. As. Soc. Beng., 1908: cxiii.
- The Races of Jute.
Agr. Ledger 1907, 14 (6): 41–137. Calcutta, 1908.
 (I.H.B. and R.S. Finlow.)
- Flowers and Insects in Great Britain, IV. Observations on the less specialized flowers of the Clova Mountains.
Ann. Bot., 22, 1908: 603–49. (J. C. Willis and I.H.B.)
- Annual Report of the Industrial Section of the Indian Museum for the year 1907–1908; 32 pp., Calcutta.

1909

- First notes on *Cymbopogon martini*, Stapf.
J. As. Soc. Beng., n.s., 5, 1909: 89–93.
- The drug Astukhudus, nowadays *Lavandula dentata*, and not *Lavandula stoechas*.
J. As. Soc. Beng., n.s., 5, 1909: 67–71.
- On *Coptis*.
J. As. Soc. Beng., n.s., 5, 1909: 73–88.

Dyes from Flowers. A summary of our present knowledge regarding the use of dyes from flowers in India, together with two reports on *Thespesia lampas* and *Hibiscus subdariffa* by A. G. Perkin.

Agr. Ledger 1908, **15** (2): 7–27, 1909.

A Working list of the flowering plants of Baluchistan.

Calcutta, 1909, 136 pp.

Indian pens, their history, classification, materials used and methods of manufacture.

Agr. Ledger, 1908–9, **15** (6): 111–30, 1909.

Note on the extension of cultivation of fibre plants in India.

Agr. Res. Inst., Pusa, Bull., **15**, 1909: 1–14.

(I.H.B. et al.)

Soy Bean.

Ind. Trade J., July 29, 1909: 136–8.

Annual Report of the Industrial Section of the Indian Museum for the year 1908–1909; 25 pp., Calcutta.

1910

Fashion in Iron Styles

J. As. Soc. Beng., n.s., **6**, 1910: 1–18.

Notes on the pollination of flowers in India, VII. A few observations made in the Central Provinces and Berar.

J. As. Soc. Beng., n.s., **6**, 1910: 101–7.

Notes on the spreading of *Croton sparsiflorus*, Morung, along the Assam-Bengal Railway.

Proc. As. Soc. Beng., 1910: ci-cii.

Notes from a journey to Nepal.

Rec. Bot. Surv. Ind., **4**, 1910: 59–140 + index, 3 pp.

Bat and Bird Guanos in India.

Agric. Ledger 1911, **17** (1): 1–9, 1910.

Edible Frogs in India.

Agric. Ledger 1911, **17** (2): 11–15, 1910.

Report and Programme of the Indian Museum, Calcutta, for the year 1910. Calcutta, 1910.

Industrial and Agricultural Chemistry. Report of the Board of Scientific Advice for 1908–09: Government of India. Calcutta, 1910.

(I.H.B. and H. E. Annet.)

Annual Report of the Industrial Section of the Indian Museum for the year 1909–1910; 52 pp., Calcutta.

1911

Determinations of the Prickly Pears now wild in India.

Rec. Bot. Surv. Ind., **4** (6), 1911: 287–322.

Swertias chinenses quatuor novas ex herbario G. Bonati descriptit.

J. As. Soc. Beng., n.s., **7**, 1911: 81–82.

Further spreading of *Croton sparsiflorus* (Morung).

J. As. Soc. Beng., n.s., **7**, 1911: 132.

The polarity of the bulbils of *Dioscorea bulbifera*, Linn.

J. As. Soc. Beng., n.s., 7, 1911: 467-9.

A Lepcha's medicine bag.

Proc. As. Soc. Beng., 1911: xcix-xc.

Corchorus capsularis var. *oocarpus*—a new variety of common jute plant.

J. As. Soc. Beng., n.s., 7, 1911: 465-6.

(I.H.B. and R. S. Finlow.)

Annual Report of the Industrial Section of the Indian Museum for the year 1910-1911; 21 pp., Calcutta.

1912

Croton sparsiflorus (Morung) from Makum.

Proc. As. Soc. Beng., 1912: cxi.

Abor Expedition.

Kew Bull., 1912: 159. [Being an abstract of a letter.]

The inheritance of red colour, and the regularity of self-fertilisation, in *Corchorus capsularis*, Linn.—the common jute plant.

Mem. Dept. Agr. in Ind., Bot. ser., 4, 1912: 73-92.

(R. S. Finlow and I.H.B.)

1913

The botany of the Abor expedition. A study of the forests of the Abor Hills, eastern Himalayas.

Rep. 82 Meeting Brit. Ass. Adv. Sci., Dundee, 1912: pp. 683-4.

[Being the abstract of a paper read to the British Association for the Advancement of Science, Section K, Dundee 1912.]

Dioscoreae Elmerianae. A contribution to our knowledge of the genus *Dioscorea* in the Philippine Islands.

Elmer, Leaflet. Philip. Bot., 5, 1913: 1589-99.

(D. Prain and I.H.B.)

The Coconut Beetles, *Oryctes rhinoceros* and *Rhyncophorus ferrugineus*.

Gard. Bull. S.S., 1, 1913: 176-188.

Clerome gracilis, a butterfly destructive to palms.

Gard. Bull. S.S., 1, 1913: 188-9.

Notes on plants of interest in the Botanic Gardens, Singapore.

Gard. Bull. S.S., 1, 1913: 189-92.

The extreme hardness of the seeds of *Caesalpinia digyna*.

Gard. Bull. S.S., 1, 1913: 193.

A disease of Agaves.

Gard. Bull. S.S., 1, 1913: 193-4.

Annual Report on the Botanic Gardens, Singapore and Penang, for the year 1912.

Government Printing Office, Singapore, 1913, 8 pp.

1914

The Sirangoon outbreak (1913) of *Brachartona catoxantha*.

Gard. Bull. S.S., 1, 1914: 207-8.

Calogramma festiva, Donovan,—a caterpillar destructive to *Crinum asiaticum*.

Gard. Bull. S.S., 1, 1914: 209.

The big Rubber Tree, Singapore.

Gard. Bull. S.S., **1**, 1914: 210–11.

Croton sparsiflorus, (*Morung*), an American invader.

Gard. Bull. S.S., **1**, 1914: 235–7.

A spadix in the axil of the spathe of *Xanthosoma*.

Gard. Bull. S.S., **1**, 1914: 244.

Grammatophyllum flowering in January.

Gard. Bull. S.S., **1**, 1914: 244.

A synopsis of the Dioscoreas of the Old World, Africa excluded, with descriptions of new species and of varieties.

J. As. Soc. Beng., **n.s.**, **10**, 1914: 5–41.

Annual Report on the Botanic Gardens, Singapore and Penang, for the year 1913.

Government Printing Office, Singapore, 1914, 8 pp.

1915

An abnormality in the coconut palm.

J. Str. Br. R. As. Soc., **68**, 1915: 15.

The Treatment to which the para-rubber trees of the Botanic Gardens, Singapore, have been subjected.

Gard. Bull. S.S., **1**, 1915: 247–95.

Some notes on philippine yams, and the results of cultivation of three indian races in 1914.

Gard. Bull. S.S., **1**, 1915: 297–304.

Preparation of yams for the table.

Gard. Bull. S.S., **1**, 1915: 304–5.

Different parts of the tubers of *Dioscorea alata* sprout at different rates.

Gard. Bull. S.S., **1**, 1915: 306–7.

Three Lepidoptera which attack Dioscoreas in Singapore.

Gard. Bull. S.S., **1**, 1915: 308–10.

Fragments of malayan geographic botany.

I. Enumeration of Pahang plants collected by the late A. M. Burn Murdoch.

Gard. Bull. S.S., **1**, 1915: 310–18.

Orchid Notes.

Gard. Bull. S.S., **1**, 1915: 318–20.

The Singapore Prickly-Pear.

Gard. Bull. S.S., **1**, 1915: 320–1.

A nest of living *Drymoglossum piloselloides*.

Gard. Bull. S.S., **1**, 1915: 321.

A very destructive flash of lightning.

Gard. Bull. S.S., **1**, 1915: 329.

A report on philippine yams.

Phil. Agr. For., **3**, 1915: 205–9.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1914.

Government Printing Office, Singapore, 1915, 7 pp.

1916

Notes on the pollination of flowers in India, VIII. Miscellanea.

J. As. Soc. Beng., n.s., **12**, 1916: 239-65.

A note on the Terai forests between Gandak and the Teesta.

J. As. Soc. Beng., n.s., **12**, 1916: 267-72.

William Jack's letters to Nathaniel Wallich, 1819-1821.

J. Str. Br. R. As. Soc., **73**, 1916: 147-268.

Selection.

Straits Times Press Ltd., Singapore 1916. [Being the substance of a lecture given to the Malacca Planters' Association.]

Orchid Notes.

Gard. Bull. S.S., **1**, 1916: 349-53.

A skipper trapped in a flower of *Dipladenia harrisii*.

Gard. Bull. S.S., **1**, 1916: 355.

Locusts in Malacca.

Gard. Bull. S.S., **1**, 1916: 355-49.

(P. C. Cowley-Brown and I.H.B.)

Dioscorea asclepiadea, Pr. et Burk.; *D. bernouilliana*, Pr. et Burk.; *D. carionis*, Pr. et Burk.; *D. melastomifolia*, Uline, and *D. truncata*, Miq.

Kew Bull., **1916**: 190-6. (D. Prain and I.H.B.)

Annual Report of the Director of Gardens, Straits Settlements, for the year 1915.

Government Printing Office, Singapore, 1916: 7 pp.

1917

Elaeocarpus barnardii, a new species described from Perak.

J. Str. Br. R. As. Soc., **75**, 1917: 41.

Notes on Dipterocarps, I. The seedling of *Anisoptera costata*, Korth.

J. Str. Br. R. As. Soc., **75**, 1917: 43-48.

Gordonia.

J. Str. Br. R. As. Soc., **76**, 1917: 133-59.

Notes on Dipterocarps, II. The seedling and the seed production in some species of *Shorea*.

J. Str. Br. R. As. Soc., **76**, 1917: 161-7.

A note upon the way in which bees settle on flowers of *Derris thyrsiflora*, and the injury resulting from their search of honey.

J. Str. Br. R. As. Soc., **77**, 1917: 263-4.

Plethiandra sahepii, a new Melastomaceae from Sarawak, described.

J. Str. Br. R. As. Soc., **77**, 1917: 265-9.

Food-Crops of the Malay Peninsula and some thoughts arising out of a review of them.

Proc. Agr. Conf. Kuala Lumpur, 25-28 April 1917, Kuala Lumpur, 1917: 16 pp.

Reprinted in *Agr. Bull. F.M.S.*, **5**, 1917: 406-21.

A report on races of the Greater or Ten-Months Yam,—*Dioscorea alata*—cultivated in the Botanic Gardens, Singapore.

Gard. Bull. S.S., **1**, 1917: 371-96.

The Lesser Yam,—*Dioscorea esculenta*.

Gard. Bull. S.S., **1**, 1917: 396-9.

Scolia erratica, Smith, a parasite of the Red Coconut Weevil (*Rhynchophorus ferrugineus*).

Gard. Bull. S.S., **1**, 1917: 399–400.

The flowering of the Pigeon Orchid, *Dendrobium crumenatum*, Lindl.

Gard. Bull. S.S., **1**, 1917: 400–5.

Precocious flowering of *Melia*.

Gard. Bull. S.S., **1**, 1917: 405.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1916.

Government Printing Office, Singapore, 1917, 8 pp.

1918

The circumstances attending the murder in 1859 of the botanist James Motley.

J. Str. Br. R. As. Soc., **79**, 1918: 37–38.

Notes on Dipterocarps, III. The seedling of *Shorea robusta*, Roxb., and the conditions under which it grows in pure forests.

J. Str. Br. R. As. Soc., **79**, 1918: 39–44.

A new *Dendrobium*, *D. gracilipes*, from the Rhio Archipelago.

J. Str. Br. R. As. Soc., **79**, 1918: 45–46.

Begonia haniffii, a small tuberous species of the Islands of Langkawi.

J. Str. Br. R. As. Soc., **79**, 1918: 103–4.

Catochrysops pandara, a butterfly destructive to cycads.

Gard. Bull. S.S., **2**, 1918: 1–2.

Promecotheca cumingii Baly, another coconut hispid and a pest in Malacca.

Gard. Bull. S.S., **2**, 1918: 3–5.

A beetle which attacks yams.

Gard. Bull. S.S., **2**, 1918: 6.

A report upon the experimental cultivation of the Greater Yam—*Dioscorea alata*—in 1917.

Gard. Bull. S.S., **2**, 1918: 37–44.

Orchid Notes.

Gard. Bull. S.S., **2**, 1918: 44–51.

Propagation of *Hevea* from stakes.

Gard. Bull. S.S., **2**, 1918: 54.

The establishment of the Botanic Gardens, Singapore.

Gard. Bull. S.S., **2**, 1918: 55–72.

The Rozelle—*Hibiscus sabdariffa*.

Gard. Bull. S.S., **2**, 1918: 73.

Some cultivated yams from Africa, and elsewhere.

Gard. Bull. S.S., **2**, 1918: 86–92.

The second phase in the history of the Botanic Gardens, Singapore.

Gard. Bull. S.S., **2**, 1918: 93–108.

Notes on Cola trees in the Economic Gardens, Singapore.

Gard. Bull. S.S., **2**, 1918: 74–86.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1917.

Government Printing Office, Singapore, 1918: 8 pp.

1919

The Gardens' Hevea tree No. 1844—*H. confusa*, Hemsl.

Gard. Bull. S.S., 2, 1919: 113–15.

A progress report on the cultivation of the Greater Yam, *Dioscorea alata*, in the Botanic Gardens, Singapore.

Gard. Bull. S.S., 2, 1919: 129–35.

It needs want to make people change their food-habits.

Gard. Bull. S.S., 2, 1919: 135–6.

Lightning and Hevea.

Gard. Bull. S.S., 2, 1919: 145.

The composition of a piece of well-drained Singapore secondary jungle thirty years old.

Gard. Bull. S.S., 2, 1919: 145–57.

Twin Nutmeg Seeds.

Gard. Bull. S.S., 2, 1919: 158.

Dioscorea alata, The Greater Yam, Race No. 50.

Gard. Bull. S.S., 2, 1919: 158.

Dioscorea kegeliana, Griseb., the "Yam Poule" of the West Indies.

Gard. Bull. S.S., 2, 1919: 158.

Yields of the Lesser Yam and of some african yams.

Gard. Bull. S.S., 2, 1919: 159–65.

Some notes on the pollination of flowers in the Botanic Gardens, Singapore, and in other parts of the Malay Peninsula.

Gard. Bull. S.S., 2, 1919: 165–76.

The genus *Gordonia* in the Philippine Islands.

Philip J. Sci., 15, 1919: 475–8.

Dioscorea sativa.

Kew Bull., 1919: 339–75. (D. Prain and I.H.B.)

Annual Report of the Director of Gardens, Straits Settlements, for the year 1918.

Government Printing Office, Singapore, 1919, 7 pp.

1920

Notes on Dipterocarps, IV. On the embryo, seedling and position of the flower in various species.

J. Str. Br. R. As. Soc., 81, 1920: 49–76.

Notes on Dipterocarps, V. The embryo and seedling of *Balanocarpus maximus*, King.

J. Str. Br. R. As. Soc. 81, 1920: 3–4.

Staking Yams.

Gard. Bull. S.S., 2, 1920: 301–2.

1921

Forests and their retention of rain water.

Gard. Bull. S.S., 2, 1921: 419–21.

[Being mainly a résumé of ENGLER, A.: Untersuchungen über den Einfluss des Waldes auf den Stand der Gewässer; *Mitteil. Schweiz Zentralanst. Forst. Versuchsw.*, 12, 1919: 1–626.]

A note upon plants grown for blue dyes in the north of the Malay Peninsula.

Gard. Bull. S.S., 2, 1921: 426–9.

A melon fly, *Bactrocera cucurbitae*.

Gard. Bull. S.S., **2**, 1921: 432.

The correct botanic names for the White and the Yellow Guinea Yams.

Gard. Bull. S.S., **2**, 1921: 438–41.

Hibiscus sabdariffa var. *altissima*.

Gard. Bull. S.S., **2**, 1921: 441.

Orchid Notes.

Gard. Bull. S.S., **2**, 1921: 441–4.

The present state of our knowledge of the vegetation of Malaya.

Sing. Naturalist: **1**, 1921: 23–24.

[Being a précis of a paper read to the Singapore Natural History Society at the Society's inaugural meeting on 8th August 1921.]

Odoardo Beccari.

J. Str. Br. R. As. Soc., **83**, 1921: 166–73.

(I.H.B. and J. C. Moulton.)

Annual Report of the Director of Gardens, Straits Settlements for the year 1919.

Government Printing Office, Singapore, 1921, 5 pp.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1920.

Government Printing Office, Singapore, 1921, 6 pp.

1922

The irregularity of a spider's feeding.

J. Str. Br. R. As. Soc., **86**, 1922: 270.

Notes on Dipterocarps, VI. On the genus *Pachynocarpus*.

J. Str. Br. R. As. Soc., **86**, 1922: 271–80

(I.H.B. and F. W. Foxworthy.)

Notes on Dipterocarps, VII. On the fruit and germination of *Isoptera borneensis*.

J. Str. Br. R. As. Soc., **86**, 1922: 281–4.

Notes on Dipterocarps, VIII. On some large-fruited species and in particular upon the effects of the pressure of the embryo against the interior of the fruit wall.

J. Str. Br. R. As. Soc., **86**, 1922: 285–91.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1921.

Government Printing Office, Singapore, 1922, 5 pp.

1923

The fertility of branched coconut palms.

Gard. Bull. S.S., **3**, 1923: 1–2.

Branching in *Arenga pinnata*.

Gard. Bull. S.S., **3**, 1923: 2.

A spiny yam from Sumatra.

Gard. Bull. S.S., **3**, 1923: 3–4.

Tahitian Yams.

Gard. Bull. S.S., **3**, 1923: 4–5.

Yams at the Malaya-Borneo Exhibition.

Gard. Bull. S.S., **3**, 1923: 5–8.

The as-yet botanically unexplored parts of the Malay Peninsula.

Gard. Bull. S.S., **3**, 1923: 8–10.

Orchid notes.

Gard. Bull. S.S., **3**, 1923: 12–18.

Haplochorema sumatranum.

Gard. Bull. S.S., **3**, 1923: 18–19.

A record of the occurrence of some ferns in northern Sumatra, being additions to Mr. Ridley's list.

J. Mal. Br. R. As. Soc., **1**, 1923: 114–15.

Notes on Dipterocarps, IX. On the differences in the seedlings between *Balanocarpus maximus*, King, and *B. heimii*, King.

J. Mal. Br. R. As. Soc., **1**, 1923: 218–22.

A botanical reconnaissance upon the main range of the Peninsula at Fraser's Hill.

Gard. Bull. S.S., **3**, 1923: 19–110.

(I.H.B. and R. E. Hottum).

The historical aspect of certain local industries.

Sing. Naturalist, **2**, 1923: 34–44.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1922.

Government Printing Office, Singapore, 1923, 6 pp.

1924

A list of oriental vernacular names of the genus *Dioscorea*.

Gard. Bull. S.S., **3**, 1924: 121–244.

Two hybrid trees of *Hevea brasiliensis* x *H. confusa*.

Gard. Bull. S.S., **3**, 1924: 257–8.

Varieties of *Dioscorea pentaphylla* in Malaysia.

Gard. Bull. S.S., **3**, 1924: 258–9.

A Chinese belief regarding *Phyllocactus hookeri*, Walp.

Gard. Bull. S.S., **3**, 1924: 280.

Cleome chelidonii, Linn. f., in the Malay Peninsula.

Gard. Bull. S.S., **3**, 1924: 280–1.

Stenomeris in the Malay Peninsula.

Gard. Bull. S.S., **3**, 1924: 289–90.

The floras of the Malay Peninsula, Borneo and the Philippine Islands.

Gard. Bull. S.S., **3**, 1924: 283–9.

Orchid notes.

Gard. Bull. S.S., **3**, 1924: 292–6.

Dioscorea piscatorum, or Tuba-ubi, a fish poison.

Gard. Bull. S.S., **3**, 1924: 260. (I.H.B. and R. E. Hottum.)

The Botany of the Abor Expedition.

Rec. Bot. Surv. Ind., **10**: 1924: 1–154; 1925: 155–420, Pt. I–X.

Annual Report of the Director of Gardens, Straits Settlements, for the year 1923.

Government Printing Office, Singapore, 1924: 5 pp.

1925

- Notes on Dipterocarps, X. On *Balanocarpus hemsleyanus*, King.
J. Mal. Br. R. As. Soc., **3**, 1925: 4–9.
- Solanum macrocarpum*.
Kew Bull., **1925**: 333–41.
- The Botanic Gardens, Singapore.
J. Kew Guild, **4**, 1925: 313–8.
- Insect vision in connection with flower fertilisation.
Sing. Naturalist, **5**, 1925: 23–46.
- The possibility of adding new species to the known flora of the Malay Peninsula.
Sing. Naturalist, **5**, 1925: 57–61.
 (I.H.B. and R. E. Holttum.)
- The flowering plants of Taiping in the Malay Peninsula.
Gard. Bull. S.S., **3**, 1925: 303–458.
 (I.H.B. and M. R. Henderson.)
- Diagnoses specierum novarum generis Dioscoreae.
Kew Bull., **1925**: 58–66. (D. Prain and I.H.B.)
- Annual Report of the Director of Gardens, Straits Settlements, for the year 1924.
 Government Printing Office, Singapore, 1925, 6 pp.

1926

- The Botanic Gardens, Singapore. Illustrated Guide.
 Waterlow & Sons, London, 1926, 67 pp.
- Island occurrence of *Ipomoea pes-caprae*.
Kew Bull., **1926**: 425–6.
- Ad Dioscorearum orientalium historiam commentarii.
Kew Bull., **1926**: 118–20. (D. Prain and I.H.B.)
- Vegetation on lava surfaces of various ages in the crater of Kilauea, Hawaii.
Proc. Linn. Soc. Lond., **138**, 1926: 53–54.

1927

- A note relating to the history of The Dell in the Gardens.
Gard. Bull. S.S., **4**, 1927: 69–77.
- Tulang Daing or Sisek Puyuh, *Carallia suffruticosa*.
Gard. Bull. S.S., **4**, 1927: 77–78.
- Botanical collectors, collections and collecting places in the Malay Peninsula.
Gard. Bull. S.S., **4**, 1927: 113–202.
- Dioscorea tamarisciflora*, Pr. and Burk.
Gard. Bull. S.S., **4**, 1927: 86–88. (D. Prain and I.H.B.)
- The genus *Dioscorea* in Siam.
Kew Bull., **1927**: 225–47. (D. Prain and I.H.B.)
- Insect vision.
London Naturalist for 1926, 1927: 3–6.

1928

The main features of the vegetation of Pahang.

Malayan Naturalist, **2**, 1928: 11–21.

1929

Anisophyllea gaudichaudiana, Baill., is *A. grandis*, Benth.

Gard. Bull. S.S., **4**, 1929: 426.

1930

The chinese mustards in the Malay Peninsula.

Gard. Bull. S.S., **5**, 1930: 99–117.

Cosmos in the East.

Gard. Bull. S.S., **5**, 1930: 118–20.

Cedrela in the Malay Peninsula.

Gard. Bull. S.S., **5**, 1930: 120–2.

Blainvillea, Cass.

Gard. Bull. S.S. **5**, 1930: 123.

Cricket fighting.

J. Siam Soc. Nat. Hist. Suppl., **8**, 1930: 119–20.

Cardamoms.

Kew Bull., **1930**: 32–37.

Malay Village Medicine.

Gard. Bull. S.S., **6**, 1930: 165–321. [Reprinted 1960.]

(I.H.B. and Mohamed Haniff.)

“The medical book of Malayan Medicine”. Translated by Inche Ismail, Munshi, possibly in Penang, circa 1886. Edited with medical notes and determinations.

Gard. Bull. S.S., **6**, 1930: 323–474. [Reprinted 1960.]

(J. G. Gimlette and I.H.B.)

On *Dioscorea gibbiflora*, Hook. fil.

Gard. Bull. S.S., **5**, 1930: 51–57.

(D. Prain and I.H.B.)

1931

An enumeration of the species of *Paramignya*, *Atalantia* and *Citrus* found in Malaya.

Gard. Bull. S.S., **5**, 1931: 212–23.

Notes on Gluta in Malaya.

Gard. Bull. S.S., **5**, 1931: 224–30.

Herpestis monniera, H.B. and K., as pa-chi-t'ien.

Gard. Bull. S.S., **5**, 1931: 231.

Erythropsis colorata.

Gard. Bull. S.S., **5**, 1931: 231.

Sir George Watt. [Obituary]

Proc. Linn. Soc. Lond. Sess. **142 (1929-30)**, 1931: 226–9.

Dioscorea: Section *Stenocorea*.

Kew Bull., **1931**: 88–91. (D. Prain and I.H.B.)

Dioscoreae novae asiaticae.

Kew Bull., **1931**: 425–7. (D. Prain and I.H.B.)

1932

Edward Arthur FitzGerald. [Obituary]

Proc. Linn. Soc. Lond. Sess. 143 (1930-31), 1932: 176.An experiment upon the polarity of the tuber of *Tamus communis* Linn.*Proc. Linn. Soc. Lond., Sess. 144 (1931-32)*, 1932: Pt. III; 60–62.

1933

Dioscoreae novae asiaticae.

Kew Bull., 1933: 240–6. (D. Prain and I.H.B.)

1934

Dioscoréacées.

In LECOMTE, H., and H. HUMBERT, *Flora générale de l'Indo-Chine*, Paris, 6, 1934: 698–745.

(D. Prain and I.H.B.)

1935

Some changes in plant names.

Kew Bull., 1935: 316–19.

A dictionary of the economic products of the Malay Peninsula.

O.U.P., 1935, 2 vol., 2402 pp.

[Second edition in press, Kuala Lumpur, 1966.]

The bracteole in *Scilla nutans*, Sm., and extra organs in the flower.*J. Bot.*, 73, 1935: 280–6.

1936

The phyllotaxy of *Dioscorea glauca*, Muhl.*J. Bot.*, 74, 1936: 89–101.The phyllotaxy of *Tamus communis*, L.*J. Bot.*, 74, 1936: 153–63.*Dioscorea garrettii*, Pr. and Burk.: *D. hainanensis*, Pr. and Burk.: and *D. scortechinii*, Pr. and Burk., var. *parviflora*.*Kew Bull.*, 1936: 493–5. (D. Prain and I.H.B.)An account of the genus *Dioscorea* in the East, I. The species which twine to the left.*Ann. R. Bot. Gard. Calc.*, 14, 1936: 1–210, pl. 1–85.

(D. Prain and I.H.B.)

1937

The Races of Sorghum.

Kew Bull., 1937: 112–19.[Being a review and phytogeographic analysis of SNOWDEN, J.D.: *The Cultivated Races of Sorghum*. London, 1936.]The life-cycle of *Tamus communis* L.*J. Bot.*, 75, 1937: 1–12, 33–43, 65–74,*Phil. Soc.*, 9, 1896: 91–98.

Cedric Erroll Carr. [Obituary]

J. Bot., 75, 1937: 143–4.The development of the tuber of *Dioscorea sansibarensis* Pax.*Blumea*, Suppl. 1, 1937: 232–7.

1938

'Illustrated guide to the Trees and Flowers of England and Wales' by
H. G. Jameson. [Review]

J. Bot., **76**, 1938: 59.

Alfred Barton Rendle. [Obituary]

J. Bot., **76**, 1938: 65-68.

'Lebensgeschichte der Blütenpflanzen Mitteleuropas', vol. 2 (1).
[Review]

J. Bot., **76**, 1938: 87-88.

The vision of certain small Ophrys-visiting bees.

J. Bot., **76**, 1938: 150-1.

Stephen Troyte Dunn. [Obituary]

J. Bot., **76**, 1938: 183-4.

An account of the genus *Dioscorea* in the East, II. The species which
twine to the right; with addenda to Part I, and a summary.

Ann. R. Bot. Gard. Calc., **14**, 1938: 211-528, pl. 86-150, Index i-xx.
[Title page dated 1939.]

(D. Prain and I.H.B.)

The contact of the Portuguese with African food-plants which gave words
such as 'yam' to European languages.

Proc. Linn. Soc. Lond., **Sess. 150 (1937-38)**, 1938; pt. II: 84-95, 2 maps.

1939

The trigger mechanism in the germination of the seed of *Tamus communis*,
L.

J. Bot., **77**, 1939: 44-50.

Growth and tensions between the nerves in the leaf-blade of *Tamus*
communis, L.

J. Bot., **77**, 1939: 325-33.

Notes on the genus *Dioscorea* in the Belgian Congo.

Bull. Jard. Bot. Etat, **15**, 1939: 345-92.

Two notes on *Dioscoreas* in the Congo: (1) the acarodomatia of *D.*
minutiflora, Engl., and *D. smilacifolia*, de Wild., and (2) twining in both
directions in *D. baya*, de Wild.

Proc. Linn. Soc. Lond., **151 Sess. (1938-39)**, 1939: 57-61.

1940

The distribution of raphides in the leaves of *Tamus communis*, Linn.

J. Bot., **78**, 1940: 17-19.

Slight zygomorphy in *Dioscorea sylvatica* Ecklon.

J. Bot., **78**, 1940: 100-1.

Empis pennipes, Linn., on the flowers of *Geranium robertianum*.

J. Bot., **78**, 1940: 175-6.

Varthema's Corcopal, at one time said to be papaya, was the fruit of
Garcinia indica.

Proc. Linn. Soc. Lond., **152 Sess. (1939-40)**, 1940: 147-9.

1941

Duarte Barbosa's references to trade at Malacca in Cutch, Costus and Aleppa Galls.

J. Mal. Br. R. As. Soc., **19**, 1941: 120–1.

The make-up of the flower of *Ranunculus arvensis*, Linn.,—a study in the evolution of isomerism in phanerogamous flowers.

Proc. Linn. Soc. Lond., **153 Sess. (1940-41)**, 1941: 161–214.

An ontogenetic analysis of *Ranunculus arvensis*, Linn.

J. Bot., **79**, 1941: 121–31.

1942

The terrestrial vegetative buds of *Dioscorea alata*, Linn.

Ann. Bot. Gard. Calc., **150th Anniversary Volume**, 1942: 109–14.

1943

The biogeographic division of the Indo-Australian Archipelago. A history of the divisions which have been proposed.

Proc. Linn. Soc. Lond., **154 Sess. (1941-42)**, 1943: 127–38.

A leaf of *Tamus communis*, Linn. with two petioles as a result of an early injury.

Proc. Linn. Soc. Lond., **155 Sess. (1942-43)**, 1943: 31–34.

1944

Biological Flora of the British Isles. *Tamus*.

J. Bot., **32**, 1944: 121–9.

The way in which the leaves of *Tamus communis* and *Dioscoreas* attain their light-fixed position.

Proc. Linn. Soc. Lond., **155 Sess. (1942-43)**, 1944: 252–77.

The early economic history of the tree, *Mesua ferrea* (Guttiferae).

Proc. Linn. Soc. Lond., **156 Sess. (1943-44)**, 1944: 85–91.

David Prain, 1857–1944. [Obituary]

Obit. Not. Fellows R. Soc. **4**, 1944: 747–70.

1946

Abnormal gamopetalous flowers of the poppy, *Romneya coulteri*, and the way in which its sepals protect the sexual organs.

Proc. Linn. Soc. Lond., **157 Sess. (1944-45)**, 1946: 92–93.

Flies of the family Empididae and other insect-visitors to the flowers of *Tamus communis*.

Proc. Linn. Soc. Lond., **157 Sess. (1944-45)**, 1946: 92–102.

On the dispersal of the plants most intimate to Buddhism.

J. Arn. Arb., **27**, 1946: 327–39.

[This volume is dedicated to Elmer Drew Merrill on the occasion of his 70th birthday, 15th October, 1946.]

1947

A plea for the description from life of the african *Dioscorea minutiflora*, Engl.

Proc. Linn. Soc. Lond., **159 Sess. (1946-47)**, 1947: 77–81.

1949

William Farquhar's drawings of Malacca plants.

Gard. Bull. Sing., **12**, 1949: 404-7.

The ontogeny of the stem of the Common Bryony, *Tamus communis*, Linn.

J. Linn. Soc. Lond., **53**, 1949: 313-82.

An interruption in the after ripening of *Tamus* which alters the range of temperature controlling germination.

Proc. Linn. Soc. Lond., **1961 Sess. (1948-49)**, 1949; 151-5.

James Hornell. [Obituary]

Proc. Linn. Soc. Lond., **161 Sess. (1948-49)**, 1949: 244-7.

1950

A new *Dioscorea* from Celebes.

Kew Bull., **1950**: 259-60.

Dioscoréacées.

In HUMBERT: *Flore de Madagascar*, fam. 44: 1-78, 14 fig.

(I.H.B. and H. Perrier de la Bâthie.)

1951

Dioscoreaceae.

In VAN STEENIS, C.G.G.J.: *Flora Malesiana*, I, **4**, 1951: 293-335.

The rise and decline of the Greater Yam in the service of man.

The Advancement of Science, **7 (28)**, 1951: 443-8. [Being the substance of a paper read to Section H (Anthropology and Archeology) of the meeting of the British Association for the Advancement of Science held at Birmingham, September 1950.]

New units in the taxonomy of the madagascan Dioscoreaceae.

Mus. Natl. Hist. Nat. Not. Syst., **14**, 1951: 131-7.

(I.H.B. and H. Perrier de la Bâthie.)

1952

Testudinaria as a section of the genus *Dioscorea*.

J. S. Afr. Bot., **18**, 1952: 177-91.

Mr. Cecil Ernest Claude Fisher, 1873-1950. [Obituary]

Ind. For. **78**, 1952: 50.

1953

Vegetables eaten with rice.

Gard. Bull. Sing., **14**, 1953: 17-29.

Habits of man and the origins of the cultivated plants of the Old World.

Proc. Linn. Soc. Lond., **164, Sess. 1951-52**, 1953: 12-42.

[Hooker Lecture—Linnean Society of London, 1951.]

Chapters on the history of botany in India.

I. From the beginning to the middle of Wallich's service.

J. Bomb. Nat. Hist. Soc., **51**, 1953: 846-78.

Pepper, Nutmegs and Rubber, I.

Malaya, October 1953: 587-9.

Pepper, Nutmegs and Rubber, II.

Malaya, November 1953: 647-50.

1954

Aji and Batata as group names within the species *Ipomoea batatas*.
Ceiba, **4**, 1954: 227–40.

1955

William Farquhar's second book of drawings of Malacca plants.
Gard. Bull. Sing., **14**, 1955: 530–3.

1956

Chapters on the history of botany in India.
II. The advances, and in particular the plant collecting, of the Thirties
and Forties of the 19th century.
J. Bomb. Nat. Soc., **54**, 1956: 42–86.

Prof. E. D. Merrill. [Obituary]
Nature, **177**, April 14, 1956: 687–8.

1957

Elmer Drew Merrill. [Obituary]
Proc. Linn. Soc. Lond., **168 Sess. (1955–56)**, 1957: 51–56.
Elmer Drew Merrill, M.S., Hon. D. Sc., Hon. Ll. D., Hon. F.R.S.E.
[Obituary]
Year Book R. Soc. Edin. **1955–56**, 35–37.

1958

Inhibition of germination of the white mustard by bryony juice.
Proc. Linn. Soc. Lond., **169 Sess. (1956–57)**, 1958: 62–63.
The relics and offerings from a bronze bust of Tsong-Kha-Pa, founder
of the Lamaist Sect of the Yellow Hats.
J. Mal. Br. R. As. Soc., **31**, 1958: 175–6. [Issued July 1965.]
Henry Nicholas Ridley. [Obituary]
Proc. Linn. Soc. Lond., **169 Sess. (1956–57)**, 1958: 35–38.
John Christopher Willis. [Obituary]
Proc. Linn. Soc. Lond., **169 Sess. (1956–57)**, 1958: 245–50.

1959

A note on the Gardens Jungle.
Gard. Bull. Sing. **17 (2)**, 1959: 171.
[An issue to mark the centenary of the establishment of the Singapore
Botanic Gardens.]

1960

Organograph and evolution of Dioscoreaceae, the family of the Yams.
J. Linn. Soc. Lond. Bot., **56**, 1960: 319–412.

1961

Chapters on the history of botany in India.
III. At the middle of the 19th century.
J. Bomb. Nat. Hist. Soc., **58**, 1961: 678–706.

1962

Chapters on the history of botany in India.

IV. The Royal Gardens at Kew begin to guide the direction of botany in India.

J. Bomb. Nat., Hist. Soc., **59**. 1962: 335-59.

Chapters on the history of botany in India.

V. The undertaking of two great enterprises, The Flora of the Higher Plants, and the Forest Service.

J. Bomb. Nat. Hist. Soc., **59**. 1962: 747-77.

1963

Chapters on the history of botany in India.

VI. The publication of Hooker's Flora of British India, and what its publication released.

J. Bomb. Nat. Hist. Soc., **60**. 1963: 49-83.

Chapters on the history of botany in India.

VII. Epilogue.

J. Bomb. Nat. Hist. Soc., **60**. 1963: 356-70.

[The seven chapters of this work are reprinted in book form by the Botanical Survey of India, and published by the Government of India Press. There is an introduction by Father H. Santapau, Director of the Botanical Survey of India, and Chapter VII was rewritten by the author for the book. Pp. XI + 245, maps 2, pl. 4; 25 April 1966.]

II. BURKILLIAN TAXA

ACANTHACEAE

Fromendoncia floribunda Burkill, *sp. nov. in Thiselton-Dyer: Fl. Trop. Afr.* **5** (1899): 6.

Brillantaisia debilis Burkill, *sp. nov., l.c.*: 39.

leonensis Burkill, *sp. nov., l.c.*: 41.

nyanzarum Burkill, *sp. nov., l.c.*: 39.

subulugurica Burkill, *sp. nov., l.c.*: 42.

Eranthemum huegelii Burkill, *sp. nov., Proc. Camb. Phil. Soc.* **9**, **II** (1896): 96.

Hygropila acutisepala Burkill, *sp. nov., in Thiselton-Dyer: Fl. Trop. Afr.* **5**. (1899): 34.

ciliata Burkill, *sp. nov., l.c.*: 35.

gigas Burkill, *sp. nov., l.c.*: 36.

gracillima Burkill, *sp. nov., l.c.*: 36.

lindaviana Burkill, *sp. nov., l.c.*: 509.

linearis Burkill, *sp. nov., l.c.*: 35.

pilosa Burkill, *sp. nov., l.c.*: 35.

Thunbergia crispa Burkill, *sp. nov., l.c.*: 12.

hanningtonii Burkill, *sp. nov., l.c.*: 19.

laborans Burkill, *sp. nov., l.c.*: 507.

lathyroides Burkill, *sp. nov., l.c.*: 24.

mellinocaulis Burkill, *sp. nov., l.c.*: 23.

sericea Burkill, *sp. nov., l.c.*: 14.

stellarioides Burkill, *sp. nov., l.c.*: 26.

Synnema brevitybum Burkill, *sp. nov., l.c.*: 30.

ACTINIDIACEAE

Suarauja rufa Burkill, *sp. nov. in Kew Bull.* 1899: 97.

AMPELIDACEAE

Vitis simplex (Blanco) Burkill, *comb. nov. in Kew Bull.* 1935. 319.
(= *Cissus simplex*.)

ANNONACEAE

Fissistigma kingii (Boerl.) Burkill, *comb. nov. in Kew Bull.* 1935: 317.
(= *Melodorum kingii*.)

APOCYNACEAE

Alyxia kurzii Burkill, *nom. nov. in Kew Bull.* 1935. 317. (= *Gynopogon breviflorus* Kurz.)

Ervatamia dichotoma (Roxb.) Burkill, *comb. nov. in Kew Bull.* 1935, 317.
(= *Tabernaemontana dichotoma*.)

divaricata (Linn.) Burkill, *comb. nov. in Rec. Bot. Surv. India* 10
(1925): 320. (= *Nerium divaricatum*.)

sphaerocarpa (Blume) Burkill, *comb. nov. in Kew Bull.* 1935, 317.
= *Tabernaemontana sphaerocarpa*.)

ARACEAE

Arisaema listeri Prain ex Burkill, *sp. nov. in Rec. Bot. Surv. India* 10,
(1925): 397.

Aralia quinquefolia Dec'ne and Planch var. *angustifolia* Burkill, *var. nov. in Kew Bull.*, 1902: 7.

var. *elegantior* Burkill, *var. nov., l.c.*: 8.

var. *major* Burkill, *var. nov., l.c.*: 7.

var. *notoginseng* Burkill, *var. nov., l.c.*: 7.

var. *pseudo-ginseng* Burkill, *var. nov. l.c.*: 7.

var. *repens* Burkill, *var. nov., l.c.*: 6.

ASCLEPIADACEAE

Hoya subcalva Burkill, *sp. nov. in Kew Bull.* 1901: 141.

BEGONIACEAE

Begonia foxworthyi Burkill ex Ridley, *sp. nov. in Fl. Mal. Penins.* 5
(1925): 311.

haniffii Burkill, *sp. nov. in J. Str. Br. Roy. As. Soc.* 79 (1918): 103–4.

tampinica Burkill ex Irmsch. *sp. nov. in Mitt. Inst. Bot. Hamburg* 8
(1929): 130.

BETULACEAE

Alnus cremastogyne Burkill, *sp. nov. in J. Linn. Soc. Lond. Bot.* 26
(1899): 499.

maritima Nutt., var. *formosana* Burkill, *var. nov., l.c.*: 500.

Betula albo-sinensis Burkill, *sp. nov., l.c.*: 497.

utilis D. Don, var. *prattii* Burkill, *var. nov., l.c.*: 499.

Carpinus laxiflora Blume, var. *fargesii* Burkill, *var. nov., l.c.* 501.
pubescens Burkill, *sp. nov., l.c.*: 502.

Corylus heterophylla Fisch., var. *crista-galli* Burkill, *var. nov., l.c.*: 504.

BOMBACACEAE

- Ceiba occidentalis* (Sprengel) Burkill, *comb. nov. in Kew Bull.*, 1935: 317.
(= *Bombax occidentale*.)

BROMELIACEAE

- Karatas serra* (Grisebach) Burkill, *comb. nov. in Kew Bull.* 1935: 317.
(= *Bromelia serra*.)

BURSERACEAE

- Garuga pacifica* Burkill, *sp. nov. in J. Linn. Soc. Lond. Bot.* 35 (1901): 30-31.

COMPOSITAE

- Acomis lesteri* Burkill, *sp. nov. in Kew Bull.* 1901, 140.
Chrysanthemum umbelliferarum (Boissier) Burkill, *comb. nov. in Kew Bull.* 1935: 317. (= *Tanacetum umbelliferum*.)
Launaea crassiniana (Boiss.) Burkill, *comb. nov. in Fl. Pl. Baluchistan* 44; 1909. (= *Zollikofera crassiniana*.)
polyclada (Boiss.) Burkill, *comb. nov., l.c.*, 44. (= *Z. polyclada*.)
stenocephala (Boiss.) Burkill, *comb. nov., l.c.*, 44. (= *Z. stenocephala*.)
stocksiana (Boiss.) Burkill, *comb. nov., l.c.*, 44. (= *Z. stocksiana*.)
Icomum lineare Burkill, *sp. nov. in J. Linn. Soc. Lond. Bot.* 34, (1899) 270.
salicifolium Burkill, *sp. nov., l.c.*: 270.
subacaule Burkill, *sp. nov., l.c.*: 271.

CRUCIFERAE

- Anguillicarpus* Burkill, *gen. nov. in J. As. Soc. Bengal n.s.* 3, (1907) 59.
bulleri Burkill, *sp. nov. l.c.*: 60.

CONVOLVULACEAE

- Merremia petaloidea* (Choisy) Burkill, *comb. nov. in Kew Bull.* 1935, 318.
(= *Ipomoea petaloidea*.)

DIOSCOREACEAE

- Sec. Campanuliflorae* Burkill & Perrier, *sec. nov. in Mus. Natl. Hist. Nat. Notulae Syst.* 14 (1951): 132-7.
Sec. Illigerastrum Prain & Burkill, *sec. nov. in Kew Bull.* 1933: 241.
Sec. Pachycapsa Burkill & Perrier, *sec. nov. in Mus. Natl. Hist. Notulae Syst.* 14 (1951): 132-7.
Sec. Paramecocarpa Burkill, *sec. nov. in Gard. Bull. S.S.*, 3 (1924): 123—
(name); Prain and Burkill in *Ann. R. Bot. Gard. Calc.*, 14 (1936): 93-94
— (description).
Sec. Seriflorae Burkill & Perrier, *sec. nov. in Mus. Natl. Hist. Nat. Notulae Syst.* 14 (1951): 132-7.
Sec. Shannicorea Prain & Burkill, *sec. nov. in J. As. Soc. Bengal n.s.*, 10 (1914): 10, and *Ann. R. Bot. Gard. Calc.*, 14 (1936): 100.
Sec. Xylinocapsa Burkill & Perrier, *sec. nov. in Mus. Natl. Hist. Nat. Notulae Syst.*, 14 (1951): 132-7.

- Dioscorea acerifolia* Diels ex Prain & Burkill, sp. nov. in *J. As. Soc. Bengal* **73** (Suppl.) (1905): 7.
- aculeata* Linn. var. *fasciculata* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, n.s. **10** (1914): 20.
var. *spinosa* Prain & Burkill, var. nov. l.c. **10**: (1914) 20.
var. *tillaefolia* (Kunth) Prain & Burkill, comb. nov. in *Elmer: Leaflets Philipp. Bot.* **5** (1913): 1594, and *J. As. Soc. Bengal*, n.s. **10** (1914): 20.
- alata* Linn. var. *tarri* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, n.s. **10** (1914): 39.
- alatypes* Burkill & Perrier, sp. nov. in *Humbert: Fl. Madag. Fam.* **44** (1950): 50 — (name); Burkill & Perrier in *Not. Syst.* **14** (1951): 136 — (description).
- arachnida* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **10** (1914): 21.
- asclepiada* Prain & Burkill, sp. nov. in *Kew Bull.* **1916**: 190.
- aspera* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **4** (1908): 447.
- asteriscus* Burkill, sp. nov. in *Bull. Jard. Bot. Brux.*, **15** (1939): 356–7.
- bancana* Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 62.
- belophylloides* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s. **4** (1908): 448.
- benthamii* Prain & Burkill, sp. nov. in l.c., **4** (1908): 448–9.
- bernoulliana* Prain & Burkill, sp. nov. in *Kew Bull.* **1916**: 192.
- bicolor* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **4** (1908): 449.
- birmanica* Prain & Burkill, sp. nov. in l.c., **73** (1904): 185.
- biserialis* Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 58–59.
- blumei* Prain & Burkill, sp. nov., in *J. As. Soc. Bengal*, n.s., **10** (1914): 25.
- bonatiana* Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 61.
- bonii* Prain & Burkill, sp. nov., l.c., **1933**: 244–5.
- brandisii* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **10** (1914): 27.
- brevipetiolata* Prain & Burkill ex Craib, sp. nov. in *Kew Bull.* **1912**: 407 — (name); Prain & Burkill in *J. As. Soc. Bengal*, n.s., **10** (1914): 38 — (description).
- bulbifera* Linn., var. *birmanica* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, n.s., **10**: (1914): 26.
var. *deltoidea* Prain & Burkill, var. nov. l.c.: 26.
var. *elongata* Prain & Burkill, var. nov. l.c.: 26.
var. *cacheo* Prain & Burkill, var. nov. l.c.: 26.
var. *sativa* Prain & Burkill, var. nov. l.c.: 26.
var. *simbha* Prain & Burkill, var. nov. l.c.: 26.
var. *suavior* Prain & Burkill, var. nov. l.c.: 26.
- bullata* Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 60.
- calcicola* Prain & Burkill, sp. nov., l.c.: 64.
- cambodiana* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **10** (1914): 12.
- carionis* Prain & Burkill, sp. nov. in *Kew Bull.* **1916**: 193–4.
- chingii* Prain & Burkill, sp. nov., l.c. **1931**: 425.
- clarkei* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **10** (1914): 16.
- collinsae* Prain & Burkill, sp. nov. in *Kew Bull.* **1927**: 234.
- craibiana* Prain & Burkill, sp. nov. l.c., **1931**: 425–6.
- cumingii* Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, n.s., **4** (1908): 449–50.

Dioscorea, cont.

- daunaea* Prain & Burkill, sp. nov., l.c.: 450.
depauperata Prain & Burkill, sp. nov. in *Kew Bull.* **1933**: 245-6.
dissimulans Prain & Burkill, sp. nov. l.c.: 241-2.
elegans Ridley ex Prain & Burkill, nom. nov.: l.c.: **1925**: 65
 (= *P. papuana* Ridley.)
elmeri Prain & Burkill, sp. nov. in *Elmer: Leaflets Philipp. Bot.* **5**
 (1913): 1594.
 var. *dubia* Prain & Burkill, var. nov. l.c. 1594, *J. As. Soc. Bengal,*
n.s., 10: (1914): 24.
enneaneura Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s., 73*
Suppl. (1904): 11.
esculenta (Lour.) Burkill, comb. nov. in *Gard. Bull. S.S.* **1** (1917) 396.
 (= *Oncus esculentus*.)
esquirolii Prain & Burkill, sp. nov. in *Kew Bull.* **1931**, 426.
filicaulis Prain & Burkill, sp. nov., l.c. **1932**: 242-3.
filiformis Prain & Burkill, ex Koorders-Schumacher, nom. nov. in
syst. Verzeichn. d. Herbar Koorders **3** (1914): 20. (= *D. myriantha*
 Kunth.)
flabellifolia Prain & Burkill, sp. nov. in *Elmer: Leaflets Philipp. Bot.*
5 (1913): 1593.
fordii Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s., 4*
 (1908): 450-1.
foxworthyi Prain & Burkill, sp. nov. in *Leaflets Philipp. Bot., 5*
 (1913): 1591 — (name); *J. As. Soc. Bengal, n.s., 10* (1914): 34.
garrettii Prain & Burkill, sp. nov. in *Kew Bull.* **1936**: 493.
gedensis Prain & Burkill, sp. nov., l.c., **1925**: 64.
glabra Roxb., var. *grisea* Prain & Burkill, var. nov. in *J. As. Soc.*
Bengal, n.s., 10 (1914): 37.
 var. *hastifolia* Prain & Burkill, var. nov. l.c.: 37.
 var. *longifolia* Prain & Burkill, var. nov. l.c.: 38.
 var. *salicifolia* Prain & Burkill, var. nov. l.c.: 37.
 var. *tenuifolia* Prain & Burkill, var. nov. l.c.: 38.
gracilipes Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 63.
grata Prain & Burkill, sp. nov. in *Leaflets Philipp. Bot., 5* (1913):
 1591 — (name); *J. As. Soc. Bengal, n.s. 10* (1914): 34.
hainanensis Prain & Burkill, sp. nov. in *Kew Bull.* **1936**: 494.
havilandii Prain & Burkill, sp. nov. *J. As. Soc. Bengal, n.s., 10* (1914): 40.
hemicrypta Burkill, sp. nov. in *J. Linn. Soc. Lond. Bot.* **53** (1949): 377 —
 (name); *J. S. Afr. Bot.* **18** (1952): 187-8 — (description).
hemsleyi Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.4*
 (1908): 451-2.
hispida Dennst. var. *mollissima* Prain & Burkill, var. nov. l.c., **10**
 (1914): 25.
 var. *neo-scaphoides* Prain & Burkill, var. nov. in *Kew Bull.* **1927**: 237.
 var. *scaphoides* Prain & Burkill, var. nov. l.c.: 237.
inaequifolia Elmer ex Prain & Burkill, sp. nov. in *Leaflets Philipp.*
Bot., 5 (1913): 1595.
inopinata Prain & Burkill, sp. nov. in *Kew Bull.* **1927**: 245-6.
intempestiva Prain & Burkill, sp. nov. l.c. **1933**: 243-4.
japonica Thunb. var. *tenuiaxon* Prain & Burkill, var. nov. in *J. As.*
Soc. Bengal, n.s., 10 (1914): 28.
kalkapershadii Prain & Burkill, sp. nov. in *J. As. Soc. Bengal,*
n.s., 10 (1914): 24.

Dioscorea, cont.

- kamoonensis Kunth, var. delavayi Prain & Burkill, var. nov. l.c.: 22.
var. fargesii Prain & Burkill, var. nov., l.c.: 21.
var. henryi Prain & Burkill, var. nov., l.c.: 22.
var. straminea Prain & Burkill, var. nov. l.c.: 21.
- keduensis Prain & Burkill sp. nov. in Backer: *Handb. Flora van Java*, 3 (1924): 114 — (name); *Kew Bull.* **1925**: 59 — (description).
- kerrii Prain & Burkill sp. nov. in Craib: *Kew Bull.* **1912**: 407 — (name); *J. As. Soc. Bengal, n.s.*, **10** (1914): 20 — (description).
- kratica Prain & Burkill, sp. nov. in *Kew Bull.* **1927**: 241.
- lamprocaula Prain & Burkill, sp. nov., l.c. **1932**: 245.
- lepcharum Prain & Burkill, sp. nov., in *J. As. Soc. Bengal, n.s.*, **10** (1914): 36–37.
var. bhamoica Prain & Burkill, var. nov. l.c. 37.
- lineari-cordata Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 61–62.
- listeri Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **6** (1908): 452.
- loheri Prain & Burkill sp. nov. in Elmer: *Leaflets Philipp. Bot.*, **5** (1913): 1591 — (name); *J. As. Soc. Bengal, n.s.*, **10** (1914): 33–34 — (description).
- madiunensis Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 63.
- martini Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **10** (1914): 18–19.
- melanophyma Prain & Burkill ex Duthie sp. nov. in Strachey, *Cat. Plants Kumaon*, p. 186, 1906 — (name); *J. As. Soc. Bengal, n.s.*, **4** (1908): 452–3 — (description).
- membranacea Pierre ex Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **10** (1914): 13.
- merrillii Prain & Burkill, sp. nov. *Leaflets Philipp. Bot.* **5** (1913): 1958.
- morsei Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **4** (1908): 454.
- moultonii Prain & Burkill, sp. nov. in *Kew Bull.* **1925**: 62.
- nieuwenhuisii Prain & Burkill, sp. nov. l.c.: 65.
- nitens Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **10** (1914): 18.
- nipponica Makino, var. jamesii Prain & Burkill, var. nov. l.c.: 14.
var. rosthornii Prain & Burkill, var. nov. l.c.: 14.
- nummularia Lamk., var. glauca Prain & Burkill, var. nov. in *Leaflets Philipp. Bot.*, **5** (1913): 1599; *J. As. Soc. Bengal, n.s.*, **10** (1914): 35.
- oenea Prain & Burkill, sp. nov. in *J. As. Soc. Bengal, n.s.*, **10** (1914): 16–17.
- oryzotorum Prain & Burkill, sp. nov. in *Kew Bull.* **1927**: 242–3.
var. angustifolia Prain & Burkill, var. nov. l.c.: 243.
var. latifolia Prain & Burkill, var. nov. l.c.: 243.
var. mediifolia Prain & Burkill, var. nov. l.c.: 243.
- owenii Prain & Burkill, sp. nov., l.c., **1925**: 63–64.
- palatanifolia Prain & Burkill, sp. nov. l.c.: 60.
- palawana Prain & Burkill, sp. nov., l.c.: 59.
- paleata Burkill, sp. nov., in *Bull. Jard. Bot. Brux.*, **15** (1939): 360.
- panthaica Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, **73 Suppl.** (1904): 6.

Dioscorea, cont.

- paradoxa* Prain & Burkill, sp. nov. in *Kew Bull.* **1927**: 246-7.
pentaphylla Linn., var. *cardonii* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 23.
 var. *communis* Prain & Burkill, var. nov., l.c.: 23.
 var. *hortorum* Prain & Burkill, var. nov., l.c.: 23.
 var. *jacquemontii* Prain & Burkill, var. nov., l.c.: 23.
 var. *kussok* Prain & Burkill, var. nov., l.c.: 23.
 var. *linnaei* Prain & Burkill, var. nov., l.c.: 23.
 var. *malaica* Prain & Burkill, var. nov., l.c.: 23.
 var. *rheedei* Prain & Burkill, var. nov., l.c.: 23.
 var. *siamensis* Prain & Burkill, var. nov. in *Kew Bull.* **1927**: 236.
 var. *simplicifolia* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 23.
 var. *suli* Prain & Burkill, var. nov., l.c.: 23.
 var. *thwaitesii* Prain & Burkill, var. nov., l.c.: 23.
peperoides Prain & Burkill, sp. nov. in *Leaflets Philipp. Bot.*, **5** (1913): 1597.
 var. *angulata* Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 28.
 var. *sagittifolia* Prain & Burkill, var. nov. in *Leaflets Philipp. Bot.*, **5** (1913): 1591 — (name); *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 28 — (description).
persimilis Prain & Burkill, sp. nov., *J. As. Soc. Bengal*, **n.s.**, **4** (1908): 454-5.
petelotii Prain & Burkill, sp. nov. in *Kew Bull.* **1933**: 240-1.
pierrei Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 22.
piscatorum Prain & Burkill ex Burkill, sp. nov. in *Gard. Bull. S.S.* **3** (1924): 123 — (name); *Kew Bull.* **1925**: 61.
platanifolia Prain & Burkill, sp. nov., in *Kew Bull.* **1925**: 60.
platycarpa Prain & Burkill, sp. nov. l.c.: 65.
poilanei Prain & Burkill, sp. nov. l.c. **1933**: 240.
porteri Prain & Burkill ex Knuth sp. nov. in *Engl. Pflanzenz.* **IV**, 43: 352, 1924; ex Ridley in *Fl. Mal. Penins.* **4**, 318, 1924.
 var. *andersoni* Prain & Burkill ex Ridley, var. nov. l.c.: 318.
 var. *purpureo-venia* Prain & Burkill ex Ridley var. nov. l.c.: 318.
potanini Prain & Burkill, sp. nov. in *Kew Bull.* **1933**: 243.
praecox Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, **n.s.**, **4** (1908): 455.
prazeri Prain & Burkill, sp. nov. in *J. As. Soc. Bengal*, **73 Suppl.** (1904): 2; l.c., **n.s.**, **10** (1914): 15.
pseudo-nitens Prain & Burkill sp. nov. in *Kew Bull.* **1927**: 231.
pulvera Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 31.
pyrifolia Knuth, var. *diepenhorstii* Prain & Burkill var. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 33.
 var. *ferruginea* Prain & Burkill var. nov. l.c.: 33.
ridleyi Prain & Burkill sp. nov., l.c.: 12-13.
rockii Prain & Burkill sp. nov. in *Kew Bull.* **1927**: 229-30.
rogersii Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, **n.s.**, **10** (1914): 27.
scortechinii Prain & Burkill sp. nov. l.c., **n.s.**, **4** (1908): 455-6.
seemanii Prain & Burkill, nom. nov., l.c.: 34 (= *D. nummularia* Seemann).
seniavinii Prain & Burkill sp. nov. in *Kew Bull.* **1925**: 59.
sexrimata Prain & Burkill, sp. nov. l.c., **1950**: 259-60.
sikkimensis Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, **73 Suppl.** (1904): 3.

Dioscorea, cont.

- simulans Prain & Burkill sp. nov. in *Kew Bull.* 1931: 427.
 sitamiana Prain & Burkill sp. nov. l.c., 1925: 64–65.
 soror Prain & Burkill sp. nov. in *Leaflets Philipp. Bot.*, 5 (1913): 1958–9.
 var. glauca Prain & Burkill var. nov. l.c.: 1591 — (name); *J. As. Soc. Bengal*, n.s., 10 (1914): 34.
 spicata Roth, var. anamallayana Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, n.s., 10 (1914): 29.
 var. parvifolia Prain & Burkill, var. nov. l.c.: 29.
 stemonoides Prain & Burkill sp. nov. in *Kew Bull.* 1927: 244.
 stenomeriflora Prain & Burkill, sp. nov., 10 (1914): 40–41.
 subcalva Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, n.s., 10 (1914): 18.
 sumatrana Prain & Burkill sp. nov. in *Kew Bull.*, 1931: 90–91.
 sylvatica Ecklon var. paniculata (Dummer) Burkill, stat. nov. in *J. S. Afr. Bot.* 18 (1952): 189.
 var. brevipes (Burt-Davy) Burkill, stat. nov. l.c.: 189.
 var. rehmanni (Baker) Burkill, stat. nov. l.c.: 189.
 var. multiflora (Marloth) Burkill, stat. nov. l.c.: 189.
 tamarisciflora Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, n.s., 10 (1914): 22.
 tentaculigera Prain & Burkill, sp. nov. l.c.: 15.
 trimenii Prain & Burkill sp. nov. l.c.: 29.
 trinervia Roxb. ex Prain & Burkill, sp. nov. l.c.: 32–33.
 triphylla Linn., var. daemona Prain & Burkill var. nov. l.c.: 26.
 var. mollissima (Blume) Prain & Burkill, stat. nov. in *Leaflets Philipp. Bot.* 5 (1913): 1596; *J. As. Soc. Bengal*, n.s., 10 (1914): 26.
 var. reticulata Prain & Burkill, var. nov. in *J. As. Soc. Bengal*, n.s., 10 (1914): 26.
 van vuurenii Prain & Burkill sp. nov. in *Kew Bull.* 1925: 63.
 velutipes Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, n.s., 10 (1914): 19.
 vexans Prain & Burkill sp. nov., l.c., n.s., 4 (1908): 446.
 villosa Linn., var. coreana Prain & Burkill, var. nov. l.c., n.s., 10 (1914): 15.
 warburgiana Koorders ex Prain & Burkill sp. nov., l.c., n.s., 4 (1908): 456–7.
 wattii Prain & Burkill sp. nov. in *J. As. Soc. Bengal*, l.c.: 457.
 yokusai Prain & Burkill, sp. nov. l.c., 73 Suppl. (1904): 10.
 yunnanensis Prain Burkill, sp. nov. l.c.: 186.

DIPTEROCARPACEAE

- Isoptera seminis* (de Vries) Burkill, comb. nov. in *Kew Bull.* 1935: 317.
 (= *Hopea seminis*.)

EUPHORBIACEAE

- Euphorbia calabarica* Burkill, sp. nov. in *Kew Bull.* 1901: 133.

FAGACEAE

- Quercus lampadaria* (Gamble) Burkill, comb. nov. in *Kew Bull.* 1935: 318. (= *Pasania lampadaria*.)
 maingayi (Schottky) Burkill, comb. nov., l.c.: 318. (= *Pasania maingayi*.)

FLACOURTIACEAE

Trimeria tropica Burkill, *sp. nov. in Kew Bull.* 1898: 145.

GENTIANACEAE

- Gentiana albicalyx* Burkill, *sp. nov. in J. As. Soc. Bengal*, n.s. 2 (1906): 314-5.
amoena C.B. Clarke, var. *major* Burkill, var. *nov. l.c.*: 312.
amplicrater Burkill, *sp. nov. l.c.*: 312.
arethusae Burkill, *sp. nov. l.c.*: 329.
atkinsonii Burkill, *sp. nov. l.c.*: 309-10.
bryoides Burkill, *sp. nov. l.c.*: 316.
crassicaulis Duthie ex Burkill, *sp. nov., l.c.*: 311-2.
detonsa Rottb., var. *lutea* Burkill, var. *nov., l.c.*: 319.
 var. *ovata-deltoidea* Burkill, var. *nov., l.c.*: 319.
duthei Burkill, *sp. nov., l.c.*: 318.
intermedia Burkill, *sp. nov. l.c.*: 313.
lawrencei Burkill, *sp. nov. in Gard. Chron.* 2 (1905): 307.
lhassica Burkill, *sp. nov. in J. As. Soc. Bengal*, n.s. 2 (1906): 311.
listeri Burkill, *sp. nov. l.c.*: 314.
micantiformis Burkill, *sp. nov., l.c.*: 315-6.
panthaica Burkill, *sp. nov., l.c.*: 313-4.
pharica Burkill, *sp. nov. l.c.*: 310.
prainii Burkill, *sp. nov., l.c.*: 317.
pseudo-humilis Burkill, *sp. nov., l.c.*: 313.
saginoides Burkill, *sp. nov., l.c.*: 318.
sorocula Burkill, *sp. nov., l.c.*: 315.
waltonii Burkill, *sp. nov., l.c.*: 310-1.
yokusai Burkill, *sp. nov., l.c.*: 316-7
- Parajaeschkea* Burkill, *gen. nov. in Rec. Bot. Surv. India*, 4 (1911): 223.
smithii Burkill, *sp. nov. l.c.*: 223.
- Swertia angustifolia* Hamilton ex D. Don, var. *florida* (Wall.) Burkill *stat. nov. in J. As. Soc. Bengal*, n.s., 2 (1906): 374. (= *S. florida*.)
 var. *hamiltoniana* Burkill, *nom. nov. l.c.*, 374. (= *S. angustifolia* Ham.)
 var. *pulchella* Burkill, *stat. nov. l.c.*, 375. (= *S. pulchella* Ham et alii.)
 var. *wallichiana* Burkill, *stat. nov. l.c.*, 374. (= *S. angustifolia* Wall. in parte.)
australis Burkill *sp. nov. in J. As. Soc. Benegal*, n.s. 7 (1911): 81-82.
bisseti Moore & Burkill, *sp. nov. l.c.*, n.s. 2 (1906) 329.
bonatiana Burkill, *sp. nov., l.c. n.s. 7* (1911): 81.
carinthiaca Griseb., var. *afghanica* Burkill, var. *nov., l.c.*: n.s. 2 (1906): 324.
chumbica Burkill, *sp. nov. l.c.*: 323.
cincta Burkill, *sp. nov., l.c.*: 319.
deltoidea Burkill, *sp. nov., l.c.*: 324.
duclouxii Burkill, *sp. nov., l.c.*: n.s. 7 (1911): 81.
exacoides Burkill, *sp. nov., l.c.*: n.s. 2 (1906): 321-2.
gamosepala Burkill, *sp. nov., l.c.*: 324-5.
hickinii Burkill, *sp. nov., l.c.*: 320-1.

- hispidicalyx *Burkill, sp. nov., l.c.*: 321.
 var. major *Burkill, var. nov., l.c.*: 321.
 var. minima *Burkill, var. nov. l.c.*: 321.
- lawii (*Wright & Arnott*) *Burkill, comb. nov. l.c.*: 379. (= *Ophelia lawii*.)
- lloydoides *Burkill, sp. nov. l.c.*: n.s. 2 (1906): 323.
- patens *Burkill, sp. nov., l.c.*: n.s. 7 (1911). 82.
- paupera *Burkill, sp. nov., l.c., n.s. 2* (1906): 322.
- purpurascens Wall., var. ramosa *Burkill, var. nov., l.c., n.s. 3* (1907): 34.
- rosea *Burkill, sp. nov., l.c., n.s. 7* (1911): 82.
- sikkimensis *Burkill, sp. nov., l.c., n.s. 2* (1906): 322–3.
- souliaei *Burkill, sp. nov., l.c.*: 325–6.
- stapfii *Burkill, sp. nov., l.c.*: 325.
- speciosa Wall., var. lacei *Burkill, var. nov., l.c.*: 326.
- subspeciosa *Burkill, sp. nov., l.c.*: 326.
- tongulensis *Burkill, sp. nov., l.c.*: 319–20.
- younghusbandii *Burkill sp. nov., l.c.*: 325.
- yunnanensis *Burkill, sp. nov. l.c.*: 320.

GESNERIACEAE

- Boea hians* *Burkill, sp. nov., in Kew Bull. 1901*: 142.
- Paraboea tiumanica* *Burkill sp. nov. in Ridley: Fl. Mal. Penins. 2* (1923): 532.
- Trichosporum lampongum* (*Miquel*) *Burkill, comb. nov. in Kew Bull. 1935*: 319. (= *Aeschynanthus lamponga*.)
- nummularium* *Burkill & S. Moore ex S. Moore, sp. nov. in J. Bot. 1899*: 173.

GRAMINEAE

- Acroceras crassiapiculatum* (*Merrill*) *Burkill, comb. nov. in Kew Bull. 1935*: 316–7. (= *Panicum crassiapiculatum*.)

HYPOXIDACEAE

- Curculigo grandis* *MS. in Herb. Calc. ex Burkill sp. nov. in Rec. Bot. Surv. India, 10* (1925): 386 — (name).

LEGUMINOSAE

- Whitfordiodendron pubescens* (*Craib*) *Burkill comb. nov. in Kew Bull. 1935*: 319. (= *Padbruggea pubescens*.)

LORANTHACEAE

- Loranthus pachypus* *Burkill, sp. nov. in Kew Bull. 1899*: 109.

MELASTOMATACEAE

- Dissochaeta pentamera* *Burkill, sp. nov. in Kew Bull. 1906*: 5.
- Memecylon curtisii* *Burkill & Henderson, nom. nov. in Gard. Bull. Straits Settlements 2* (1925): 377. (= *M. gracilipes* Ridl.)
- Plethiandra sahebii* *Burkill sp. nov. in J. Straits Br. R. As. Soc. 77* (1917): 265–9.
- Pternandra azurea* (*de C.*) *Burkill comb. nov. in Kew Bull. 1935*: 319. (= *Kibessia azurea*.)

MUSACEAE

Musa pruinosa Burkill, *sp. nov.* in *Rec. Bot. Surv. Ind.*, **10** (1925): 384.

MYRTACEAE

Eugenia crosbyi Burkill, *sp. nov.* in *J. Linn. Soc. Lond.*, **35** (1901): 38.

prora Burkill, *sp. nov.* in *Kew Bull.* **1906**: 4.

samoensis Burkill, *sp. nov.* in *J. Linn. Soc. London.*, **35** (1901): 38.

Rhodamnia uniflora (Ridley) Burkill, *stat. nov.* in *Gard. Bull. Straits Settlements* **3** (1923): 42. (= *R. trinervia* var. *uniflora* Ridley.)

OCHNACEAE

Ouratea crocea (Griffith) Burkill, *comb. nov.* in *Kew Bull.* **1935**: 218.
(= *Ochna crocea*.)

hookeri (Planchon) Burkill, *comb. nov. l.c.*: 318. (= *Ochna hookeri*.)

ORCHIDACEAE

Bulbophyllum oeneum Burkill *ex* Ridley, *sp. nov.* in *Fl. Mal. Penins.* **4** (1924): 63.

Corymborchis longiflora (Hk.f.) Burkill, *comb. nov.* in *Kew Bull.* **1935**: 317. (= *Corymbis longiflora*.)

Dendrobium citrino-castaneum Burkill, *sp. nov.* in *Gard. Bull. Straits Settlements*, **3** (1923): 12.

gracilipes Burkill, *sp. nov.* in *J. Straits Br. R. As. Soc.*, **79** (1918): 45–46.

Gastrochilus subbilobus Burkill *sp. nov.* in *Valeton: Bull. Jard. Bot. Buitenzorgi II*, **27** (1918): 87; in Ridley: *Fl. Mal. Penins.*, **4** (1924): 250.

Liparis purpureo-viridis Burkill & Holttum, *sp. nov.* in *Gard. Bull. Straits Settlements* **3** (1923): 77.

Oberonia fungum-olens Burkill, *sp. nov. l.c.*, **3** (1924): 292.

Saccolabium crucicallus Burkill, *sp. nov.*, **3** (1923): 7.

PITTOSPORACEAE

Pittosporum berberoides Burkill, *sp. nov.* in *Kew Bull.* **1899**: 96.

pullifolium Burkill, *sp. nov., l.c.*: 96.

spathaceum Burkill, *sp. nov.* in *Hock. Ic. Pl. t.* 2561 (1898).

RUBIACEAE

Dolicholobium acuminatum Burkill, *sp. nov.* in *Hook. Ic. Pl. t.* 2630. (1900).

RUTACEAE

Citrus polyandra (Ridley) Burkill, *comb. nov.* in *Gard. Bull. Straits Settlements*, **5** (1931): 219. (= *Atalantia polyandra*.)

swinglei Burkill *ex* Harms, *sp. nov.* in *Engl. & Prantl, Nat. Pflanzenfam.* ed. 2, XIX c. 459, 1931.

Paramignya angulata (Willd.) Burkill, *comb. nov.* in *Gard. Bull. Straits Settlements*, **5** (1931): 214–5. (= *Citrus angulata*.)

cuspidata (Ridley) Burkill, *comb. nov., l.c.*: 213. (= *Atalantia cuspidata*.)

lobata Burkill, *nom. nov., l.c.*: 214. (= *Atalantia hispida* Ridley.)

missionis (Oliv.) Burkill, *comb. nov., l.c.*: 213 (= *Atalantia missionis*.)

ridleyi Burkill, *nom. nov., l.c.*: 214. (= *P. graffithii* Ridley.)

trimera (Oliv.) Burkill, *comb. nov., l.c.*: 213. (= *Atalantia trimera*.)

SALICACEAE

Populus tremula Linn., var. *adenopoda* (Maxim) Burkill, stat. nov. in *J. Linn. Soc. Lond. Bot.* **26** (1899): 537. (= *P. adenopoda* Maxim.)

Salix daltoniana Anderss., var. *franchetiana* Burkill, var. nov., l.c.: 528.

fargesii Burkill, sp. nov., l.c.: 528–9.

floccosa Burkill, sp. nov., l.c.: 529.

henryi Burkill, sp. nov., l.c.: 530.

longiflora Anderss., var. *albescens* Burkill, var. nov., l.c.: 530.

subpyncnostachya Burkill, sp. nov., l.c.: 532.

SAPOTACEAE

Planchonella pohlmanniana (Benth. & Hook. f.) Burkill, comb. nov. in *Kew Bull.* **1935**: 319 (= *Sideroxylon pohlmanniana*.)

Sideroxylon vitiense (A. Gray) Burkill, comb. nov. in *J. Linn. Soc. Lond. Bot.* **35** (1901): 44. (= *Sapota vitiense*.)

STERCULARIACEAE

Erythropsis colorata (Roxb.) Burkill, comb. nov. in *Gard. Bull. Straits Settlements* **5** (1931): 231. (= *Sterculia colorata*.)

Firmiana lychnophora (Hance) Burkill, comb. nov. in *Kew Bull.* **1935**: 317. (= *Sterculia lychnophora*.)

Pterospermum proteus Burkill, sp. nov., l.c. **1901**: 138.

THEACEAE

Gordonia benguetica Burkill, sp. nov. in *Philipp. J. Sci.*, **5** (1919): 478.
concentricatrix Burkill, sp. nov. in *J. Straits Br. R. As. Soc.*, **76** (1917): 152–3.

havillandii Burkill, sp. nov., l.c.: 156–7.

lanceifolia Burkill, sp. nov., l.c.: 150–1.

polisana Burkill, sp. nov., in *Philipp. J. Sci.* **15** (1919): 478.

subclavata Burkill, sp. nov., l.c.: 478.

taipingensis Burkill, sp. nov. in *J. Straits Br. R. As. Soc.* **76** (1917): 148.

TILIACEAE

Corchorus capsularis Linn., var. *oocarpus* Burkill & Finlow, var. nov. in *Proc. As. Soc. Bengal*, **1910**, 101; *J. As. Soc. Bengal n.s.* **7** (1911): 465–6.

Elaeocarpus barnardii Burkill, sp. nov. in *J. Straits Br. A. As. Soc.* **75** (1917): 41.

tonganus Burkill, sp. nov. in *J. Linn. Soc. Lond. Bot.* **35** (1901) 29.

UMBELLIFERAE

Ducrosia anethifolia (de C.) Boiss., var. *jamiatii* Burkill var. nov. in *J. As. Soc. Bengal, n.s.*, **3** (1907): 564.

URTICACEAE

Polychroa javanica (Weddell) Burkill, comb. nov. in *Kew Bull.* **1935**: 319. (= *Pellionia javanica*.)

VIOLACEAE

Rinorea hookeriana (King) Burkill comb. nov. in *Kew Bull.* **1935**: 319. (= *Alsodeia hookeriana*.)

ZINGIBERACEAE

Aframomum macrospermum (Smith) Burkill, comb. nov. in *Kew Bull.* **1930**: 37. (= *Amomum macrospermum*.)

Alpinia oceanica Burkill, sp. nov. in *Proc. Camb. Phil. Soc.* IX, II: 93, 1896.

Amomum kepulaga Sprague & Burkill, nom. nov. in *Kew Bull.* **1930**: 35. (= *Amomum cardamomum* Roxb.)

Elettaria cardamomum Maton, var. *minuscula* Burkill, var. nov. in *Kew Bull.* **1930**: 35.

Haplochorema sumatrana Burkill, sp. nov. in *Gard. Bull. Straits Settlements* **3** (1923): 18–19.

Languas allughas (Roscoe) Burkill, comb. nov. in *Kew Bull.* **1935**: 317. (= *Alpinia allughas*.)

cannifolia (Ridl.) Burkill, comb. nov., l.c.: 318. (= *Alpinia cannifolia*.)

conchigera (Griff.) Burkill, comb. nov., l.c.: **1930**: 37. (= *Alpinia conchigera*.)

elegans (K. Schumann) Burkill, comb. nov., l.c., **1935**: 318. (= *Alpinia elegans*.)

galanga (Swartz) Burkill, comb. nov., l.c., **1930**: 36 (= *Alpinia galanga*.)

globosa (Horanin) Burkill, comb. nov., in *Gard. Bull. Straits Settlements* **6** (1929): 80; *Kew Bull.* **1930**: 36. (= *Alpinia globosa*.)

javanica (Blume) Burkill, comb. nov. in *Kew Bull.* **1935**: 318. (= *Alpinia javanica*.)

melanocarpa (Ridl.) Burkill, comb. nov. in *Gard. Bull. Straits Settlements* **6** (1930): 260; *Kew Bull.* **1935**: 318. (= *Alpinia melanocarpa*.)

officinarium (Hance) Burkill, comb. nov. in *Gard. Bull. Straits Settlements* **6** (1929): 81; *Kew Bull.* **1931**: 324. (= *Alpinia officinaum*.)

padacanca (Val.) Burkill, comb. nov. in *Kew Bull.* **1935**: 318. (= *Alpinia padacanca*.)

rafflesiana (Wall.) Burkill comb. nov., l.c.: 318 (= *Alpinia rafflesiana*.)

regia (Val.) Burkill, comb. nov., l.c.: 318. (= *Alpinia regia*.)

uviformis (Horaninow) Burkill, comb. nov., l.c.: 318. (= *Alpinia uviformis*.)

scabra (Benth.) Burkill, comb. nov. in *Gard. Bull. Straits Settlements* **6** (1930): 260. (= *Alpinia scabra*.)

Phaeomeria heyneana (Valeton) Burkill, comb. nov. in *Kew Bull.* **1935**: 318. (= *Nicolaia heyneana*.)

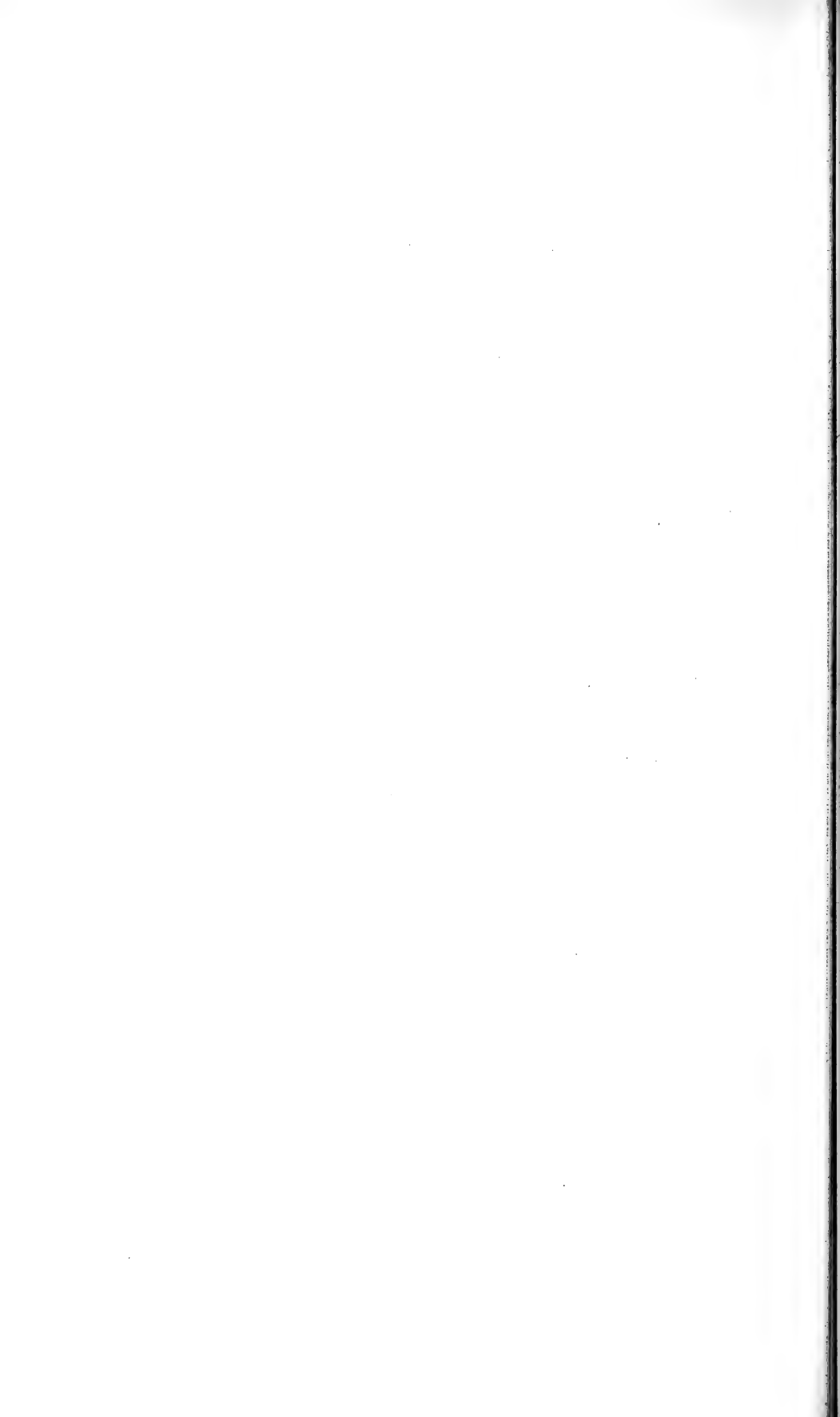
III. TAXA NAMED AFTER I. H. BURKILL

Begonia burkillii Dunn (Begoniaceae) in *Kew Bull.*, **1920**, 110.

Begonia burkillii Irmsch. (Begoniaceae) in *Mitt. Inst. Bot. Hamburg* **8**: 116, 1929.

Bulbophyllum burkillii Gage (Orchidaceae) in *J. As. Soc. Bengal*, n.s., **2**: 343, 1906.

- Burkillanthus Swingle (Rutaceae) in *J. Arn. Arb.* **20**: 255–6, 1939.
- Burkillia West & West (Coelastraceae-Chlorococcales) in *Ann. R. Bot. Gard. Calcutta* **6**: 228, 1907.
- Burkillia Ridley (Leguminosae) in *Fl. Mal. Penins.* **5**: 304, 1925.
- Calamus burkillianthus Becc. ex Ridley (Palmae) in *Fl. Mal. Penins.*, **5**: 56, 1925; Furtado in *Gard. Bull. S.S.* **8**: 245, 1935.
- Cosmarium burkillii West & West (Desmidiaceae) in *Ann. R. Bot. Gard. Calcutta*, **6**: 208, 1907.
- Dioscorea burkillii Knuth (Dioscoreaceae) in *Engl. Pflanzenr. IV*, **43**: 143, 1924.
- Ficus burkillii Ridley ex Burkill & Holttum (Moraceae) in *Gard. Bull.* **3**: 73, 1923; Ridley in *Fl. Mal. Penins.* **3**: 330, 1924.
- Homalonema burkilliana Ridley (Araceae) in *J. Mal. Br. R. As. Soc.*, **1**: 104–5, 1923.
- Galera burkillii Masee (Agaricaceae) in *Kew Bull.*, **1910**, 2.
- Lithocarpus burkillii A. Camus (Fagaceae) in *Bull. Mus. Hist. Nat. Paris II*, **5**: 88, 1933.
- Pandanus burkillianus Ridley (Pandanaceae) in *J. Mal. Br. R. As. Soc.*, **1**: 106, 1923.
- Piper burkillii Ridley (Piperaceae) in *J. Straits Br. R. As. Soc.*, **82**: 189, 1920.
- Psaliota burkillii Masee (Agaricaceae) in *Kew Bull.*, **1907**, 123.
- Rubus burkillii Rolfe (Rosaceae) in *Kew Bull.*, **1920**, 109.
- Schefflera burkillii Merrill (Araliaceae) in *J. Straits Br. R. As. Soc.*, **79**: 28–29, 1918.
- Sordaria burkillii Masee (Ascomycetes) in *Kew Bull.*, **1913**, 105.
- Staurostrum burkillii West & West (Desmidiaceae) in *Ann. Roy. Bot. Gard., Calcutta* **6**: 216, 1907.
- Stemona burkillii Prain (Roxburgiaceae) in *J. As. Soc. Bengal*, **73**: 43, 1904.
- Strobilanthus burkillii Dunn (Acanthaceae) in *Kew Bull.*, **1920**, 208.
- Sewertia burkilliana W. W. Smith (Gentianaceae) in *J. As. Soc. Bengal*, **n.s. 7**: 78, 1911.
- Wendlandia burkillii Cowan (Rubiaceae) in *Notes Bot. Gard. Edinb.* **16**: 277, 1932.
- Xanthidium burkillii West & West (Desmidiaceae) in *Ann. R. Bot. Gard.*, **6**: 210, 1907.
- Xanthophyllum burkillii Drummond & Dunn (Polygalaceae) in *Kew Bull.*, **1920**, 245–6.
- Rana burkillii Annandale, in *Rec. Ind. Mus. Calc.*, **5**, 1910. (a Burmese frog).
- The following are named after E. M. Burkill, the wife of I. H. Burkill, who collected fungi at Calcutta and at Singapore, and prepared coloured drawings. The material was curated by I. H. Burkill.
- Annularia burkillae Masee (Agaricaceae) in *Kew Bull.*, **1912**, 255.
- Entoloma burkillae Masee (Agaricaceae) in *Kew Bull.*, **1914**, 74.



H. B. Gilliland, 1911 - 1965

An Appreciation.

Hamish Boyd Gilliland was born on 2nd October 1911 in Southern Rhodesia, educated at George Watson's College, Edinburgh, and read Botany and Zoology in the University of Edinburgh, for the degree of B.Sc. In due course he read for an honours degree under Professor Sir William Wright Smith, Regius Professor and Regius Keeper of the Royal Botanic Garden. His interests were both taxonomic and ecological. Later he studied at the British Museum (Nat. Hist.), where he improved his knowledge of systematic botany and generally prepared himself for a career in southern Africa. Persons who helped and influenced Gilliland at this stage were John Ramsbottom, then Keeper of the Botanical Department at the Museum, and George Taylor. For these he always had special niches in his heart and in his mind.

In the course of field studies in Southern Rhodesia, supported by a Beit Scholarship, Gilliland visited the University of the Witwatersrand in 1934, when his obvious interest and ability in taxonomy and field ecology led to his being invited to serve on the staff of the Department of Botany, then under the administration of Professor John Phillips.

In June, 1935 Gilliland took up his appointment and in a remarkably short time proved himself an excellent lecturer and demonstrator, a keen guide to post-graduate students and an indefatigable investigator. Because of the emphasis then laid upon both taxonomy and pure and applied ecology in the Department, he was able to make important contributions to these subjects before the onset of war in 1940.

Shortly before the war he published an important contribution to the ecology of Manicaland, Rhodesia (*Journal of South African Botany*, 1938) based upon his studies as a Beit Research Scholar.

Volunteering to serve in the South African Forces as a private, Gilliland in a short time proved his competence as a soldier and in due course was commissioned. He served in East and North Africa and, during the course of the campaign, was gazetted by the Military Administration to study various ecological and related matters in British Somaliland. His co-worker for a time was one of the Department's and also Gilliland's own earlier students, P. E. Glover, later to become known for his ecological researches in East Africa.

Gilliland's own studies in North-east Africa provided information which he admirably worked up after the war for a thesis for the degree of D.Sc., which was awarded by the University of the Witwatersrand in 1947. Abstracts from this thesis were published in the *Journal of Ecology* in 1952.

On his return from active service Gilliland enthusiastically supported his Professor in the educating and training of large special classes of ex-servicemen being prepared for careers in conservation and veld and pasture management and in other aspects of applied ecology.

In 1948 the Head of his Department was invited to undertake advisory work abroad and for several years Gilliland served as Acting Head — a duty which he fulfilled with ability.

Throughout his career in South Africa Gilliland showed himself to be a capable, keen and pleasant colleague, a friendly and able guide to students and one who was interested in and prepared to work for the general good of the University and of his adopted country, South Africa. Many a student during the periods 1935–1940 and 1945–1955 was generously and ably helped toward a career in pure or applied botany.

Although by nature reserved, Gilliland ever showed to those he worked with a kindness, a warmth and a generosity of spirit. He was always objective, no matter how great the subjectivity of some of those with whom he inevitably had contact at various times. Critical of all that was ethically unworthy and scientifically slipshod, he was the first to encourage sincere effort no matter how faltering this might be. For these and other qualities his name and influence will remain cherished by a large number of people in South Africa and Rhodesia.

Gilliland came to Singapore in September, 1955 as the second holder of the Chair of Botany in the young University of Malaya. He had a staff of three lecturers and some temporary assistance and very cramped quarters and inadequate equipment. The department in that year had through its hand some 37–40 science and medical students. The air was heady with political change, and expansion was the order of the day. By the end of 1964, the department had grown in stature to 6 lecturers and 220 students, in quarters, though very greatly expanded, which still were barely adequate. The path was far from smooth, and within a couple of years of his arrival Gilliland was faced with the necessity of establishing a new and separately equipped and staffed department at the new Kuala Lumpur Division of the University of Malaya. He had in fact two departments of botany on his hands 240 miles apart, one established and inadequately provided for, the other with nothing, but the promise of money and the prospect of a very large number of students. In 1959, when the Department of Botany at Kuala Lumpur opened its doors he had to operate both departments with staff commuting to and fro between Singapore and Kuala Lumpur. This difficult situation was resolved in part by three of his lecturers and certain subordinate staff from Singapore opting to transfer permanently to Kuala Lumpur. In 1960 the department in Kuala Lumpur became separate under its own professor, and in the 1961/62 session the two divisions of the University of Malaya split, that in Kuala Lumpur retaining the University name, while that in Singapore, where Gilliland remained, became the University of Singapore.

These staffing problems were a challenge to Gilliland, and even though after 1960 he had responsibilities only towards the Singapore department, it was a no easy matter to engage adequate competent staff. While promising graduates of the university were the obvious source for future staffing, there was still the hiatus to be bridged between their going overseas for higher degrees and their return. Amongst the families of British Service personnel stationed in Singapore, there has always been an immensely varied talent, and Gilliland made providential temporary use of dependents with university training in botany to help out. Visiting research workers and Ph.D. students from overseas were also called upon till adequate teaching staff could be recruited from local and expatriate sources. It was not in fact till 1962 that the Department was functioning with a full complement of staff.

Singapore has an unusually good health record amongst tropical cities, but the climate can be trying, and after some five years in Singapore Gilliland began to suffer from an asthmatic condition. This placed great physical strain on him which made field work especially arduous. Nevertheless he accepted this as no excuse for lightening his load of duties, neither towards his students and teaching, nor towards his own botanical interests. From May, 1960 till mid 1964 he was Dean of Science, and for two occasions in the latter half of 1964, he was Acting Vice-Chancellor during a particularly difficult period for the University administration which he handled with shrewd competence, charm and tact.

Though heavily preoccupied with administrative duties, his botanical interest in ecology and secondary vegetation was diligently followed. The observations of earlier workers on Singapore's secondary vegetation were used as a basis for succession studies, which, if these areas survive untouched, will make an interesting starting point for future ecologists to record the final stages of transition to climax forest. His special botanical interest was in grasses, an interest which he brought from his earlier days in South Africa. Shortly prior to his departure from Singapore he completed the text of 'Grasses of Malaya' which has been accepted for publication as Volume 3 of the revised *Flora of Malaya*. He was also keenly interested in conservation and served as a trustee on the Singapore Nature Reserves Board for 5½ years between 1955 and 1961. He sought to bring out the educational aspects of conservation so that the common citizen with no special training in biology, as well as biology students, might learn to understand and appreciate natural history.

In 1964 he was taken seriously ill with a pneumo-thorax and had to spend some time in hospital. For many months before this he had accepted the fact that to regain full health he would have to move to a drier climate, and it was mixed feelings that he left Singapore on 3rd February, 1965 for South Africa where he

took up an appointment at the Botany Department of the University of Natal at Pietermaritzburg. First indications were hopeful: his health appeared to improve; he liked the department: he liked his colleagues, and he enjoyed the stimulating change of students.

Soon after his arrival in Pietermaritzburg, he made an 800 mile car journey to Johannesburg and back to attend his son's graduation at Witwatersrand University. The effort of this, the sudden change to a high elevation climate, and the lack of his physical reserves of strength brought on a relapse of pneumo-thorax and shortly after he had an attack of pneumonia which brought his life to an end on 23rd June, 1965 at the age of 54 years.

Known as Gilly to a wide circle of friends, Hamish Boyd Gilliland and his wife Rita, will long be remembered in Singapore. Their university flat was an open house for students, and often there would be a group come in for a social gathering to meet some eminent biologist travelling through Singapore, or simply to have a get-together. Gilliland was an active Rotarian and was a founder member of the Rotary Club of Singapore-West. He was dedicated to the cause of international co-operation, goodwill and service.

A Bibliography

1931. Anomalous stem structure in *Ruscus aculeatus*, Linn. *Trans. & Proc. Bot. Soc. Edin.*, 30, 284-285: 1931.
1935. A new giant *Lobelia* from Rhodesian Manicaland. *J. Bot. Lond.*, 23, 247-8: 1935.
1938. A proposed delimitation of botanical countires for Southern Rhodesia. *J. S. Afr. Bot.*, 4, 65-71: 1938.
The vegetation of Rhodesian Manicaland. *J. S. Afr. Bot.*, 4, 73-99 (35 Pl.): 1938.
Notes on the flora of Rhodesian Manicaland.
I. Bryophyta (with W. R. Sherrin)
II. Pteridophyta (with A. H. G. Alston)
III. Gymnospermæ.
J. S. Afr. Bot., 4, 143-56 (5 Pl.): 1938.
'*Flora of Tropical Africa*, ed. Sir. A. W. Hill, 10 (1).
Arundinella to *Agrostis*, by E. C. Hubbard. A review. *J. S. Afr. Bot.*, c, 31: 1938.
'*Conspectus Floræ Angolensis*, ed. Dr. L. Wiltnich Carisso, I, *Ranunculaceæ* to *Malvaceæ*, by A. W. Exell and F. A. Mun-donca.' A review. *l.c.* 4, 31-2: 1938.
'*The Geology and Archeology of the Vaal River Basin*, by P. G. Sohngé, D. J. L. Visser and C. van Riet Lowe.' A review. *l.c.*, 4, 32, 1938.
1939. A note on the Rhodesian Cycad. *Trans. Rhod. Sci. Ass.*, 37, 133: 1939.
1939. 'The classification of Tropical Woody Vegetation types, by Dr. J. Burtt Davy. *Imp. For. Inst. Pap.* 13. A review. *J. S. Afr. Bot.*, 5, 59: 1939.
1940. The propagation of lawn grass, *Cynodon dactylon*.
I. *J. S. Afr. Hort. Jour.* 2 (2), 7: 1940.
II. *l.c.* 2 (3), 18-19: 1940.
1947. An approach to the problem of the government of nomadic peoples; with special reference to Eastern British Somaliland. *S. Afr. Geogr. J.*, April 1947.
[Thesis for D.Sc. Witwatersrand University.]
1949. Some current problems concerning the understanding of African vegetation. *Geogr. Rev.*, XL (3), 466-468: 1949.
- 1950/52. *Synopsis of the flora of the Witwatersrand*. Witwatersrand University. [Prepared and commenced to issue in multi-copy form for the students — the first seven parts.]

1951. Three new Acacias from the Ogaden, *Kew Bull.* 1951. 139–40. Notes on Witwatersrand Acacias, vol. 3, no. 3 of *Trees in South Africa*, 1951, Tree Society of South Africa, Johannesburg.
1952. *Africa south of the Sahara*, ed. Anne Walsh, South African Institute for International Affairs: Chapter 4: *The vegetation of Africa*, O.U.P.
The vegetation of eastern British Somaliland. *J. Ecol.*, 40, 91–124: 1952.
A student's key to the Monocotyledons of the Witwatersrand. Witwatersrand Univ. Press.
Experiments on the vegetative propagation of Cynodon species. Chapter 9 ex *Better turf through research*: Johannesburg.
1953. The birth of Joubert Park. *J. Tvl. Hort. Soc.*, 2 (6), 154: 1953. On the history of the plant study upon the Witwatersrand. *J. S. Afr. Bot.*, 19, 93–104: 1953.
The experimental investigation of grass communities on the Witwatersrand University's Field Research Station, Frankenwald at Johannesburg, S. Africa. *Proc. 7 Int. Bot. Congr., Stockholm, 1950*, p. 241.
1954. Witwatersrand plant records. *Afr. Wild Life Mag.* 8, 58–60: 1954.
The International Code of Nomenclature for Cultivated Plants. *J. Tvl. Hort. Soc.*, 2 (9), 21: 2 (10), 255: 2 (11), 277: 1954.
1955. On the phenology of the veld around Johannesburg. I. Monocotyledons, *J. S. Afr. Bot.*, 21, 77–82: 1955.
1956. *On classifying vegetation*. Inaugural address delivered on 16/11/56. Univ. Mal. Press, Singapore.
1958. Plant communities on Singapore Island. *Gard. Bull. Sing.* 17 (1), 82–90: 1958.
Common Malayan plants. Univ. Mal. Press, Singapore. [Edited extracts from Watanabe: *Illustrations of useful plants of the Southern Regions*. Botanic Gardens, Shonan: Showa 20 (= Singapore: 1942).]
1959. An Evocative Habitat. *Trans. Bot. Soc. Edin.* 38, 56–63: 1959. Regenerating high forest on Singapore Island. *Gard. Bull. Sing.*, 17 (2), 228–43: 1959. (With M. J. Wantman.)
1960. Progress with vegetation studies in Brunei, North Borneo, Sarawak and Singapore. *Proc. Symp. Humid Trop. Veget., Tjiawi, Indonesia*, Dec. 1958, 12–14, UNESCO Sci. Coop. Office S.E. Asia, 1960.
Notes on the classification of vegetation, *loc. cit.* 60–68. (With Muhammed bin Habil.)
A coniferous forest from Borneo. *Mal. For.* 1960.
On the symmetry of the orchid embryo, *Proc. Cent. Bicent. Congr. Biol., Singapore, Dec. 2–9, 1958*. 277–9, Univ. Mal. Press. Singapore, 1960.
1961. Conservation and education. *Mal. Nat. J. Conservation Issue*, 26–28: 1961.
'The grasses of Burma, Ceylon, India and Pakistan (excluding Bambuseæ)' by N. L. Bor — a review, *Gard. Bull. Sing.*, 18 (3), 330–2: 1961.
1962. A checklist of Malayan grasses. *Gard. Bull. Sing.* 19 (1), 147–80: 1962.
1963. Geographical distribution of Malayan grasses. *J. Trop. Geog.* 17, 20: 1963.
1964. Further notes on the grasses of the Malay Peninsula, I. *Gard. Bull. Sing.* 20 (4), 313–14: 1964.
1965. Further notes on the grasses of the Malay Peninsula, II. *Gard. Bull. Sing.* 21 (2), 209–211: 1965.
- In Press. Flora of Malaya, III. Grasses. Government Printing Office, Singapore.

H. B. GILLILAND

2nd October 1911 — 23rd June 1965.



Taken on 2nd February 1965,
the day before he left Singapore.

With acknowledgement to the Botany Department, University of Singapore.

Observations on *Ancistrocladus tectorius*

by

HSUAN KENG

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The conserved generic name *Ancistrocladus* (ancistrus — a small hook, cladus — a branch; referring to the sympodially hooked young shoot) was first proposed by N. Wallich in 1832. A full description was provided by G. A. W. Arnott four years later. It is a rather small genus comprising about 12 species, disjunctively distributed in tropical western Africa (with about 3 species) and in southeastern Asia (with about 9 species). The only Malesian species, *Ancistrocladus tectorius* (Lour.) Merr., also known as *A. pinangianus* Planch. or *A. extensus* Planch., occurs in the Malay Peninsula, S. Sumatra, W. Borneo and their adjacent small islands. Outside of the Malesian region, this species is found in Burma, Thailand, The Andamans, Indo-China, S. China and Hainan Island. For a citation of literature and synonyms of the genus and of this species, see Steenis, 1948. The same author pointed out that owing to the deficiency of properly preserved flowering material which after drying always shinks to brittle remnants) and fruiting material in herbarium specimens, certain androecial, gynoecial, and seed characters are not fully understood, and the descriptions given by various authors are sometimes controversial. The seedling character is completely unknown.

The following observations are based on the preserved flower buds collected by Mr. Engkik Soepadmo at the Bogor Botanic Garden, and the flowers, fruit and seedlings collected by myself from Kuala Sidili, Johore, Malaysia in October, 1965 and in April, 1966. Microtome sections were made at 8–10 μ and stained with a safranin-fast green combination.

Observations

Ancistrocladus tectorius (Lour.) Merr. is a woody climber. The young plants if growing solitarily in open places are, however, more or less erect as a result of the intertwining of the vigorous young shoots. The modified young shoots are tendril-like (Plate 1, a). They consist of 3 or more sympodially arranged segments, each normally bearing a curved hook at the tip. From the extra-axillary bud of the basal segment, or sometimes from 2 or 3 buds of the basal segments of these tendril-like shoots, the dwarf foliage branches arise. Inflorescences are borne sub-terminally on the dwarf foliage branches, which in turn, are on the old stems scrambling on or above the ground. They are flat-topped, composed of profusely dichotomously branched cymes (Plate 1, b). Flowers are borne on the cymules. Peduncles are subtended by minute, ovate bracts.

Observations on the major flower parts (perianth, androecium, gynoecium), flower anatomy, fruit, seed and seedling follow.

Perianth

Calyx and corolla are clearly differentiated (Figs. 1 & 2).

The calyx is 5-lobed; the tube or hypanthium is cup-shaped. The aestivation of the calyx-lobes in all the literature is described as imbricate. From a study of the serial sections of young flower buds, it reveals that they are quincuncially arranged at the base (Fig. 2, b) with two slightly larger exterior lobes covering the other three, of which two are completely interior, and the fifth one is intermediate.

Two or three conspicuous glands are found on the waist of the external surface of some of the calyx-lobes. Usually two (very rarely three or one) of these cup-shaped glands are present on the two exterior calyx-lobes, one is found on the intermediate ones. So far, none has been observed on either of the two interior calyx-lobes. They are apothecium- or perithecium-like in the sectional views with a large number of segmented hypha-like glandular hairs compactly arranged.

The corolla consists of 5 free petals which are papery in texture, and strongly contorted (Figs. 1 & 2). Moderately thick-walled secretory cells are distributed in the parenchyma tissues of sepals and petals, especially abundant on the hypodermal layers of the abaxial surfaces.

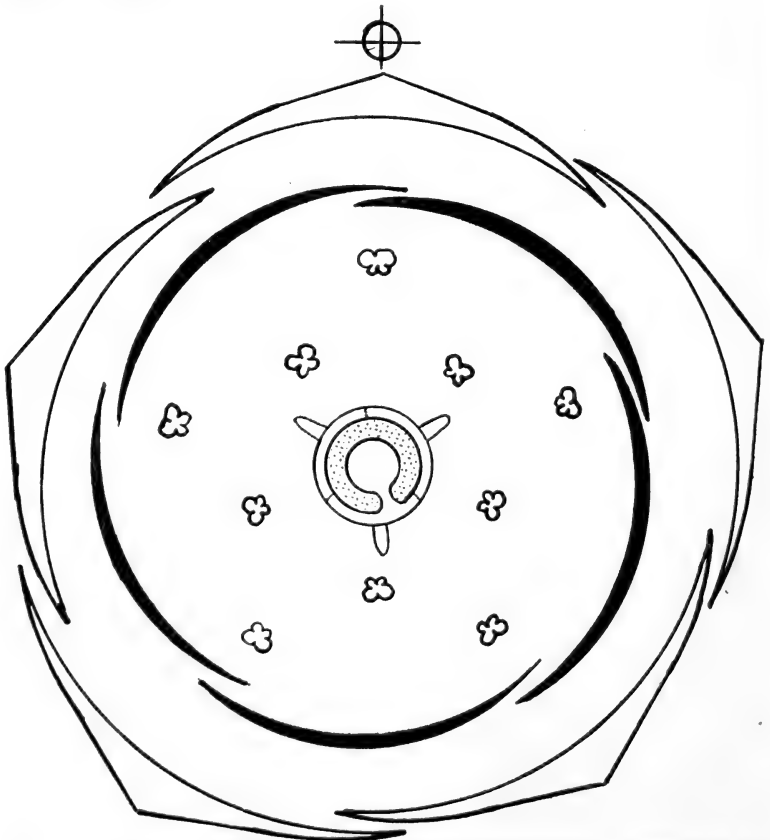


Figure 1. Floral diagram of *Ancistrocladus tectorius* Merr. (based on the transverse sections of flower buds).

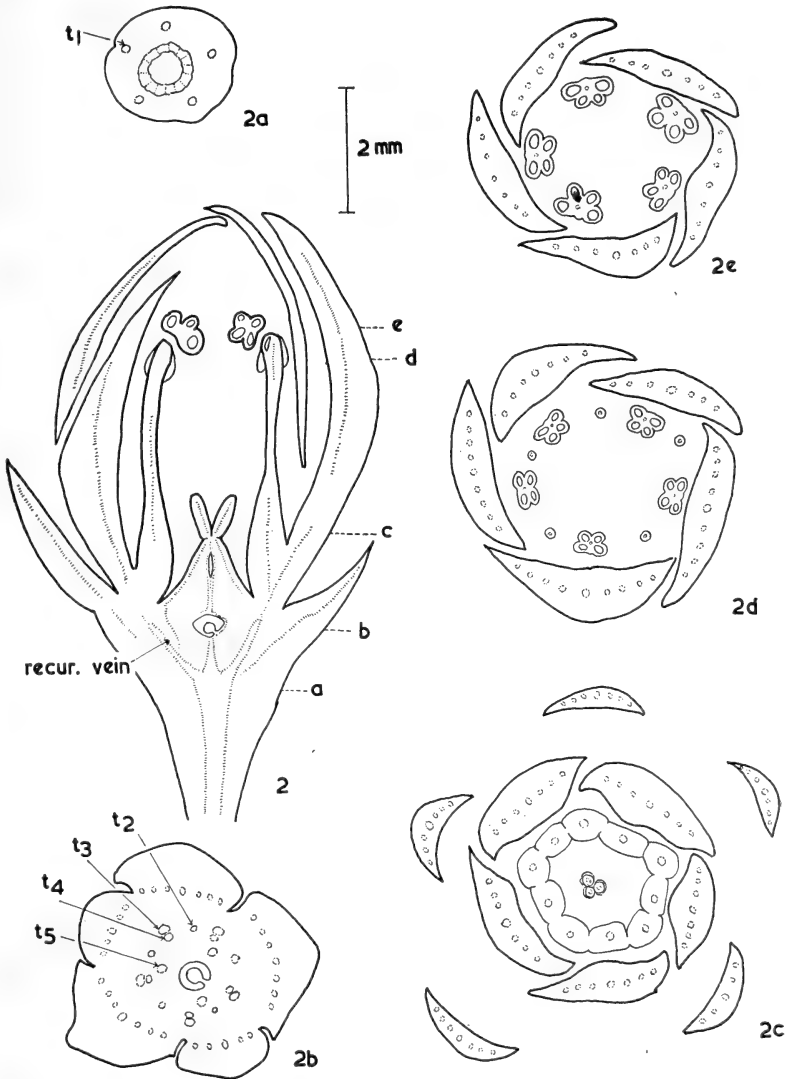


Figure 2. Flower bud of *Ancistrocladus tectorius* Merr. in sections. The position of the serial transverse sections a~e are indicated on the longitudinal section.

Androecium

The number of stamens in a flower of the genus varies from 10 to 5. Based on this character alone, the species of the genus are arranged in 2 groups (Gilg 1895): only the Ceylonese species (*A. hamatus* Gilg) belongs to the 5-stamen group, whereas the rest, including the Malesian species belong to the 10-stamen group.

From a study of the flower sections of *A. tectorius*, two types of androecium are observed: (1) the anthers of ten stamens are almost equal in size, but the filaments differ in length, with the antisepalous ones slightly longer than the antipetalous ones, (2)

the ten stamens differ in the size of their anthers and in the length of their filaments, with those of the antisepalous ones both larger and longer than those of the antipetalous ones.

The anthers are 2-lobed and 4-loculate, intro-latorse (Plate 2, i). Owing to the disintegration of the tissue between adjacent locules of the anther—lobes, they merge and thus the mature anthers appear to be 2-loculate (Plate 2, j). The longitudinal lines of dehiscence are lateral. A short projection ('awn') is found on the upper end of each anther-lobe.

The filaments are comparatively short. They are swollen at the base and almost joined together into a ring (Fig. 2, c, Plate 2, m), which is in turn, adnate to the basal portion of the corolla.

A transverse section of a filament is orbicular or quadrangular in outline. The epidermis is cutinized and the ground tissue is composed of 2–5 layers of parenchyma cells. A single vascular bundle, often associated with a few thick-walled secretory cells is observed.

The epidermis of the anther consists of a layer of small, elongate cells with prominent nuclei. The endothecium in a mature anther is composed of a layer of very large cells with strips of secondary thickening, underneath which, one or sometimes two layers of parietal cells line the pollen sac cavity.

Gynoecium

The three styles are articulated at the medial portions (cf. Plate 2, g, h & k). The upper halves are totally free, erect or recurved, with the rounded or truncate tips probably serving as stigmas. The lower halves are partly connivent and partly joined form a cone-shaped structure. Only this cone-shaped structure is persistent and becomes very prominent in fruit, while the upper halves are deciduous.

The ovary wall is completely fused with the calyx-tube or hypanthium, therefore the position of the ovary is typically inferior (Fig. 2; Plate 2, g, h & 1). The ovary is one-loculate, one-ovulate, with the ovule basal-laterally attached (Plate 2, 1). All the sections of the flower-buds studied fail to reveal the detailed structure of the ovules themselves. It suggests that the differentiation of the tissues in the ovule comes likely at a very late stage of development.

Vascular anatomy of flower

The elongate pedicel contains a cylindrical vascular region. In the receptacle at the level of sepal attachment, one single trace (which later divides into 3, 5 or 7) diverges from the vascular cylinder and enters each sepal (Fig. 2a, t₁). Above this level, the bundles which form the vascular cylinder separate and ramify. At first, 5 traces between the 5 main traces, and another 3 traces inside the main traces become clear. Each of the 5 traces (those between the main traces) (t₂ in Fig. 2b & Plate 2, n) enters into one antisepalous stamen; and all the 3 traces (those inside the main traces) (t₁ in Fig. 2b & Plate 2, n) enter into the gynoecium as dorsal traces of the carpels and end at the tips of the styles. From the main traces (t₃ in

Fig. 2a & Plate 2, n) 5 bundles further diverge; each of them divides tangentially into 2 traces, the outer one (which further divides into 3, 5 or 7 branches) and the inner one enter a petal and an anti-petalous stamen respectively. The main traces themselves, however, travel in a downward direction (forming the so-called "recurrent" veins) (t_1 in Fig. 2a & Plate 2, n; also in Fig. 2 & Plate 2, 1) at low level and then bend abruptly upward and meet at the base of the ovary-locule where the placenta is located. These traces further appear on the top of the ovary-locule and finally meet the dorsal traces at the tip of the styles.

Fruit

The fruit is an indehiscent nut, enveloped by the corky hypanthium, and crowned by the shining accrescent calyx-lobes (Fig. 3 & Plate 1, c). The five quincuncially arranged calyx-lobes are unequally developed: the two interior ones are usually much smaller and form the short wings; the two exterior and the fifth sepal are larger and form the long wings. In the fruiting stage their aestivation nevertheless, is almost sub-valvate.

The cone-shaped basal portions of the styles are completely fused and enlarged, constituting the persistent spherical or columnar structure. The pericarp is corky, adnate to, and inseparable from the hypanthium tissue.

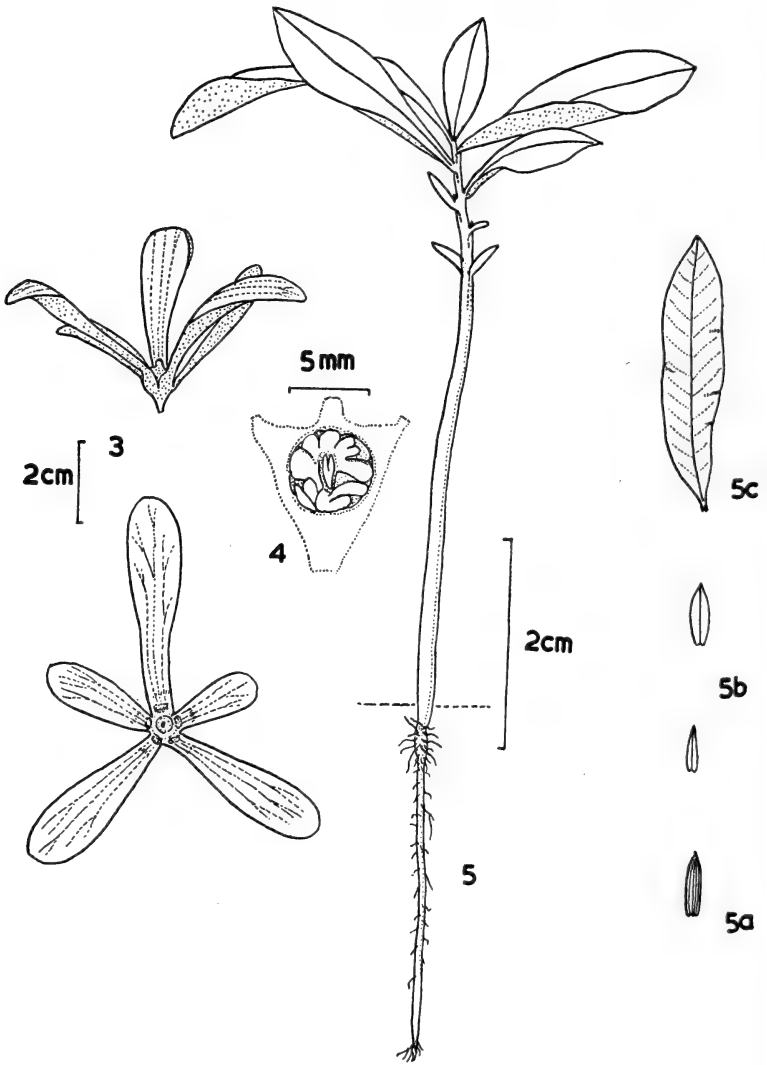
Seed

The seed is pyramidal with a thin membranous seedcoat. The endosperm is ruminant, cerebral-like, starchy and horny (Fig. 4 & Plate 1, d). This ruminant endosperm was erroneously identified as the "remarkably folded" cotyledons (Hutchinson 1959, p. 286). The embryo is fairly small, erect, medially but generally slightly obliquely disposed and embedded in endosperm. The cotyledons are somewhat divergent.

Seedling

The primary root is slender, tapering, with a large number of short lateral rootlets (Fig. 5), black in colour. The hypocotyl is 3–5 cm. long, suberect, tetragonal and thick. The cotyledons emerge from the pericarp almost simultaneously with the well-organized young shoot (Plate 1, e & f). They are narrowly lanceolate (2–3 mm. by 0.5 mm.), sessile and prolonged decurrent at the base, wither and cease to function at a very early stage and when they are replaced by the foliage leaves. The transitional leaves (Fig. 5, b) usually two, are subulate, (3–4 mm. by 0.6–0.8 mm.) sessile and decurrent.

The foliage leaves on young seedlings are simple, entire, exstipulate, alternate and spirally arranged (Fig. 5). The lamina of each is elliptic or lanceolate (1.5–3.5 cm. by 0.6–1.2 cm.), glabrous, deep green above, with a distinct midrib; the lateral nerves are inconspicuous. Their petioles are very short (2–3 mm. long) and strongly decurrent, usually with a large purplish crateriform gland on the exterior surface near the base.



Figures 3-5. *Ancistrocladus tectorius* Merr.

3. Winged fruit, in two different views.

4. Sectional view of the seed (semi-diagrammatic).

5. A seedling. 5a, a cotyledon; 5b, two transitional leaves; 5c, a juvenile foliage leaf.



Plate 1. *Ancistrocladus tectorius* Merr.

- (a) Terminal branch bearing tendril-like young shoots; (b) Fruiting inflorescence; (c) Two winged fruits; (d) Seeds (external and sectional views); (e) Seedlings in various stages of development; (f) Detail of e. A young seedling showing the radicle, hypocotyl and cotyledons (with white background) just emerged from the pericarp.

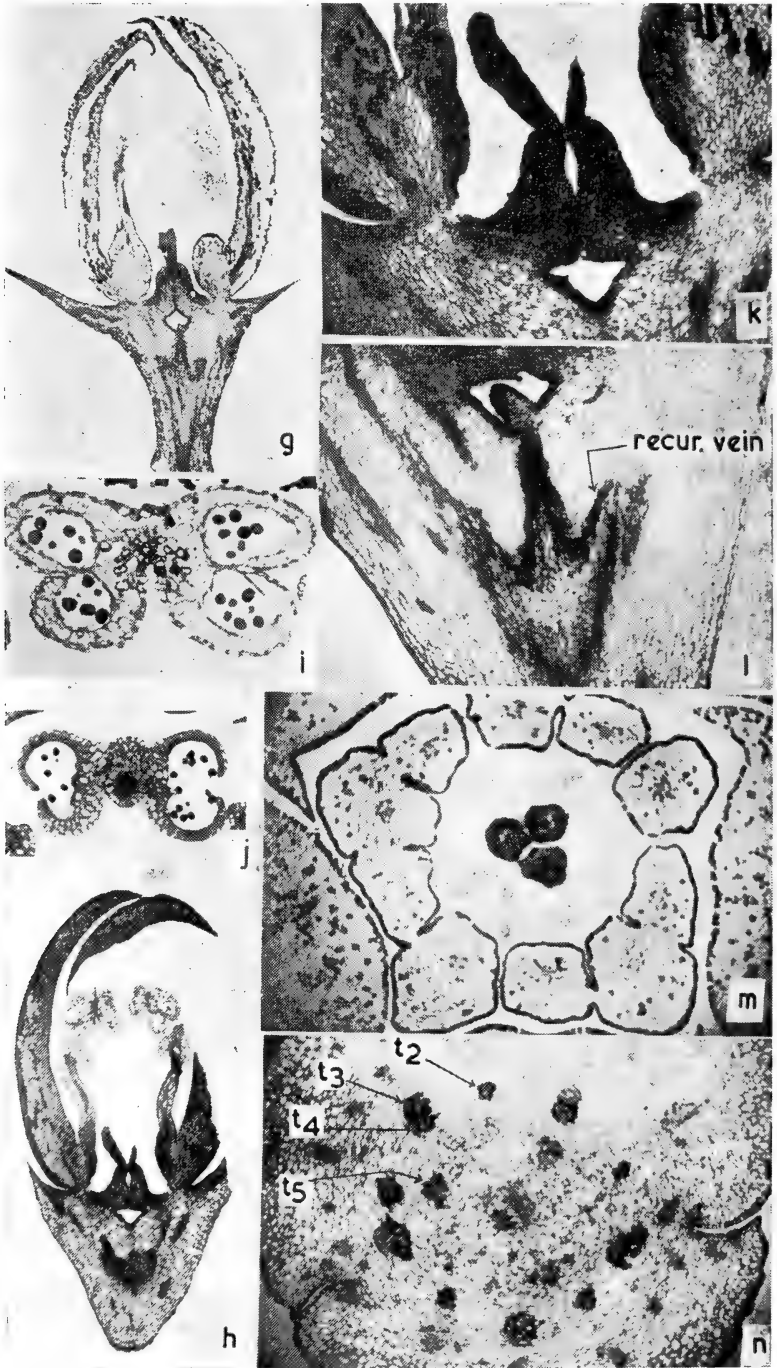


Plate 2. *Ancistrocladus tectorius* Merr.

(g) and (h) Longitudinal sections of flower buds (cf. fig. 2); (i) and (j) young and mature anthers in transverse sections; (k) Detail of h, showing style structures; (l) Enlargement of portion of a longitudinal section of the flower bud, showing the basi-laterally attached ovule and the recurrent veins (cf. fig. 2); (m) Transverse section of a flower bud showing the filaments almost joined together into a ring (slightly above the level showing in fig. 2, c); (n) Transverse section of flower bud through the receptacular region showing the vasculature (slightly below the level showing in fig. 2, b).

Phylogenetic consideration — A review

The genus of *Ancistrocladus* in modern classification systems is generally considered to represent a monogeneric family, the Ancistrocladaceae. The phylogenetic position of this family, however, is not well established. There are very few, if any, angiosperous families like the Ancistrocladaceae which it has been suggested at one time or another is related to such vastly distinct families as: Annonaceae, Combretaceae, Dioncophyllaceae, Dipterocarpaceae, Linaceae, Malpighiaceae, Myristicaceae, Pittosporaceae, Symplocaceae, Violaceae (Gilg 1995, Melchior 1964, Steenis 1948).

Current opinions still revolve around the placement of the Ancistrocladaceae in either the Guttiferales (or Parietales in part, including Dipterocarpaceae, Dioncophyllaceae and others) or the Geraniales (including Linaceae and others). Hutchinson (1959) shares with Planchon's original view that this family and the Dipterocarpaceae are closely related and both are classified under his order Ochnales. At first, Erdtman (1952) stated that pollen morphological evidence did not conflict with this family being referred to, or placed near to such families as Cactaceae, Dipterocarpaceae and Theaceae. He later (1958, cited by Melchior 1964) pointed out the similarities between pollen grains of this family and the Dinocophyllaceae, a small monogeneric African family which is grouped under the Guttiferae by Melchior (1964). Steenis (1948) listed a number of important characters which distinguish this family from the Dipterocarpaceae; he appears to be in favour of Miquel's and Hallier f.'s suggestion that this family is probably allied to the Linaceae-Hugoniaceae.

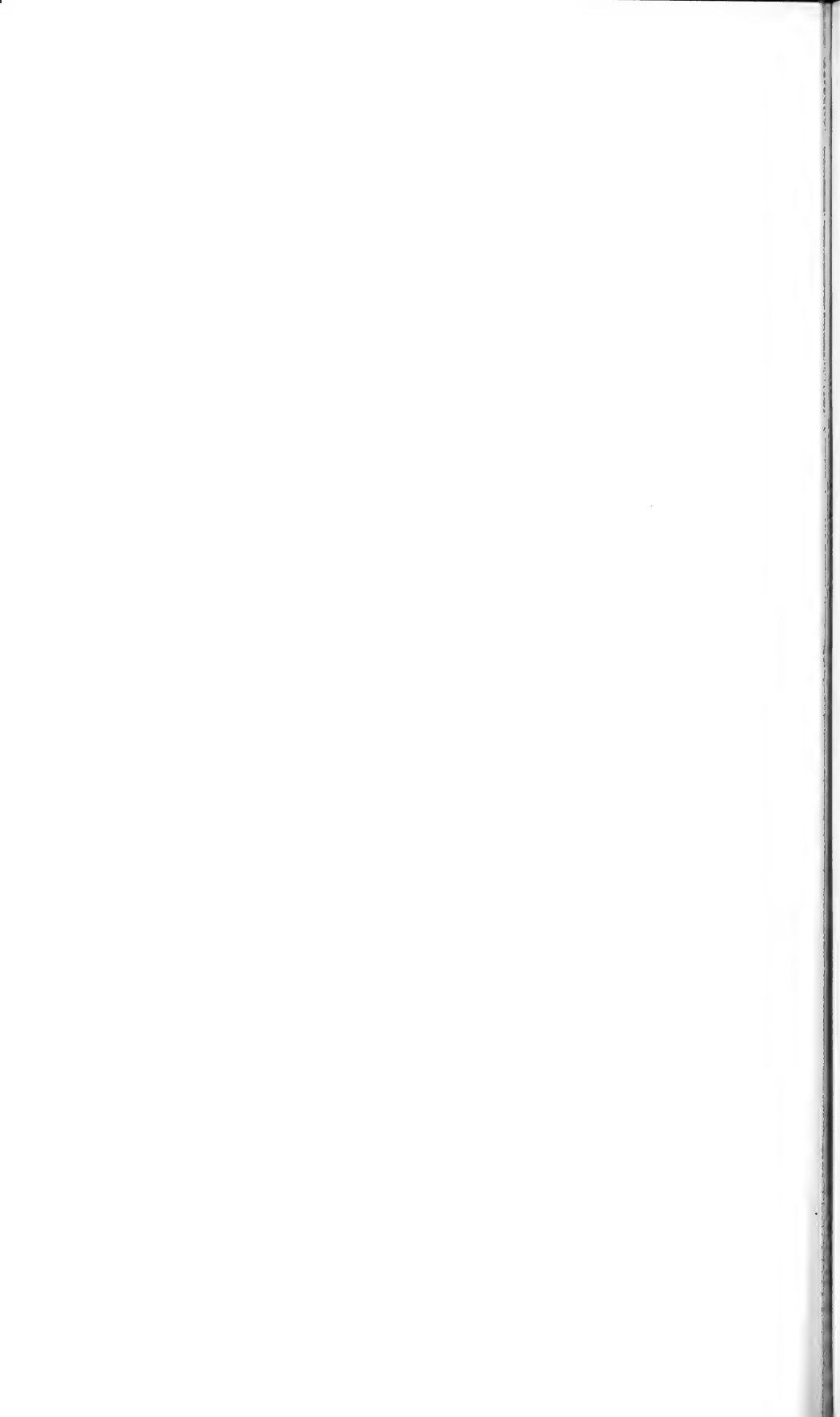
No positive conclusion can be drawn without thorough comparative morphological study of the above-mentioned taxa. The present writer, nevertheless, feels that the resemblance of the persistent and accrescent calyx-lobes in Ancistrocladaceae and Dipterocarpaceae is rather superficial. Similar types of fruit can be found in other unrelated families (Ridley 1930, pp. 103–112). The seed and seedling characters apparently indicate no affinities existing between these two families.

Acknowledgement

The writer wishes to express his thanks Dr. J. M. Machin for reading the manuscript of this paper, to Mr. E. Soepadmo, for supplying the preserved flower buds used in the study, and to Mr. D. Teow for taking the photograph reproduced in this paper.

Literature cited.

- ERDTMAN, G. (1952)—Pollen morphology and plant taxonomy: Angiosperms. Stockholm: Almqvist and Wilsell.
- GILG, E. (1895)—Ancistrocladaceae, in A. Engler and E. Prantl, Die natürlichen Pflanzen familien III, VI, 6: 274–276.
- HUTCHINSON, J. (1959)—The families of flowering plants. vol. 1: Dicotyledons. 2d ed. Oxford: Clarendon Press.
- MELCHIOR, H. (1964)—A. Engler's Syllabus der Pflanzenfamilien, ed. 12, II. Angiospermen. Berlin: Gebrüder Borntr.
- RIDLEY, H. N. (1930)—The dispersal of plants throughout the world. Kent: L. Reeve & Co.
- STEENIS, C. G. G. J. VAN (1948)—Ancistrocladaceae, in Flora Malesiana, ser. 1, 4¹: 8–10.



New records of plant diseases in Sarawak for the year 1965

by

G. J. TURNER

Department of Agriculture, Sarawak

Plant diseases recorded for the first time in Sarawak, are given below. The causal organisms are arranged alphabetically under their individual hosts. The frequency of occurrence is given, together with the Commonwealth Mycological Institute Herbarium serial number, where identification has been performed by the Institute.

Acacia auriculiformis A. Cunn. ex Benth. (Black wattle)			
Sooty mould	<i>Meliola</i> species	Locally common	115463
Damping-off	<i>Pythium</i> species	1 record	—
Allium ascalonicum L. (Shallot)			
Leaf blight	<i>Phyllostictina</i> species	Common	115456
Amaranthus gangeticus L. (Bayam)			
Leaf spot	<i>Cercospora</i> species	Common	115453
Leaf spot	<i>Phyllosticta atriplicis</i> Desm.	1 record	115451
Ananas comosus Merr. (Pineapple)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Annona muricata L. (Soursop)			
Leaf blight	<i>Pestalotiopsis glandicola</i> (Cast.) Steyaert	1 record	114589
Antigonon leptopus Hook. & Arn. (Coral creeper)			
Leaf rot	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	Occasional	—
Apium graveolens L. (Celery)			
Leaf spot	<i>Cercospora apii</i> Fresen.	Common	114588a
Leaf smut	<i>Entyloma helosciadii</i> Magn.	1 record	114588b
Argyreia speciosa Sweet (Elephant vine)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Artocarpus elastica Reinw. (Terap)			
Seedling blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Trunk rot	<i>Ganoderma lucidum</i> (Leyss. ex Fr.) Karst.	1 record	—

Artocarpus integra Merr. (Jack fruit)			
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Averrhoa carambola L. (Carambola)			
Leaf spot	<i>Glomerella cingulata</i> (Stonem.) Spauld. & Schrenk.	Occasional	115452a
Baccaurea motleyana Muell. Arg. (Rambai)			
Sooty mould	<i>Asterina aporosae</i> Hansf.	1 record	115459
Bambusa species (Bamboo)			
Sooty mould	<i>Caldariomyces</i> species	1 record	115466
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Bidens pilosa L.			
Leaf spot	<i>Cercospora bidentis</i> Tharp.	Locally common	115449b
Rust	<i>Uromyces bidenticola</i> Arth.	Locally Common	115449a
Bignonia magnifica Bull.			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Camellia sinensis (L.) Kuntze (Tea)			
Red root disease	<i>Ganoderma pseudoferreum</i> (Wakef.) van Over. & Steinm.	1 record	—
Canavalia ensiformis L. (Jack bean)			
Leaf rot	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Capsicum annuum L. (Chilli)			
On branches	<i>Septobasidium</i> species	1 record	—
Carica papaya L. (Papaya)			
Leaf spot	<i>Cladosporium</i> species	1 record	115450e
Leaf spot	<i>Curvularia intermedia</i> Boedijn	1 record	115450c
Leaf spot	<i>Mycosphaerella caricae</i> Syd.	1 record	115450b
Leaf spot	<i>Nigrospora sphaerica</i> (Sacc.) Mason	1 record	115450d
Celosia cristata L. (Cockscomb)			
Leaf speckle	<i>Cercospora celosiae</i> Syd.	1 record	115473a
Leaf spot	<i>Physalospora</i> species	1 record	115473b
Chrysanthemum species			
Bud blight	<i>Cladosporium</i> species	1 record	115490b
Bud blight	<i>Corynespora cassicola</i> (Berk. & Curt.) Wei.	1 record	115490a

Cinnamomum zeylanicum Breyn (Cinnamon)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Citrus grandis (L.) Osb. (Pomelo)			
Branch die back	<i>Botryodiplodia theobromae</i> Pat.	1 record	—
Citrus nobilis Lour. (Mandarin)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Clerodendron thomsonae Balf. F.			
Flower blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Cocos nucifera L. (Coconut)			
Leaf spot	<i>Helminthosporium incurvatum</i> Bern.	1 record	115471
Coffea arabica L. (Arabian coffee)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Congea species			
Flower and leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Crossandra undulifolia Salisb.			
White root disease	<i>Fomes lignosus</i> (Klotzsch) Bres.	1 record	--
Desmodium uncinatum DC.			
Leaf rot	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Dioscorea alata L. (Yam)			
Leaf spot	<i>Pestalotiopsis</i> species	1 record	115470
Dioscorea bulbifera L. (Potato yam)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Elaeis guineensis Jacq. (Oil palm)			
On dying leaves	<i>Botryodiplodia theobromae</i> Pat.	Occasional	—
Eleusine indica Gaertn.			
Flower mould	<i>Cochliobolus nodulosus</i> Luttrell	1 record	114582a
Stem blight	<i>Colletotrichum graminicola</i> (Ces.) Wilson	1 record	114582b

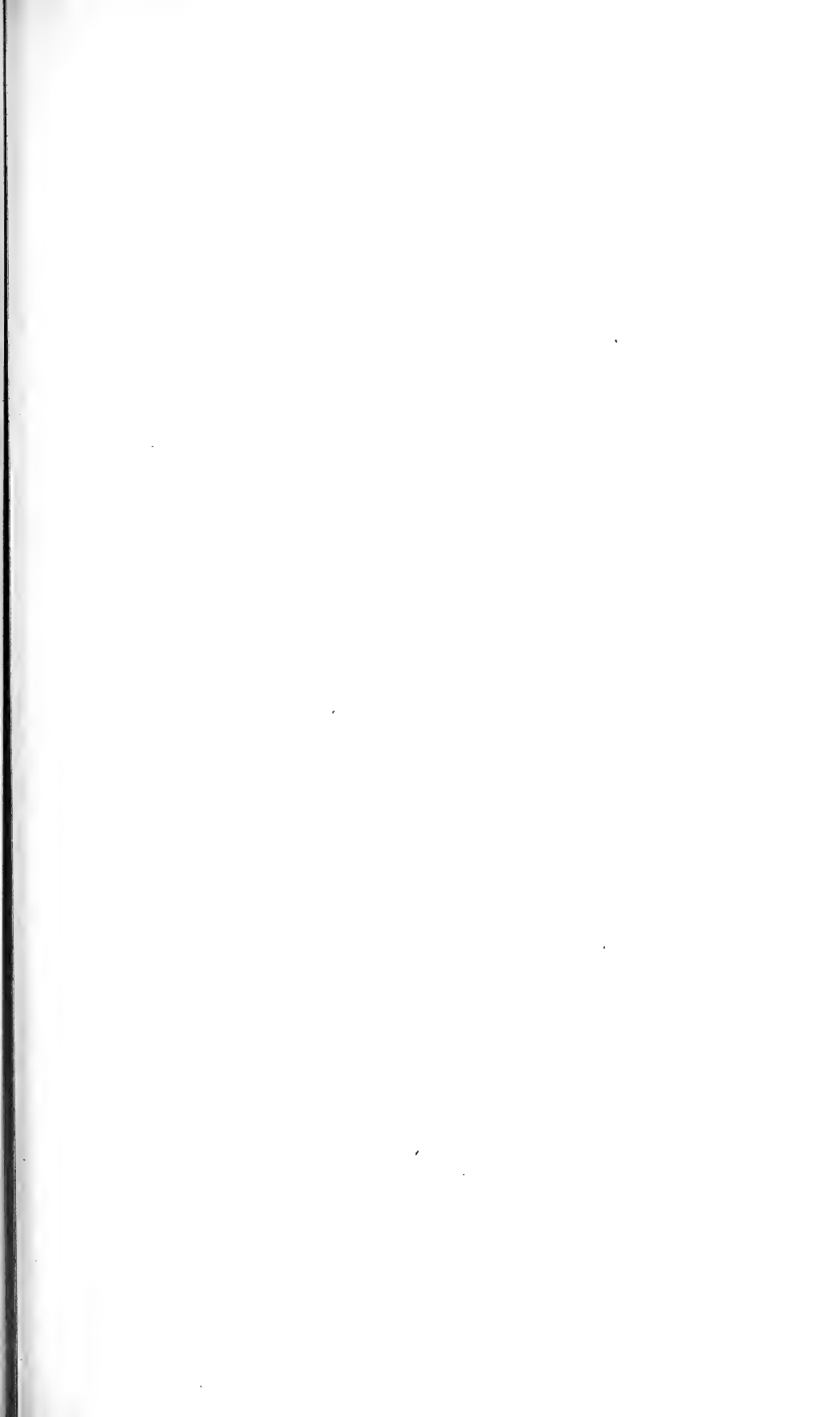
Eugenia malaccensis L. (Malay apple)			
On leaves	<i>Aschersonia</i> species	1 record	—
Sooty mould	<i>Phaeosaccardinula javanica</i> (Zimm.) Yamamoto	1 record	114591
Eugenia species (Jambu)			
Leaf spot	<i>Cercospora</i> species	1 record	115474
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Garcinia mangostana L. (Mangosteen)			
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Hevea brasiliensis Muell. Arg. (Rubber)			
Leaf spot and rim blight	<i>Ascochyta heveae</i> Petch	1 record	115457
Imperata cylindrica Beauv. (Lalang)			
On leaves	<i>Pirostoma</i> species	1 record	111054
Ipomoea batatas Lam. (Sweet potato)			
Leaf spot	<i>Cercospora timorensis</i> Cooke	1 record	115454
Ipomoea carnea Jacq.			
Sooty mould	<i>Meliola malacotricha</i> Speg.	1 record	114585
Ischaemum rugosum Salisb.			
False smut	<i>Cerebella andropogonis</i> Ces.	Occasional	111052
Ixora species			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Jasminum sambac Ait (Jasmine)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	Occasional	—
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Mangifera indica L. (Mango)			
On branches	<i>Septobasidium</i> species	1 record	—
Mangifera odorata Griff. (Kwini)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Mucuna benettii F. Muell. (New Guinea creeper)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Muntingia calabura L. (Japanese cherry)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Deis & Reid Denis	1 record	—

Musa textilis Née (Manila hemp)			
Stem rot	<i>Marasmius stenophyllus</i> Mont.	Locally common	
Myristica fragrans L. (Nutmeg)			
Pink disease	<i>Corticium salmonicolor</i> Berk. & Br.	1 record	—
Nephelium lappaceum L. (Rambutan)			
Seedling blight	<i>Corticium salmonicolor</i> Berk. & Br.	1 record	114577
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Powdery mildew	<i>Oidium nephelii</i> Hadi.	1 record	119468
Pachyrrhizus erosus Urban (Yam bean)			
Leaf rot	<i>Choanephora</i> <i>cucurbitarum</i> (Berk. & Rav.) Thaxt.	1 record	—
Leaf spot	<i>Myrothecium roridum</i> Tode ex Fr.	1 record	—
Paspalum scrobiculatum L.			
False smut	<i>Cerebella andropogonis</i> Ces.	Occasional	114575
Psidium cattleyanum (Sabine) Purple Guava			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Rhynchospora aurea Valh.			
Smut	<i>Cintractia spicularum</i> Rac.	Occasional	115464
Rosa species (Rose)			
Leaf spot	<i>Cercospora puderi</i> B.H. Davis	1 record	115455
Saccharum officinarum L. (Sugar cane)			
Leaf spot	<i>Leptosphaeria sacchari</i> v. Breda de Haan.	1 record	114576b
Sesamum indicum L. (Sesame)			
Leaf spot	<i>Cercospora sesami</i> Zimm.	Common	114578
Leaf spot	<i>Mycosphaerella</i> species	1 record	114579
Sesbania aculeata Poir.			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Solanum melongena L. (Brinjal)			
Wilt	<i>Sclerotium rolfsii</i> Sacc.	1 record	—
Sorghum almum Parodi (Columbus grass)			
Leaf spot	<i>Phyllachora sorghi</i> Hohn	1 record	114580
Spathodea campanulata Beauv. (African tulip tree)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—

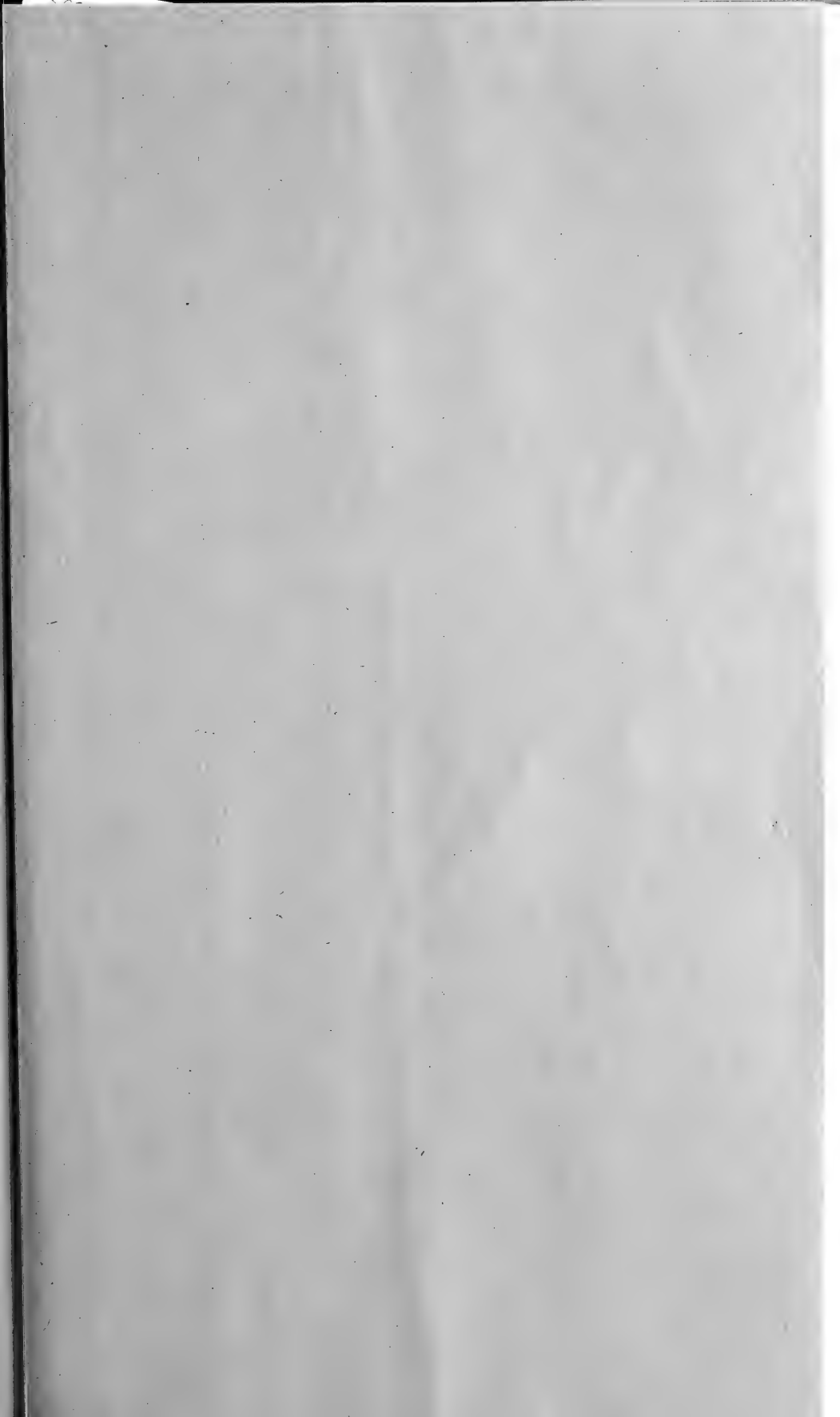
Stenochlaena palustris Bedd. (Paku miding, Edible fern)			
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Horse hair blight	<i>Marasmius equicrinus</i> Müll.	1 record	—
Tabernaemontana coronaria Willd.			
Leaf spot	<i>Cercospora tabernaemontanae</i> H. & P. Syd.	Common	115476
Pink disease	<i>Corticium salmonicolor</i> Berk & Br.	1 record	—
Thread blight	<i>Marasmiellus scandens</i> (Mass.) Denis & Reid	1 record	—
Theobroma cacao L. (Cocoa)			
Brown pod	<i>Botryodiplodia theobromae</i> Pat.	locally common	—
Thunbergia grandiflora Roxb.			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Zea mays L. (Maize)			
Leaf blight	<i>Corticium solani</i> (Prill. & Delacr.) Bourd. & Galz.	1 record	—
Smut	<i>Ustilago maydis</i> (DC.) Corda.	1 record	115477

Acknowledgements

The writer wishes to thank the Director of Agriculture, Sarawak, for permission to publish this list, and the Director and staff of the Commonwealth Mycological Institute without whose help, in identifying many of the species, this list could not have been published.







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27th December, 1967

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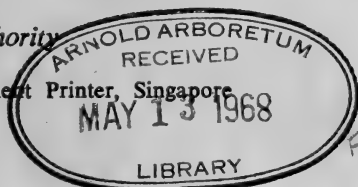
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Printed by Lim Bian Han, Government Printer, Singapore

1967





Materials for a Monograph of Freycinetia (Pandanaeae). I.

by

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Department of Botany, University of Malaya, Kuala Lumpur.

The following notes represent the results of studies in the genus *Freycinetia*, a large and somewhat neglected group of plants with perhaps as many as two hundred species. Previous studies in the group have appeared by the present author in the form of a review of the species of the Solomon Islands (*Proc. Biol. Soc. Wash.* 76: 1-8. 1963), a proposed new species from Morotai, Moluccas Is. (*Journ. Arn. Arb.* 43: 248-350. 1962), and a review of the species known from Fiji, Samoa, and Tonga (*Proc. Biol. Soc. Wash.*, 80: 47-60. 1967). The work here reported concerns species of Polynesia, Micronesia, Melanesia, and Malaysia, and consists chiefly of some shorter studies in particular species, some nomenclatural adjustments, some reports of recent collections, and the description of a few new taxa. Because it is proposed to initiate further publications in this series, paragraphs or sections are numbered for ready future reference.

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- 1.1. The typification of the genus *Freycinetia* and remarks on the Hawaiian species.
- 1.2. *Freycinetia kiekie* B. C. Stone, nom. nov.
- 1.3. *Freycinetia distigmata* B. C. Stone, nom. nov.
- 1.4. *Freycinetia* collected in New Guinea in 1959 by L. J. Brass.
- 1.5. *Freycinetia* of Micronesia.
- 1.6. Preliminary studies on 'leaf spectrum' series in *Freycinetia*.
- 1.7. A note on *Freycinetia boninensis* Nakai.

1.1. The typification of the genus *Freycinetia* and remarks on the Hawaiian species.

The genus *Freycinetia* was established by Gaudichaud (*Bot. Voy. Freycinet . . . l'Uranie et Physicienne . . . Atlas*, t. 41. 1826), with three species: *F. arborea*, *F. scandens*, and *F. radicans*. The first of these is selected as generitype. It is represented by a collection made by Gaudichaud in Hawaii, and is well figured in the table referred to above. *Freycinetia scandens* Gaud., a valid species, is from Timor (the holotype is Zollinger 647), and *F. radicans* is from Rawak, New Guinea (the holotype a Gaudichaud specimen).

Freycinetia arborea Gaud. is the only species occurring in the Hawaiian Archipelago. However, in Hillebrand's *Flora of the Hawaiian Islands* (1888: 453) the species is described under the name "*Freycinetia Arnotti* Gaudich." This was proposed by Gaudichaud in a later publication, of 1843 (*Bot. Voy. La Bonite*, Atlas t. 36, 37), and was taken up by some later authors. It is however nothing more than a slightly differing specimen of the single widely distributed species in the Hawaiian group. The alleged distinction, based on the number of stigmata per berry, is unnatural; stigmatic number varies in this species generally, from 4 to 10 (or more), and the supposedly distinctive ranges ("4-6" in *F. Arnotti*, "6-9" in *F. arborea*) are mere samplings of the inclusive range.

Hillebrand was aware that but a single species was to be found in the Hawaiian flora, but he took up the latter name *F. Arnotti* because "the older name *F. arborea* has to be abandoned as inappropriate and misleading." He was right in saying that the older name was inappropriate, as the species is a woody climber, as are all other known species of the genus, but with regard to the choice of name we are retroactively required to use the earlier name.

Freycinetia arborea Gaud., in Freyc. Voy. Uranie et Physicienne, Bot., Atlas t. 41. 1826. Solms-Laubach, *Linnaea* n.s. 8: 100. 1878-79. Mann, Enum. Haw. Plts. n. 469. 1866. [Fig I: 1.]

F. scandens sensu Hooker & Arnott, Bot. Beechey Voy. 87. 141. (non Gaudichaud).

F. arnotti Gaud., Bot. Voy. Bonite, Atlas t. 36, 37. 1843.

F. arnotti Gaud., Bot. Voy. Bonite, Atlas t. 36, 37. 1843. Solms-Laubach, *Linnaea* n.s. 8: 95. 1878-79. Hillebrand, Fl. Haw. Is. 453. 1888.

Holotype: HAWAIIAN ISLANDS: "In insulis Sandwich" (Gaudichaud). PARIS; and isotype in the Delessert Herbarium (GENEVA). The holotype of *F. Arnotti* is also marked simply "In insulis Sandwich" (Gaudichaud).

Occurrence: A common species throughout the six major islands of the Hawaiian Archipelago (Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii). It does not occur on the dry barren island of Kahoolawe, nor on the tiny crescentic rim Molokini. It apparently does not occur on the island of Niihau (neither Forbes, in his Enumeration of Niihau Plants of 1913, nor St. John, in his paper on Niihau plants in 1959, records the species). It is not known from the Leeward Islands of the Hawaiian group (Nihoa, Necker, Laysan, Lisiansky, Midway and Kure).

Habitat: *Freycinetia arborea* is most abundant in the lower and middle forest zones (of Rock, 1913) or Vegetation Zones B, C, and D (of Ripperton and Hosaka, 1942), where it may be found climbing by its clinging roots on forest trees, or sometimes with the loose stems falling and intermingling to form dense clumps of what appears to be terrestrial growth especially on steep slopes. It roots in old lava soils, either rocky or in rich loam. The largest

plants are found in moderate shade, but they tolerate windswept exposed conditions on cliffs as well. In general, *Freycinetia arborea* can be considered a rather common species between about 300 meters and about 1500 meters altitude.

Some recent collections of *F. arborea*:

HAWAIIAN ISLANDS: Kauai: Summit of Mt. Haupu, S.E. side at 700 m alt., Dec. 1956, *Stone* 1645 (BISHOP, K, US); Oahu: Puulupe, Kawailoa, Feb. 1937, *Degener, Topping, Martinez & Salucop* 11070 (US); Waimano, Oct. 1935, *Degener, Park & Shigeura* 10140 (US); Piko trail, Mokuleia, *Yuncker* 3316 (US); Punaluu, Castle Trail, *Stone* 1166 (BISHOP); Manoa Cliff Trail, *Stone* 3109 (BISHOP); Pupukeya, Sept. 1958, *Stone* s.n. (BISHOP); Maui: Puu Mukui, Sept. 1916, *Hitchcock* 14777 (US); without locality, April 1911, *Curran* 83 (US); Hawaii: Volcano Road, July 1924, *Setchell* s.n. (US); Honaunau Mountains, Sept. 1916, *Hitchcock* 14561 (US).

An illustration of the berry and seed is provided (Fig. I).

1.2. *Freycinetia kiekie* B. C. Stone, nom. nov.

F. monticola F. B. H. Brown, Bishop Mus. Bull. 84: 29. pl. 19. 1931; not *F. monticola* Rendle, Journ. Linn. Soc. Bot. 45: 259. 1921.

Type locality: French Oceania: Marquesas Islands: Hivaoa Island, Feani, *F. Brown* 870 (BISHOP).

This endemic species is also reported from Uapou Island on the basis of *Quayle* 1135. It is quite distinct from Rendle's species; rather it is related to the above Hawaiian *F. arborea*. The new name is taken from the Marquesan version of the widespread Polynesian name for this genus. Subject to the normal changes (as in glottal stops) the same word is used throughout Polynesia. In Hawaii, it is 'ie'ie.

1.3. *Freycinetia distigmata* B. C. Stone, nom. nov.

F. klossii Ridley in Kew Bull. 1926: 92. 1926; not *F. Klossii* Ridley in Trans. Linn. Soc. Bot. 9: 236. 1916.

Type locality: Sumatra: Mentawi Island; Siberut, *Boden-Kloss* 14547.

Ridley inadvertently used the same epithet twice in the genus in honor of Boden-Kloss. The species first so named, and to which the name continues to apply, is from New Guinea. The Sumatran species requires a new name, given above in reference to its generally 2-stigmatic carpels.

1.4. *Freycinetia* collected in New Guinea in 1959 by L. J. Brass.

During a year spent at the U. S. National Herbarium (Smithsonian Institution, Washington D.C.), I had the opportunity of studying the collections of *Freycinetia* made by Leonard J. Brass in 1959, during the Fifth Archbold Expedition, sponsored by the American Museum of Natural History with the aid of a grant from the National Science Foundation. As is well known, the series of

Archbold Expeditions have been invaluable in increasing our knowledge of New Guinea, and Mr. Brass's collections are generally exemplary in quality. In fact, a large number of species of Pandanaceae are based on Brass specimens.

The following account details collection data of species collected, and includes the descriptions of two proposed new species of *Freycinetia* based on Mr. Brass's material. The text may be considered as a continuation of the papers by Merrill and Perry on previous Pandanaceae from New Guinea, which appeared in *Journ. Arn. Arb.* 20: 139–186. 1939; and 21: 163–175. 1940. I am grateful to Dr. Lily M. Perry for her kind assistance during a visit to the Harvard University Herbaria in 1961, and also to Dr. Richard A. Howard, Director of the Arnold Arboretum.

Section *Freycinetia*¹

In the interest of convenience there are included here a few nomenclatural adjustments.

1. *Freycinetia funicularis* (Savigny) Merr., *Interpret. Rumph. Herb. Amb.* 83. 1917; Merr. & Perry, *Journ. Arn. Arb.* 20: 155. 1939; 21: 168. 1940. [Fig. I: 2.]

Freycinetia strobilacea Bl. in *Rumphia* 1: 156. t. 39. 1835; Schnizlein, *Icon.* 1: t. 74, f. 3–5. 1846; Solms-Laubach, *Ann. Jard. Bot. Buitenz.* 3: 99. 1883; Warb. in *Pflanzenr.* 3 (IV. 9): 34. 1900; Martelli, *Webbia* 3: 315. 1910.

Freycinetia cyrtocarpa Kanehira, *Bot. Mag. Tokyo* 55: 295. f. 13. 1941. *Syn. nov.*

Type locality: Amboina. Recorded from the Solomon Islands by Merrill & Perry. The type of *F. strobilacea* is the Rumphian plate, on which is based the correct name taken up by Merrill.

The type of Kanehira's species is from "Netherlands New Guinea (Boemi, about 40 km inland from Geelvink Bay, at about 300 m alt., *Kanehira & Hatusima* 12680)". Although this species may be distinct, (we are less than certain of all details of the plant pictured by Rumphius) it seems to be synonymous. The few differences are the smaller, nearly smooth leaves, the unarmed bracts, and the slightly curving syncarps; but these do not carry much significance.

NEW GUINEA: Papua: Northern District, near Koreaf, Tuji subdistrict, 23 September 1954, *Hoogland* 4794 (A); near Budi Barracks, "urur" in Onjob language, 25 August 1954, *Hoogland* 4552 (A, US); Morobe District, Sattelberg, 1000 m alt., 8 Nov. 1935, *Clemens* 832 (A). Finschhafen Peninsula, in beach woods, 19 October 1936, *Clemens* 4286 (A).

¹ Article 22 of the International Code of Botanical Nomenclature requires that the name of the section that includes the type species of a genus repeat that name unaltered as its epithet. Consequently Sect. *Freycinetia* must be used for the section including *F. arborea* Gaud., rather than the earlier proposed Sect. *Pleio stigma* Warb. in *Pflanzenr.* 3 (IV. 9): 28. 1900. This section is characterized by berries with mostly 5–10 stigmas.

Both Hoogland and Clemens note that the bracts are "deep red" or "flame color". Solomon Islands specimens collected by L. J. Brass were, according to Brass's field data, characterized by "pink bracts." These specimens have also the much less conspicuously dentate vegetative bracts which Kanehira mentions for his *F. cyrtocarpa*.

2. ***Freycinetia salamauensis*** Merr. & Perry, Journ. Arn. Arb. 20: 152. pl. 1, f. 7. 1939. [Fig. I: 3.]

Type locality: North-eastern New Guinea, Morobe District, Sattelberg, Salamaua (*Clemens* 28, A).

This species appears to be very close to *F. biroi* Warb. The authors distinguished it by its shorter common peduncle, longer pedicels, and the hispidulous angles and apex of the pedicels. It is one of the species which is intermediate between the generic sections, having for the most part berries with 3 stigmas; the range is from 2 to 6 stigmas per berry.

NEW GUINEA: Eastern Highlands District, Kassam Gap, 1460 m alt., 28 Oct. 1959, climbing to middle spaces in Castanopsis-oak forest; leaves glaucous on both sides; ripening fruits orange-red, *Brass* 32285 (US, and to be distrib.).

3. ***Freycinetia sogerensis*** Rendle, Journ. Bot. 61. Suppl. 58. 1923.

Type locality: "New Guinea, Sogere, 2,500 ft." (*Forbes* 75).

NEW GUINEA: Eastern Highlands District, Purosa, Okapa area, 150 m alt., common root-climber on exposed tree-trunks in rainforest; ripe fruiting heads orange, soft, ovoid, avg. 3.5 cm long, 2.5 cm broad, 2 October 1959, *Brass* 31851 (US, and distrib.).

4. ***Freycinetia stenodonta*** Merr. & Perry, Journ. Arn. Arb. 20: 151. 1939.

Type locality: Papua, Central Division, Ononge Road, Dieni (*Brass* 3838).

NEW GUINEA: Morobe District, Gurakor, 640 m alt., climbing to 3 m in oak-dipterocarp forest, flat leaves appressed to supporting trunk, sterile, 6 May 1959, *Brass* 29452 (US); Sattelberg, 3200 ft. alt., *Clemens* 862i-bis (A).

A readily recognizable species, with marked vegetative characters. The syncarps of the Clemens specimen are shortly oblong, and they are noted as "red, fleshy."

5. ***Freycinetia perryana*** B. C. Stone, sp. nov. (Sect. *Freycinetia*). [Fig. I: 4.]

Scandens; caule lignoso subrobusto ad 1 cm crasso; foliis ensiformibus basi imbricatis 39–47 cm longis, 16–18 mm latis, apice anguste acuminatis, basi vix angustatis, amplexicaulibus, margine basim et apicem versus et costa media in parte superiore serrato-dentatis; auriculis scarioso-membranaceis, circiter 8–9 cm longis, 8–9 mm latis, margine integerrimis, in parte superiore decurrentibus (vel rotundatis?) adnatis, demum transverse fractis; inflorescentia terminalia, spathis caducis non visis, pedicellis 5–6.5 cm longis ad 4 mm crassis, ubique denticulis crassis deltoideis

erectis 0.3–0.6 mm longis et latis armatis, pedicello apicem versus subdense scabridis; syncarpiis 5, cylindraceutis, circiter 8 cm longis, et 1.7 cm latis; baccis circiter 9 mm longis et 3 mm latis, infra 4/5 carnosis apice coriaceis truncatis angulosis, areola stigmatica pallide brunnea nitente annulos cinctos kermesinos, stigmatibus vulgo 2 vel 4 rarius 5; fissuris stigmaticis angustis conspicuis; seminibus anguste semi-ellipsoideis usque ad 1.5–1.7 mm longis, fusco-rubris, raphide cum cellulis raphidophoris argenteis niten-tibus, strophiole nullo.

Holotype: NEW GUINEA: Eastern Highlands District, Mt. Wilhelm, eastern slopes, 2770 m alt., 29 July 1959, L. J. Brass 30765 (US, and isotypes for distrib.).

This species is similar to *Freycinetia trachypoda* Merr. & Perry and also to *F. tafaensis* Merr. & Perry; differing however from the former in having smaller leaves, coarsely scabrid (rather than hispidulous) pedicels, and more numerous syncarps; and from the latter in having somewhat longer leaves with apically narrowed, entire auricles (rather than truncate, spinulose auricles), longer more coarsely scabrid pedicels (to 6.5 cm long, rather than only 1.5 cm long), and larger more numerous syncarps per inflorescence.

It is a pleasure to dedicate the species to Dr. Lily M. Perry, long an associate and colleague of Dr. E. D. Merrill, long associated with the Arnold Arboretum, and well-known for numerous studies on Melanesian plants.

Section *Oligostigma* Warb.

6. *Freycinetia angustissima* Ridley, Journ. Bot. 24: 359. 1886; Martelli, Webbia 3: 309; 1910; Rendle, Journ. Bot. 61. Suppl. 57. 1923; Kanehira, Bot. Tokyo 55: 251. f. 1. 1941; Merr. & Perry, Journ. Arn. Arb. 21: 163. 1940.

Freycinetia stenophylla Warb. in K. Schum. & Lauterb. Fl. Deutsch. Schützeb. i. d. Südsee, Nachtr. 53. 1905; Martelli, Webbia 3: 315. 1910; Journ. Arn. Arb. 10: 137. 1929; White, Journ. Arn. Arb. 10: 201. 1929; Merr. & Perry, Journ. Arn. Arb. 20: 141. 1939.

F. sp. Solms-Laubach, Jard. Bot. Buitenz. Bull. 3: 101. 1883.

Freycinetia polyclada Merr. & Perry, Journ. Arn. Arb. 20: 141. pl. 1, f. 3. 1939.

Type locality: New Guinea, Sogere, 2000 ft. (*Forbes*).

The type of *Freycinetia stenophylla* was from the Torricelli Mountains, Kaiser-Wilhelmsland, 600 m alt. (*Schlechter* 14525); and that of *F. polyclada* was from North-eastern New Guinea, Central Division, Mount Tafa, 2400 m alt. (*Brass* 4961). The latter species was synonymized by Merrill and Perry in their second paper of 1940 on New Guinea Pandanaceae (Journ. Arn. Arb. 21).

NEW GUINEA: Eastern Highlands District, Mt. Otto, south slopes, 2200 m alt., common in disturbed forest, climbing to 7 m not much branched; fruit-heads usually solitary, sometimes 2 or 3, ovoid or subglobose, orange, about 2.5 cm in diameter when ripe; 14 Aug. 1959, *Brass* 31050 (US and distrib.); same loc., 2680 m alt., plentiful in mossy beech forest, 7 August 1959, *Brass*

30874 (US, unicate). Papua: Boridi, in forest, fruit to 2 cm long, 16 September 1935, *Carr* 13182 (A, BM). Morobe District; Sattelberg, 12 May 1938, *Clemens* 8221 (A).

7. *Freycinetia archboldiana* Merr. & Perry, Journ. Arn. Arb. 20: 147. pl. 1, f. 10. 1939.

Freycinetia inouei Kanehira, Bot. Mag. Tokyo 55: 254. f. 4. 1941. Syn. nov.

Type locality: Papua, Central Division, Bella Vista (*Brass* 5458).

The type of *Freycinetia inouei* Kaneh. was from Dallmann in then Netherlands New Guinea (*Kanehira* & *Hatusima* 12163). Kanehira stated that the species is distinguished from *F. archboldiana* by its "much thicker syncarp and more numerous drupes" (sic; i.e. berries), but these differences seem more due to individual variation than to a species difference. A comparison of an isotype (A) with the type of *F. archboldiana* (also at A) failed to reveal any further differences of significance.

Kanehira mentions that the leaves are rigid, erect, and tinged purplish when fresh. The seeds show a conspicuous raphe but lack a strophiole.

8. *Freycinetia arfakiana* Martelli, *Webbia* 3: 173. 1910.

Type locality: "Netherlands New Guinea, Mt. Arfak, Putat" (*Beccari* 821).

NEW GUINEA: Eastern Highlands District; Arau, 1400 m alt., frequent in castanopsis-oak forest, climbing to several meters and sparingly branched, bracts white with pale green tips, 14 Oct. 1959, *Brass* 32070 (US and distrib.).

This specimen is referred here with some hesitation; the leaves are mostly 25–29 cm long and 4–4.5 cm broad (shorter than those of *Beccari*'s type by 10–15 cm), entire, with auricles 5–6 cm long and 8–9 mm broad, these entire and deciduous; syncarps terminal, narrowly cylindrical, on smooth pedicels 2–3 cm long, about 3 mm thick, four in number, each syncarp to 3 cm long and 9 mm thick; berries with mostly 2–4 stigmas but very immature.

9. *Freycinetia brassii* Merr. & Perry, Journ. Arn. Arb. 20: 145. 1939. [Fig. I: 6.]

Type locality: Papua, Fly River, 528 Mile Camp (*Brass* 6651).

NEW GUINEA: Morobe District; Gurakor, 640 m alt., scrambling to 10 meters in rainforest, 5 May 1959, *Brass* 29431 (US, unicate).

This specimen matches the original description well except that the inflorescence is lateral (i.e. pseudo-lateral). Since this is a variable character, (sometimes both terminal and 'lateral' inflorescences occur on the same plant), and the other features correspond so closely, there is no apparent reason for keeping it distinct. It should be remarked that *Freycinetia lacunculata* Kanehira is scarcely to be distinguished from *F. brassii*. Kanehira stated that the differences lie in the ellipsoid, rather than oblong-cylindric

syncarps of the former, and the brownish to orange-red color of the berries; these differences are however unimportant. Brass's notes mention that the syncarps of his no. 6657 (cited by Merrill and Perry under *F. brassii*) were orange-red; while those of his no. 6927 were brown.

10. ***Freycinetia crucigera*** Kanehira, Bot. Mag. Tokyo 55: 252. 1941.

Type locality: "Netherlands New Guinea; Dallmann, 600 m alt." (*Kanehira & Hatusima* 12286).

NEW GUINEA: Eastern Highlands District; Mt. Michael, north-eastern slopes 2000 m alt., climbing to 2 meters in castanopsis-oak-nothofagus forest; fruits immature; seeds purple; 9 September 1959, *Brass* 31471 (US); Purosa, Okapa area, 1950 m alt., frequent in mixed rainforest, climbing to several meters, leaves thin and crinkled, flowering bracts green, fruits unripe, 20 September 1959, *Brass* 31593 (US).

The first specimen cited fits the original description and figure very well, except for the terminal infructescence; and the second specimen bears smaller leaves, but of the same proportions, and the infructescence is either lateral or terminal, indicating this character's variability. The principal difference between this species and *Freycinetia beccarii* seems to be the relatively broader leaves and the seeds without strophiole, of the present species.

11. ***Freycinetia fibrosa*** Martelli, Journ. Arn. Arb. 10: 138. 1929; Merr. & Perry, *ibid.* 21: 164. 1940.

F. sogerensis sensu Merr. & Perry, loc. cit. 20: 147. 1939, non Rendle 1923.

Type locality: Papua; Gulf District, Vailala River, Hokoro, 100 m alt. (*Brass* 1048).

NEW GUINEA: Eastern Highlands District; Mt. Elandora, Kratke Mts., 2130 m alt., climbing on forest undergrowth, fruits immature; 18 Oct. 1959, *Brass & J. D. Collins* 32164 (US); Purosa, Okapa Area, 1950 m alt., climbing to 10 meters in rainforest, common, flowering bracts thin, greenish-white; 21 September 1959, *Brass* 31632 (US).

13. ***Freycinetia kanehirae*** B. C. Stone, nom. nov.

Freycinetia platyphylla Kanehira, Bot. Mag. Tokyo 55: 261. f. 10. 1941; not *F. platyphylla* Merrill, Philipp. Journ. Sci. Bot. 13: 267. 1918.

Type locality: "Netherlands New Guinea: Dallman-Patema, 600 m alt.;" (*Kanehira & Hatusima* 12285).

The required new name commemorates Professor Ryoza Kanehira, formerly of the Department of Agriculture of the Kyushu Imperial University in Fukuoka, Japan, a student of the Pandanaceae and authority on the flora of Micronesia. There is also a *Pandanus kanehirae* Martelli from Palau. Merrill's species is from the Philippines.

Freycinetia kanehirae is characterized by its very large leaves (120 cm long, 7–8 cm broad), its large cylindrical syncarps of numerous slender berries, and its smooth fruit-pedicels. It is reminiscent of *F. tessellata* Merr. & Perry of the Solomon Islands, but differs in its smooth rather than scabrid pedicels; and of *F. ponapensis* Martelli of Ponape (Caroline Islands), but differs in the obtuse leaf tips and much longer syncarps.

14. ***Freycinetia radicans*** Gaudich., in Freycinet, Voy. autour du Monde . . . sur les corvettes l'Uranie et le Physicienne . . . Bot. 432; et Atlas Bot. t. 43. 1826; emend. Warb. in Pflanzenr. 3 (IV. 9): 34. 1900. [Fig. I: 5.]

Type locality: Is. Rawak, near West Irian (West New Guinea). The type is Gaudichaud's collection.

NEW GUINEA: Morobe District; Kaindi, 2250 m alt., occasional in *Nothofagus* forest, scandent to 20 meters or more; 10 May 1959, Brass 29666 (US).

This species is imperfectly known; but the Brass collection corresponds with what little is known.

15. ***Freycinetia spinellosa*** Kanehira, Bot. Mag. Tokyo 55: 265. f. 12. 1941.

Type locality: "Netherlands New Guinea: Dallmann (*Kanehira* & *Hatusima* 12507).

NEW GUINEA: North-western New Guinea: Sorong, Kp. Baroe, in forest, nom. vern. "riligino", 28 July 1948, *Djamhari* 389 (A).

A species notable for its long narrow leaves and spinulose-margined auricles.

16. ***Freycinetia tafaensis*** Merr. & Perry, Journ. Arn. Arb. 20: 146. 1939.

Type locality: Papua: Central Division, Mt. Tafa, 2400 m alt.; (Brass 5001).

NEW GUINEA: Eastern Highlands District, Mt. Elandora, Kratke Mts., 2530 m alt., scrambling to 1.5 meters in scrubby growth of summit, flower bracts orange; 18 Oct. 1959, Brass and Collins 32144 (US). Morobe District, Mt. Kaindi, 2200 m alt., frequent in *Nothofagus* forest, climbing to 12 meters, branches spreading, flower bracts orange-yellow; 23 May 1959, Brass 29733. (US).

17. ***Freycinetia elegantula*** B. C. Stone, sp. nov. (Sect. *Oligostigma*). [Fig. I: 7.]

Liana nana ad arbores adpressa, caulis lignosis, 2–6 mm diametro, laevis, in sicco rugulosus; ramis angustis, radicibus fibrosis emittens; folia minima, ovata, 15–22 mm longa, 5–9 mm lata, acuta, longitudine nervosa (nervis utrinque circiter 8) margine et in costa dorsale spinulosa vel fimbriatulusa (spinulis 1–1.3 vel 2 mm longis et 1–2 per mm); auriculis caducis minutis inconspicuis amplectentibus; inflorescentia lateralia, caule breve (8–10 mm longo) bracteato

terminans; bracteis caulae basin versus deltoideis acuminatis margine integerrimis; bracteis caulae apicem versus foliaceis; bracteis floraleis viridis margine integerrimis; pedicellis 3, apicem versus minute et persparse breve-spinulosis vel sublaevibus, 5–7 mm longis; syncarpiis 3, subglobosis, ad 12 mm diametro; baccis carnosis, circiter 4 mm longis, 1.5–3 mm latis, apice rotundatis; stigmatibus 1–2; seminibus anguste semi-ovatis, circiter 0.7 mm longis, strophiole nullo (?).

Holotype: NEW GUINEA: Eastern Highlands District, Arau, 1400 m alt., 8 October 1959, *L. J. Brass* 31945 (US, and isotypes for distrib.).

An extraordinary, tiny and elegant species related to *Freycinetia beccarii* but with smaller yet proportionately broader leaves with conspicuously spinulose margins and costa.

From the available material, which is without flowering or fruiting spikes, I judge this species to be the same or very nearly the same as that described in English only in 1939 by A. D. E. Elmer under the name *Freycinetia brevifolia* (*Leafl. Philipp. Bot.* 10: 3771. 1939). This name is invalid, since it is without a Latin diagnosis and printed after 1935; it is also a later homonym, since there is the earlier valid name *Freycinetia brevifolia* Martelli (*Webbia* 3: 186. 1910). Elmer's sole collection was from Camp Lambi, Nueva Ecija Province, Luzon. The leaves are described as 25 mm long, 20 mm broad, ovate-elliptic, and "margine serratuli-spinulosis, supra distincte nervatis". This corresponds very closely to the above description of *Freycinetia elegantula* except in the greater width. It is possible that but a single species is concerned, occurring both in New Guinea and the Philippines.

FIGURE I

Details of features of some species of *Freycinetia*.

1. *Freycinetia arborea*. Berry in profile and top view, x 5; seed x 5, and enlarged x 20. (From *Stone* 3109).
2. *Freycinetia funicularis*. Staminate plant; stamens x 5; male inflorescence x $\frac{1}{2}$; leaf apex x $\frac{1}{2}$. (From *Hoogland* 4552).
3. *Freycinetia salamauensis*. Berry in profile and top view x 5; seed enlarged x 20; portion of cellular structure of strophiole, greatly enlarged. The embryo is 0.2 mm thick; endosperm dark pink; seed walls crimson, 0.05 mm thick; raphe and strophiole translucent. (From *Brass* 32285).
4. *Freycinetia perryana*. Berry in profile and top view x 5; seed, two views, x 5. (From holotype, *Brass* 30765).
5. *Freycinetia radicans*. Berry in profile and top view x 5. (From *Brass* 29666).
6. *Freycinetia brassii*. Berry in profile and top view x 5; leaf apex x $\frac{1}{2}$. (From *Brass* 29431).
7. *Freycinetia elegantula*. Berry in profile and top view x 5; seed x 5; leaf x 1; and infructescence x 1. (From holotype, *Brass* 31945).

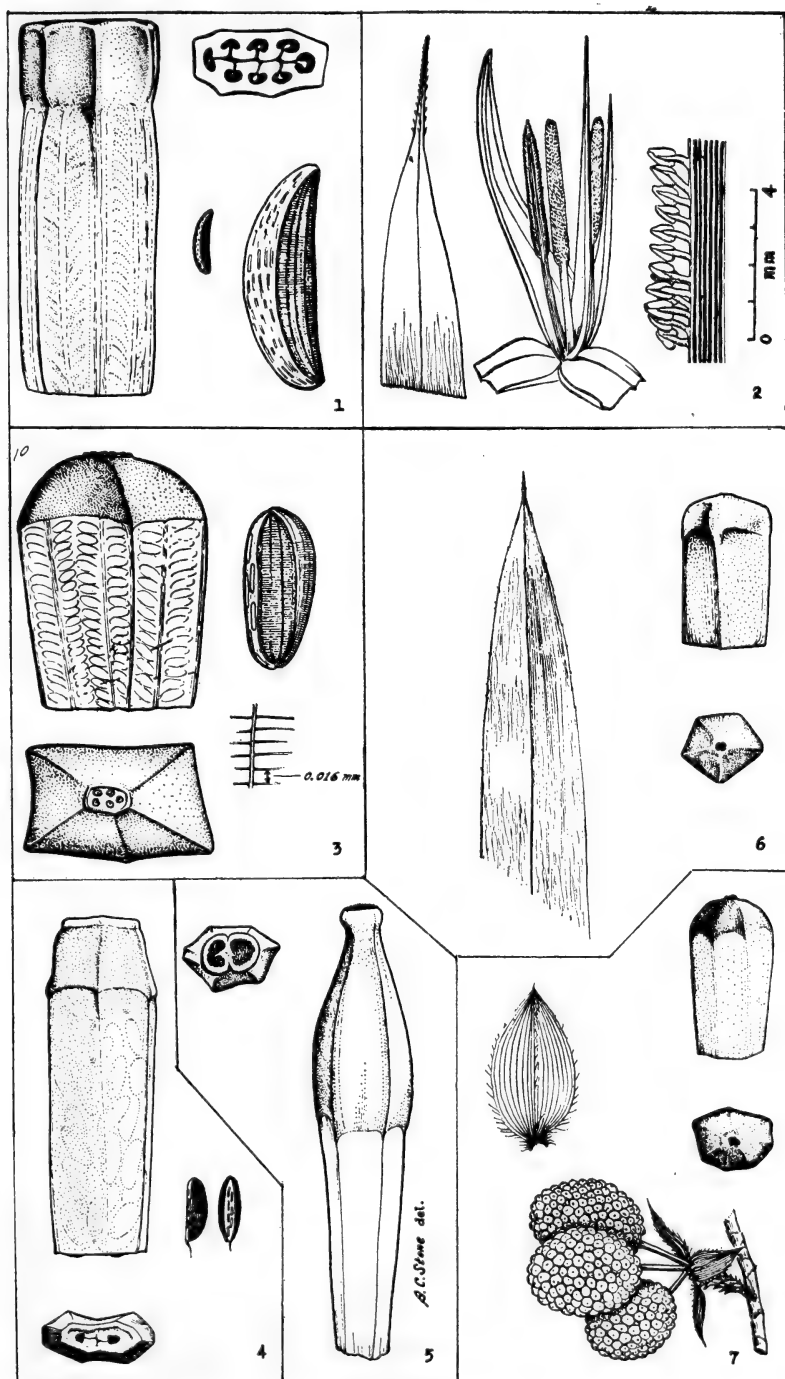


FIGURE I

See caption on page 10

1.5. The genus *Freycinetia* in Micronesia.

Four species have been recorded from Micronesia (Caroline and Marianne Is.), but the number is here reduced to three, based on the reduction of Kanehira's proposed *Freycinetia almonoguiensis* to synonymy with *F. villalobosii* Martelli emend. St. John. *Freycinetia ponapensis* Martelli is very closely similar to *F. mariannensis* but after long consideration I here maintain their specific difference. However, Kanehira's proposed *F. carolinensis* of Palau is identical with *F. mariannensis* (not with *F. ponapensis*, as Kanehira himself later decided). Hosokawa described the Ponape plants as *F. mariannensis* var. *microsyncarpia*, while reducing *F. ponapensis* to the synonymy of *F. mariannensis*: but he indicated (*Journ. Jap. Bot.* 13: 191. 1937) that both his newly described and the typical varieties occurred in Ponape; while only the typical var. (*mariannensis*) was elsewhere in Micronesia. His discussion of the leaf tessellations, said to be distinctive as a taxonomic feature by both Merrill and Kanehira, discloses that it is too variable a feature for any taxonomic use. Hosokawa did not, however, investigate the auricles, leaf spectrum, seeds, or pedicels, all characteristic structures of major taxonomic importance. The following key will show some of the specific character correlations of the taxa here regarded as species:

Key to Micronesian species of *Freycinetia*

1. Stigmas mostly 1–3 per berry (Sect. *Oligostigma*); leaves thick coriaceous, mostly 3–5 cm broad, the apex acuminate with some degree of negative or concave curvature; auricles rounded gradually at apex, unarmed; syncarps stout cylindrical.
 2. Pedicels of syncarps sparsely scabrid at their distal ends; seeds nearly straight, about 1.3 mm long, the raphe scarcely or not exceeding the embryo; syncarps mostly 6–7 cm long.

Freycinetia ponapensis
 2. Pedicels glabrous, smooth; seeds slightly lunulate, about 1.7 mm long, the raphe slightly exceeding the embryo; syncarps usually 8–9 cm long.

Freycinetia mariannensis
1. Stigmas mostly 3–10 per berry (Sect. *Freycinetia*); leaves rather thinly brittle coriaceous, mostly 1–3 cm broad, the apex tapered, not acuminate, to a narrow swordlike point; auricles abruptly rounded at apex and there with a few prickles; syncarps slender cylindrical.

Freycinetia villalobosii

Sect. *Oligostigma*

1. *Freycinetia mariannensis* Merr., Philipp. Journ. Sci. Bot. 9: 48. 1941; Kanehira, Bot. Mag. Tokyo, 49: 185. 1935; Journ. Dept. Agric. Kyushu Imper. Univ. (Enum. Micron. Pl.) 4 (6): 259. 1935; Bot. Mag. Tokyo 51: 906, f. 62–63. 1937; Hosokawa, Bull. Biogeogr. Soc. Jap. 5 (2): 132. 1934; Glassman, Journ. Arn. Arb. 29: 178, in obs. 1948. [Fig. II and III: 1–4, Pl. I and II.]

Freycinetia carolinensis Kanehira, Bot. Mag. Tokyo 49: 185. f. 17. 1935; Journ. Dept. Agric. Kyushu Imper. Univ. (Enum. Micron. Pl.) 4 (6): 259. 1935; Bot. Mag. Tokyo 51: 906. in synon. 1937.

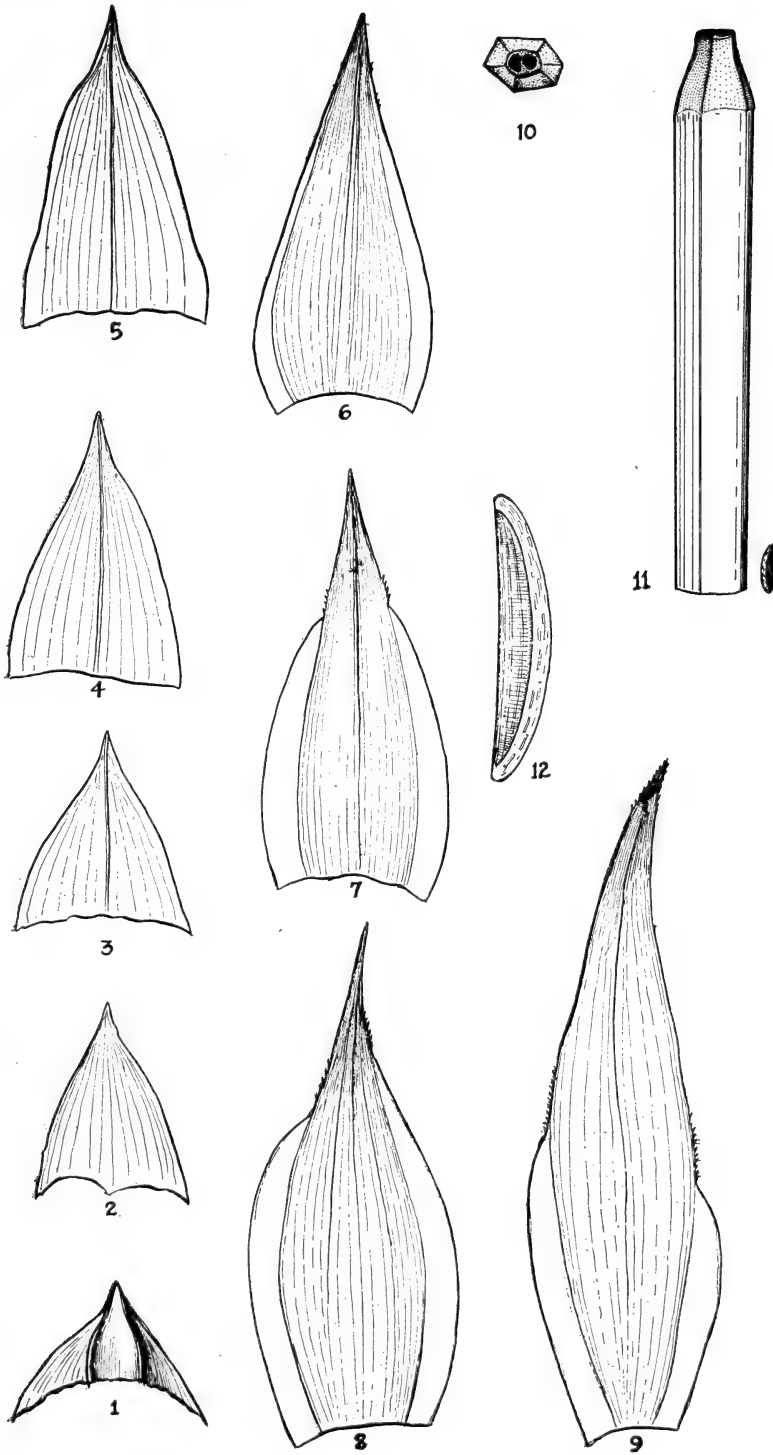


FIGURE II.

Freycinetia mariannensis. 1-9: 'leaf spectrum' from first vegetative bract (prophyll) to first foliage leaf (9). 10: berry in top view. 11: berry in profile x 5. 12: seed, x 20. 1-9, from Guam, Stone 4492; 10-12, from Palau, Kanehira 2359).

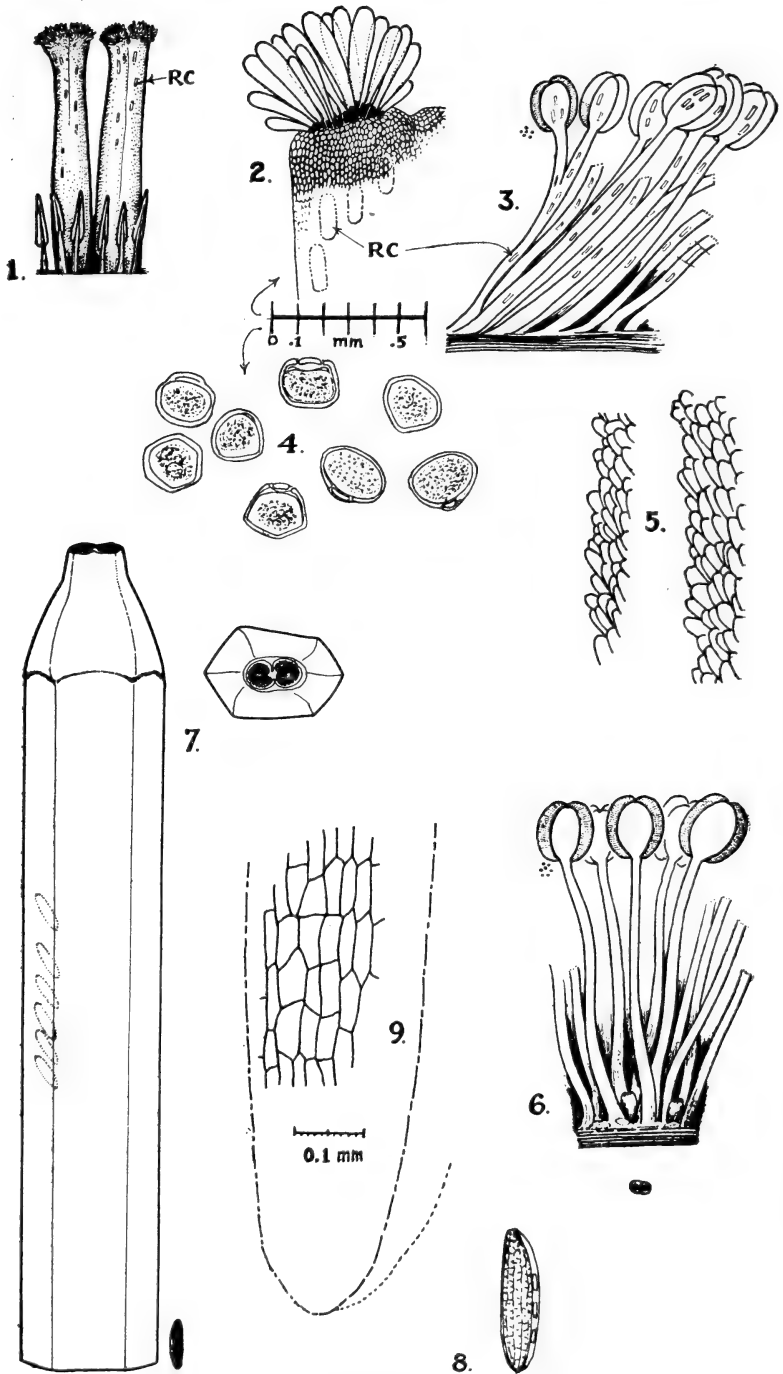


FIGURE III

See caption on page 143

Type locality: Guam, Marianas Is.

Distribution: Marianas Islands, Caroline Islands (Palau, Truk).

GUAM: North of Yona, *Rodin* 577 (US); 1.5 miles north-west of Yona, *Rodin* 759 (US); 2 miles S. of North-West Field, *Steere* 12 (US); between Agana and North-West Field, *Steere* 15 (US); Mt. Alifan, *Bryan* 1207 (BISHOP, US); Mt. Almagosa, *Hosaka* 3173 (BISHOP, US); Talofoto Valley, *Stone* 3970, 3971 (BISHOP, GUAM, L, US); Agat hills, *Stone* 4217 (BISHOP, GUAM, L, US); Fena River, *Stone* 4491, 4492 (BISHOP, GUAM, L, US); Guam, without locality, *Costenoble* (US, isosyntype); *Moore* 291 (US).

ROTA: Sabana, high plateau, in forest, *Stone* 5206a, b (GUAM); Feb. 1941, *Tuyama* s.n. (TOKYO).

SAIPAN: April 1930, *Shizuwo Momose* (TOKYO). (For previous collections see also Kanehira, Enum. Micron. Pl. 1935).

The seeds are slightly lunulate, or sometimes straight, about 1.6–1.7 mm long, and 0.25–0.37 mm broad, the raphe moderately slender, white, with scattered shining raphidophorous cells, exceeding the seed proper slightly at both ends, about 0.1 mm broad; no strophiole is present.

Kanehira originally reduced his *Freycinetia carolinensis* to *F. ponapensis*; however, the glabrous pedicels serve to associate it rather with *F. mariannensis* under this revised treatment.

2. ***Freycinetia ponapensis*** Martelli in Kanehira, in Bot. Mag. Tokyo 48: 129. 1934; Kanehira, Journ. Dept. Agric. Kyushu Imper. Univ. (Enum. Micron. Pl.) 4 (6): 259. 1935; Hosokawa, Trans. Nat. Hist. Soc. Formosa 33: 18. 1943; Glassman, Bishop Mus. Bull. 209: 111. 1952. [**Fig. II: 5–9, Pl. III.**]

FIGURE III.

1–4. *Freycinetia mariannensis*. Floral details.

- 1: small part of a pistillate spike, showing two flowers, each consisting of a carpel with 2 papillate stigmas, and a few (3–5) staminodes at base. RC=raphidophorous cells. Magnified x 10.
- 2: apex of a carpel, showing the papillae of the stigma, small epidermal cells, and the interior RC. Divisions of scale=0.1 mm.
- 3: small part of a staminate spike, showing stamens; note RC in filaments. Magnification x 10.
- 4: pollen grains to same scale as 2. (All from *Stone* 5206a–b).

5–9. *Freycinetia ponapensis*. Floral details and berry.

- 5: cellular detail from filament margin; to same scale as fig. 2.
- 6: stamens with pistillodes at base, and top view of one pistillode. Magnification x 10.
- 7: berry in profile and top view, with seed, all x 10.
- 8: seed, showing raphe, x 20.
- 9: epidermis of seed, greatly enlarged. (All from *Stone* 5479 and 5480).

F. mariannensis var. *microsyncarpia* Hosokawa, Journ. Jap. Bot. 13: 191. 1937; Kudoa 5: 79. 1937.

Type locality: Ponape; Patapat (*Ledermann* 13245).

Distribution: Ponape and Kusaie.

Specimens examined: PONAPE: Mt. Nanalaut, near summit, June 1957, *Stone* 2034 (BISHOP); Headlands of Pilen-kiepw River, 400 m alt., March 1957, *Stone* 1728 (BISHOP); Mt. Nginani, summit, 2550 ft. alt. Feb. 1965, *Stone* 5479, 5480 (BISHOP, GUAM, UNIV. MALAYA); without locality, Jan. 1915, July 1915, *Koidzumi* s.n. (TOKYO).

KUSAIE: Innemu River, 130 m alt., Dec. 1945, *St. John* 21449 (BISHOP); Limes, near Lele, 100 m alt., May 1957, *Stone* 1903 (BISHOP); Jan. 1941, *Tuyama* (TOKYO).

The *St. John* specimen and *Stone* 5479 are both staminate plants, thus permitting the following description:

Bracts of male inflorescence yellow at base, apically scarlet; spadices 3, on pedicels 2.5–3 cm long and c. 3 mm thick, smooth, cylindric, about 6 cm long and 1 cm thick, the stamens numerous and densely congested, with long slender filaments 3.5–4 mm long; white anthers about 0.7 mm long.

The seeds of this species appear to differ from those of *F. mariannensis*; they are ellipsoid, nearly straight, about 1.2–1.3 mm long, 0.35–0.39 mm broad, raphe 0.1 mm broad, white, barely or not exceeding the embryo, strophiole lacking.

The differences in the seeds, and in the pedical scabridity, serve to differentiate these species, which had been considered identical by Hosokawa. It should be noted that the male inflorescence bracts of all specimens were yellow.

Sect. *Freycinetia*

3. *Freycinetia villalobosii* Martelli in Kanehira, Bot. Mag. Tokyo 48: 128, as *Villalobosensis*. 1934; Kanehira, Bot. Mag. Tokyo 49: 195. 1935; Journ. Dept. Agric. Kyushu Imper. Univ. (Enum. Micron. Pl.) 4 (6): 259. 1935. Nom. emend. H. St. John, Philipp. Journ. Sci. 88 (3): 403. 1960 [Fig. IV: 4–6; Pl. IV.]

Freycinetia almonoguiensis Kanehira, Bot. Mag. Tokyo 49: 186. f. 18. 1935; Journ. Dept. Agric. Kyushu Imper. Univ. (Enum. Micron. Pl.) 4 (6): 259. 1935.

Type locality: Palau Is., Babeldaob Is., in forest at 200–300 m alt., "Urwaldähnl. Mittelwald 10–15 m h. mit viel Fiederpalmen, viel Unterholz; . . . Hochkelternd, Kolben grün, B. glanzend dunkel grün, Rind grau," Feb. 1914 (*Ledermann* 14323).

The type of Kanehira's proposed species was from "Palau, Almonogui; coll. Feb. 1933, *Nisida* 2775". Almonogui (also spelled Arumonogui) is the headland to the north of the large bay or inlet at the mouth of the Gaspan R. in Babeldaob (Babelthuap) Island, on the west coast toward the southern end. It is probably not very far from the locality where *Ledermann* obtained the specimen upon which Martelli based the species description.

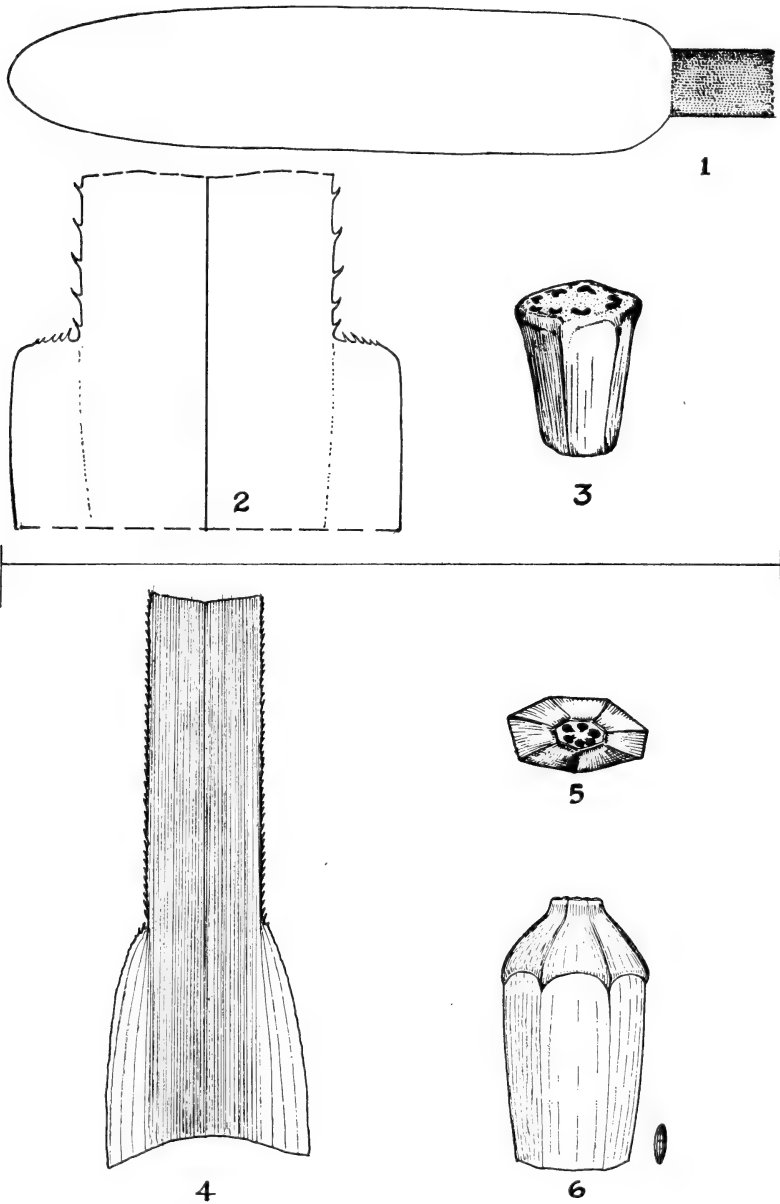


FIGURE IV.

- 1-3. *Freycinetia boninensis*. 1- outline of syncarp and part of pedicel, natural size. 2- part of leaf base, showing part of blade and part of auricular sheath, natural size. 3- berry, x 5. (From isotype).
- 4-6. *Freycinetia villalobosii*. 4- base of leaf, showing auricular sheath, natural size. 5- top view of berry, x 5. 6- profile of berry, with seed to scale (but immature), x 5. (From *Hosokawa* 6902).

Distribution: Endemic to Palau Islands, West Caroline Is.

In his original description, Martelli stated: "I named this plant in honour of the Spanish navigator Arrecipes Ruy Lopez de Villalobos, who discovered the groups of the Islands in 1543 and died at Amboina." Somehow he attached the Latin place-name ending to this man's name, and published it as *Villalobosensis*. The necessary correction of orthography was made recently by St. John.

The only apparent differences which might serve to distinguish *Freycinetia almonoguiensis* are the larger syncarps (7.5 cm vs. 10 cm); and an alleged slight difference in leaf-tip shape. Not mentioned by Kanehira is the pedicel scabridity or lack of it; in his figure, the pedicels appear smooth and glabrous. In *F. villalobosii*, there is a minute scabridity distally on the pedicels. One specimen studied (*Takamatsu* 1548, cited below) does have glabrous pedicels. Certainly the syncarp sizes are too similar for any significant difference; the leaf tip shape does not seem different at all; and the pedicel scabridity is a somewhat variable character. All told, it seems difficult to consider the available specimens as representing more than one species, and thus I have united them; a viewpoint in concordance with that of T. Hosokawa (in herb.).

On the other hand, *Freycinetia villalobosii* needs further comparison with certain species of the Philippines (the nearest Malaysian land area, using the term Malaysian in the sense of van Steenis). Martelli mentioned the similarity of such Philippine species as *Freycinetia negrosensis*, *F. superba*, and some of Elmer's later, unvalidated species. It remains to be determined whether the Palau form is an endemic species (as does appear likely) or if it may be a Micronesian outlier of a Philippine species.

Specimens examined: PALAU: Babeldaob Island; Almonogui, Feb. 1933, *S. Nisida* 2775 (TOKYO, isotype); Aimiriik (Aimelik), July 1933, *Kanehira* 2366 (TOKYO); Garamiscan, or Almiokan, River, swamp-forest, *Fosberg* 25729 (US); Mt. Luisalumogui (=Almonogui), *Hosokawa* 6902 (A, BISHOP, TAIWAN); near Ngaldok Lake, in thickets, *Hosokawa* 9290 (TAIWAN); Garamsumao, *Takamatsu* 1548 (BISHOP); Banks of Garamiscan River, observed only, Jan. 1963, *Stone*; Garamiscan, Sept. 1937, *Tuyama*, (TOKYO).

1.6. Preliminary studies on 'leaf spectrum' series in *Freycinetia*. [Fig. II.]

As pointed out by Melville (Proc. Linn. Soc. Lond. 164: 173-181. 1953) a sequence of leaves in ontogeny, follows a characteristic pattern, which may be termed the leaf spectrum. As an example,

selected leaves from *Freycinetia mariannensis* are shown in Fig. II, beginning with the first foliar organ produced on the lateral shoot emergent immediately below an infructescence. This has on occasion been called a "vegetative bract". It differs, as do also to a lessening extent the subsequent organs (Fig. II. 2-9), from fully developed foliage leaves in several major features; it is unarmed (as are nos. 2-5); it is much shorter (as are nos. 2-9); it lacks the characteristic auricles (as do nos. 2-6, although in nos. 5 and 6 they are partially developed); it has a central, ventral longitudinal channel, the result of its being pressed closely against the stem which terminates in an infructescence, and this channel is thickly ridged on both sides; its midrib is inconspicuous (this is also true of no. 2); and it is considerably thicker, especially at the base, than foliage leaves. The spectrum shown here would be continued by an organ which, although with a blade not much longer than no. 9, would have to be considered a mature foliage leaf.

Since in the Pandanaceae there is also a continuous series of organs from foliage leaves to inflorescence bracts, it may be necessary to include the latter in the leaf spectrum. Only a few species, in both *Pandanus* and *Freycinetia*, produce what may be termed a lateral inflorescence. This is a morphological structure deserving much more intensive study. In some *Freycinetiae*, both these 'lateral' and the more common 'terminal' inflorescences are produced by the same plant. In 'lateral' inflorescences the foliage leaf stage is omitted, the transition being from the "vegetative tract" directly to the "inflorescence bract".

A study of leaf spectra of various species is planned as living plants are encountered in the field.

1.7. A note on *Freycinetia boninensis* Nakai. [Fig. IV: 1.3.]

Previously published accounts of this species failed to give a clear idea of the auricles, which have proved to be necessary in the taxonomy of the genus. During a short study visit at the Department of Botany, University of Tokyo, I was enabled, through the courtesy of Prof. Hiroshi Hara and Dr. Y. Kimura, to study material of this species. The following notes and accompanying figures partly clarify the morphology of this species.

Freycinetia boninensis (Nakai) Nakai, Journ. Jap. Bot. 11: 153. 1935.

Type locality: Bonin Is.

First described as a variety of *F. formosana*, this species is very similar to Formosan material, but a critical review of both species is still required. The following notes add to available information concerning the Bonin Is. plant:

Leaves upwards of a meter in length; at base stoutly toothed on the margins; the apex caudate-flagellate, toothed; but intervening middle margins unarmed. Syncarps 3 or more per inflorescence on minutely scabridulous peduncles, the scabridity on all the surfaces and along the whole length of the peduncle. Bracts bright red-orange. Stigmas 4–8, or rarely 9–10, per berry.

The syncarps reach a length of 9.5 cm, but perfectly mature ones have not been seen; the diameter is about 1.8 cm.

Figure IV: 1–3 show auricles, syncarp, and berry.

Literature Cited

- FORBES, CHARLES N. 1913. Notes on the Flora of Kahoolawe and Molokini; (and) An Enumeration of Niihau Plants. Bishop Museum, Occas. Pap. 5 (3).
- ST. JOHN, HAROLD. 1959. Botanical Novelties on the Island of Niihau. Hawaiian Islands. Pacific Plant Studies 25. Pacific Science 13: 156–190.
- RIPPERTON, J. C., and E. Y. HOSAKA. 1942. Vegetation Zones of Hawaii.
- ROCK, JOSEPH F. 1913. The Indigenous Trees of the Hawaiian Islands. Honolulu, privately printed.



Plate I.

Freycinetia mariannensis. A fruiting specimen, in riverine forest along the Ugum River, Guam. (Photo: B. C. Stone).



Plate II.

Freycinetia mariannensis. A specimen with young spikes to show bracts and leaf apex; from Rota Is., Stone 5206a.



Plate III.

Freycinetia ponapensis Martelli, in mossy forest at the summit of Mt. Nginani, Ponape, alt. 2550 ft.; ripe syncarps red. (Stone 5480).



Plate IV.

Freycinetia villalobosii Martelli emend. St. John. Palau (Hosokawa 9290).

A Revision of *Symphorema*. Verbenaceae.

by

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INTRODUCTION

The genus *Symphorema* was founded by Roxburgh in 1798 on *S. involucratum*, a species described from Coromandel, the eastern coast of southern India. The generic description is brief, but it is accompanied with a coloured plate (t. 186) and a detailed description of the species. The plant is stated to flower "in February, March and April".

In 1805 Jussieu established the genus *Analectis* which has been declared to be congeneric with *Symphorema*. Wallich (Cat. 1828 p. 47, No. 1734) placed the genus "Analectis Juss, *apud* Vahl" (1810) between *Congea* and *Symphorema*, a statement recorded by Meisner (1843 p. 200) on the authority of Wallich, since Meisner was not able to examine the specimen. It is not sure whether Wallich considered the genus as published by Jussieu (1805), or merely Vahl's use of the name in connection with his new species *Analectis speciosa* (1810). Steudal (1840) listed the genus as of uncertain position. Vahl's binomial is found listed in Moldenke's *Résumé* (1959 p. 234) as a synonym of *S. involucratum* Roxb. It is desirable to know the locality and the collector of the specimen.

Blanco in his *Flora Filipinas* (1845) 284 described a philippine plant as a species of *Lauraceae*, namely *Litsaea luzonica*, which Llanos (1858) referred to the genus *Symphorema*. In 1863 Turczaninow established *Szczegleewia* on Cuming's No. 648 from the Philippines, with *S. luconiensis* as the type. This genus was recognized by Bentham and Hooker (1876) to be also congeneric with *Symphorema* Roxb., though they made no reference to Blanco's species.

Presently the genus consists of only three species: *S. involucratum* Roxb., *S. polyandrum* Wight and *S. luzonicum* (Blanco) F-Villar. The types of the first two species were from India, and the type of the third one was from the Philippines. Those described from India are closely allied in their floral characters and in the shape of their leaves and in having stellate tomentum on their leaves and branchlets.

The basionym of *S. luzonicum* (Blanco) F-Villar is *Litsaea luzonica* Blanco (1845) based on a specimen from Arayat in the island of Luzon, Philippines. Llanos and others like Fernandez-Villar (1880), Perkins (1904) and Merrill (1906) have recognized

* Colombo Plan Fellow, Botanic Gardens, Singapore, 1965.

that it is a true *Symphorema*. However, before Blanco's species was made the basionym of the new combination under *Symphorema*, *Szegleewia luconiensis* Turcz. (1863) and *Symphorema glabrum* Hassk., (1965) were published, apparently based on two different collections of Cuming. This Philippine species is the only one of this genus which has glabrous and entire leaves and glabrous twigs. The leaves are oblong-elliptic and superficially resemble those of the species of some genera of *Lauraceae*. Hence, it was regarded by Blanco as a lauraceous species.

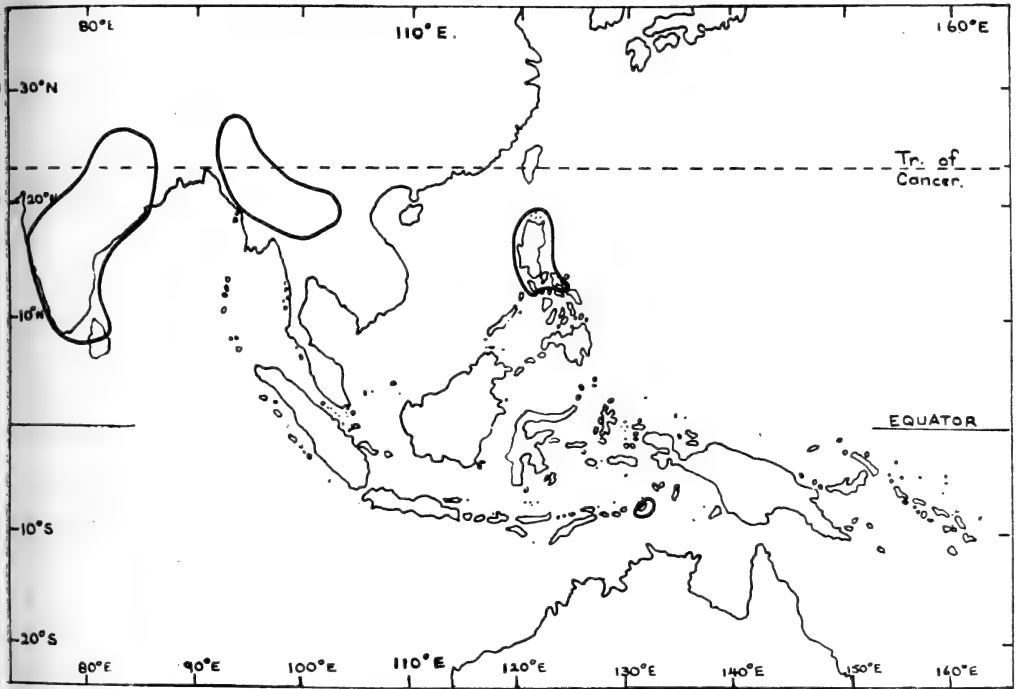
Distribution

Of the two species which occur in India, *S. involucreatum* has the widest distribution, occurring also in Burma and northern regions of Thailand, while the other *S. polyandrum*, is restricted to India only. These two are confined to the area lying between 70–105° East longitude and 7–27° North latitude (See **Maps 2 & 3**). *S. luzonicum* is apparently limited to an area in Luzon and a few neighbouring islands lying southwest of Luzon, between 120–124° East longitude and 11–19° North latitude. But there is a collection from the Tanimbar Islands lying to the south of the Moluccas, between 130–135° East longitude and 5–10° South latitude (See **Map 4**). The collector has not given any clue of its being cultivated or wild.

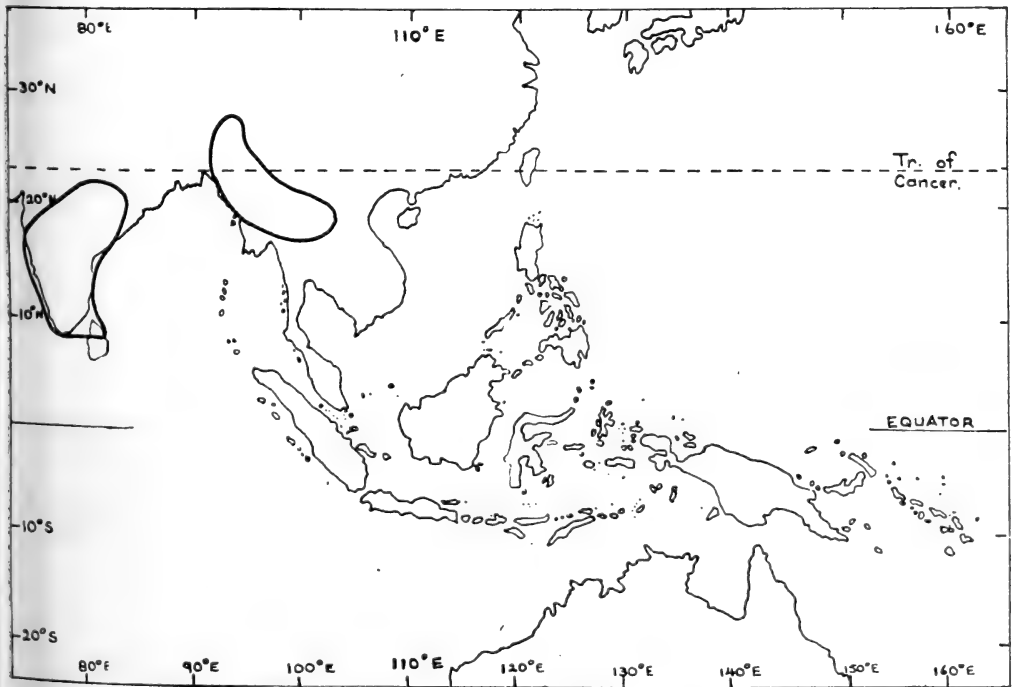
Involucral Bracts in *Symphoremeae*

Inflorescence in *Symphoremeae* consists of cymes disposed on axillary and terminal panicles. Each cyme consists of a peduncle and a cluster of flowers surrounded by involucral bracts. These bracts are generally much longer than the floral calyces, the only exception being in *Sphenodesme eryciboides* Kurz where bracts are comparatively smaller **Fig. 1-C**). In *Symphorema* and *Sphenodesme* these bracts are always free to the base, while in *Congea* they are either free or united to form a cup at the base. Bearing these general characters of the flower-heads in mind, it would be easy to understand the many variations discussed below.

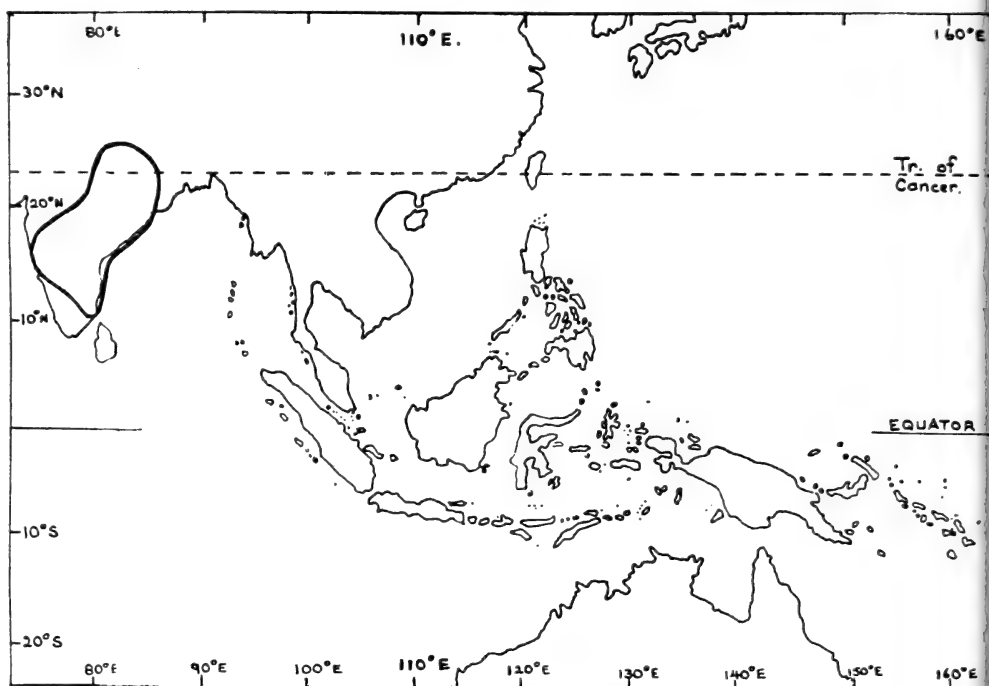
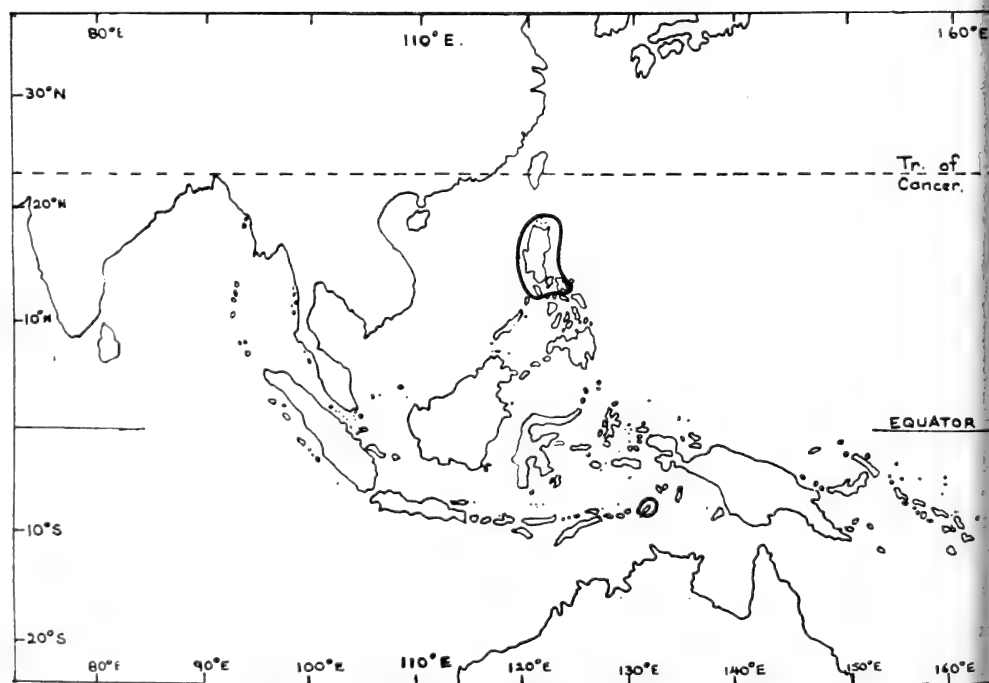
The structure of the involucral-heads in *Symphorema* and *Sphenodesme* shows that these two genera are closer to each other than either is to *Congea*. In both these genera the bracts are always 6, subequal, and free to the base. But, as shown in my paper on *Sphenodesme* (*Gard. Bull. Sing. Vol. XXI, Part III*), the flower-head consists of two dichotomous branchlets with main axis ending in a flower. Each of these branchlets ends in a bract with one axillary flower and bears two lateral bracts each with a flower. One can often see that these two main bracts are the largest and best developed. These are regarded by Wight (1850 p. 215) as true bracts while the other four as subsidiary ones or "bracteoles". Since these "bracteoles" are often almost as large as the real bracts, it is not easy to distinguish between them without a careful examination.



Map 1. Distribution of Genus *Symphorema* (———).



Map 2. Distribution of *S. involucreatum* (———).

Map 3. Distribution of *S. polyandrum* (———).Map 4. Distribution of *S. luzonicum* (———).

However, that Wight's view is correct is readily seen in the species of *Congea*. Here the involucrel bracts show different stages of development not present in the other two genera. The bracteolar head consists of not more than 4 distinct members nor less than 3 to a cyme. Moreover, the bracts may be entirely free or united at base to form a cup surrounding the flowers in the head. But *Congea forbesii* and its var. *ridleyana* show an intermediate stage in the reduction of the bracts from 6 to 4. In both these taxa there are six involucrel bracts, all free to the base, of which two are so reduced that they have been often overlooked (Fig. 1-D).

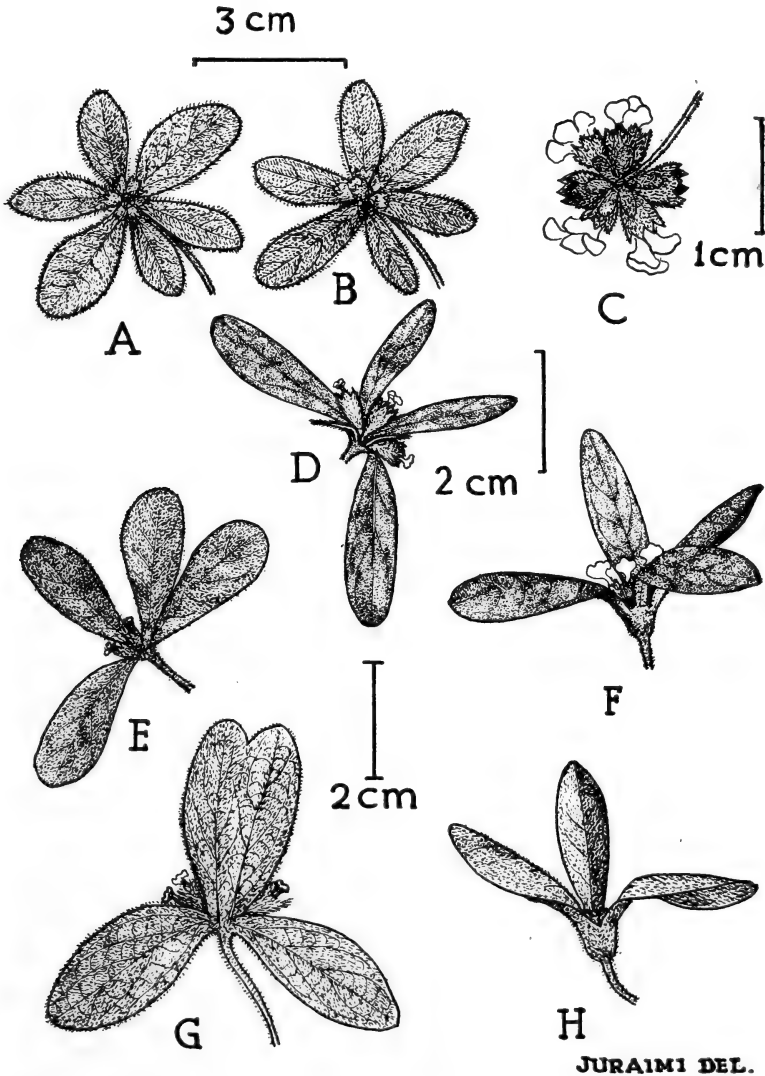


Fig. 1. Variation in Involucrel Bracts of Symphoremeae.

- A, *Symphorema*. B, *Sphenodesme*. C, *Sphenodesme erciboides*.
- D, *Congea forbesii*. E, *Congea griffithiana*. F, *Congea chinensis*.
- G, *Congea tomentosa*. H, *Congea connata*.

In *C. griffithiana* and *C. rockii* these two reduced bracts are absent and the four present are large and free to the base (Fig. 1-E). The number of bracts to a cyme in *C. chinensis* and its variety is also four, but they are united below into a cup (Fig. 1-F), but in *C. pedicellata*, *C. vestita* and *C. tomentosa*, two of the four bracts are connate half-way to make them sub 4; otherwise the bracts are free (Fig. 1-G). In *C. siamensis*, *C. connata* and *C. velutina* the bracts are united to form a definite cup at the base, but, while in *S. siamensis* they are 3 or sub 4, in *C. connata* and *C. velutina* they are always three (Fig. 1-H).

Systematic Position of *Symphorema* and allied genera

Roxburgh established the genus *Symphorema* in 1798 as a member of the group "Octandria Monogynia". Subsequently, in 1819, the same author published (posthumously) the genus *Congea* under "Didynamia Angiospermia, Natural Order Vitices Juss." In Roxburgh's manuscript itself this second genus was named *Roscoea*, a name, owing to the delay in publishing the manuscript became unusable from 1804, when it was taken up for another taxon (see introduction of my paper on *Congea*, *Gard. Bull. Sing.* Vol. XXI, Part III). Endlicher (1836) placed *Symphorema* and *Congea* (with *Sphenodesme* as a synonym) under the tribe **Aegiphyleae** Endl. Almost simultaneously Meisner (1836) created a new tribe **Symphoremeae** exclusively for *Symphorema* and *Congea* with *Sphenodesme* included in the latter as its synonym. Presl (1844) published two monotypic genera *Calochlamys* and *Viticastrum* and placed them under the tribe **Lantaneae** Endl.

Schauer (1847), who made a careful revision of *Verbenaceae* and recognized *Sphenodesme* Jack as distinct from *Congea* Roxb. and *Calochlamys capitata* Presl and *Viticastrum racemosum* Presl as species of *Congea* and *Sphenodesme* respectively, divided the family into three tribes and many subtribes. The tribes are as follows: **Verbeneae**, **Viteae** (or **Viticeae**) and **Avicennieae**. In this classification **Symphoremeae** Meisner is made a subtribe of **Viticeae** for three genera: *Symphorema*, *Congea* and *Sphenodesme*. In 1850 Wight who had previously suggested (1840) that the two genera *Symphorema* and *Congea* with *Sphenodesme* as the synonym of the latter, should form a distinct family, examined the status of these tribes of Schauer. After a detailed analysis of these divisions he concluded that **Symphoremeae** cannot be placed as a subtribe of **Viticeae**, being quite distinct from the latter though in many respects allied to **Avicenneae**. He therefore retained the group as a tribe by itself between **Viticeae** and **Avicenneae**, and stressed some characteristics which, in my opinion, would justify raising **Symphoremeae** and **Avicenneae** to the status of subfamilies, or even of families, if smaller families are desirable. Bentham and Hooker (1876) included in *Verbenaceae* the anomalous genus *Phryma* Linn. which Schauer had made the type of *Phrymaceae* Schauer (DC. Prodr. XI, 1847 p. 520), and subdivided the family

thus constituted into 8 tribes as follows: **Phrymaeae**, **Stilbeae**, **Chloanthaeae**, **Verbeneae**, **Viticeae**, **Caryopterideae**, **Symphoremeae** and **Avicenneae**.

Briquet (1897) who, like Schauer, had in 1895 treated *Phryma* as forming a distinct family, did not include the genus under *Verbenaceae*, but raised the remaining seven tribes of Bentham and Hooker into higher groups (probably subfamilies) as: **Stilboideae**, **Chloanthoideae**, **Verbenoideae**, **Viticoideae**, **Caryopteridoideae**, **Symphoremoideae** and **Avicennioideae**. In addition he subdivided Verbenoideae, Chloanthoideae and Viticoideae into 6, 3 and 4 tribes (?) respectively, with their names ending in *ae*. Lam (1919 & 1921) who dealt with Indonesian Verbenaceae regarded Briquet's names ending in *oideae* and *ae* as tribes and subtribes respectively.

Moldenke (1959) like Schauer and Briquet retained **Phrymaeae** as valid; but in addition separated **Stilboideae**, **Symphoremoideae** and **Avicennioideae** as distinct families viz: **Stilbaceae**, **Symphoremaceae** and **Avicenniaceae**. The remaining three groups **Verbenoideae**, **Viticoideae** and **Caryopteridoideae** Moldenke retained as subfamilies of **Verbenaceae**, but added a new subfamily **Nyctanthoidea** consisting of *Nyctanthes* and *Dimetra*, which were generally regarded as members of *Oleaceae*.

Without going into the propriety either of including the two oleaceous genera in *Verbenaceae* or of separating *Stilbaceae* from it, there seems to be justifiable reason either to retain **Symphoremoideae** and **Avicennioideae** as two subfamilies or, if microfamilies are desirable, to follow Moldenke who raised them to the rank of two distinct families.

Moldenke characterises these two families as follows: placenta central, free; ovules apically attached, pendulous, orthotropous; while the other two, **Stilbaceae** and **Verbenaceae** as follows: placenta axial, carpels 2 or 4, each bearing 2 ovules, but one carpel often more or less aborted, the carpel-edges turning back from the middle of the ovary to the midrib of each carpel, making false partitions; ovules basally or laterally attached, anatropous or hemi-anatropous, apotropous. The distinctions between the first two families are as follows:

Avicenniaceae

Ovary incompletely 4-celled; cotyledons folded; growth in diameter of trunks and stems brought about by concentric layers of mestome rings; branches, branchlets, and twigs commonly terete, prominently nodose and articulated; typically saline lagoon shrubs or trees.

Symphoremaceae

Ovary 2-celled to the middle; cotyledons not folded; trunk and stem growth normal; branches, branchlets, and twigs commonly more or less tetragonal, not articulate; typically woody vines (climbers) of non saline situations.

ACKNOWLEDGEMENT

It is my pleasant duty to record my gratitude to the following: to the Government of Singapore for extending my Fellowship which enabled me to complete the research in the genera of the *Symphoremeeae* group of *Verbenaceae*; to Mr. H. M. Burkill, Director of Gardens, Singapore, and to Dr. Chew Wee-Lek, Keeper of the Herbarium, for putting at my disposal the facilities of the Singapore Botanic Gardens; to Dr. C. X. Furtado for his general guidance; to Che Juraimi bin Samsuri for making the drawings published here; to the typist who patiently typed the manuscript.

My thanks are due to the Directors and Curators of the institutions mentioned below for the loan of herbarium specimens:

1. Arnold Arboretum, Harvard University, 22 Divinity Avenue, Cambridge 38, Massachusetts, U.S.A. (A).
2. Botanisches Garten und Museum, Berlin-Dahlem, Germany. (B).
3. Forest Herbarium, Bangkok, Thailand. (BKF).
4. British Museum of Natural History, London, S.W. 7, England. (BM).
5. Botanic Gardens, Brisbane, Queensland, Australia. (BRI).
6. Botanic Gardens, Calcutta, India. (CAL).
7. Forest Research Institute, Dehra Dun, India. (DD.)
8. Royal Botanic Garden, Edinburgh, Scotland. (E).
9. Royal Botanic Gardens, Kew, Richmond, Surrey, England. (K).
10. Forest Research Institute, Kepong, Selangor. (KEP).
11. Rijksherbarium, Schelpenkade 6, Leiden, Holland. (L).
12. New York Botanical Garden, Bronx Park, New York, U.S.A. N.Y).
13. National Herbarium & Museum, Manila, Philippines. (PHN).
14. Herbarium, Department of Botany, University of California, Berkeley 4, U.S.A. (UC).

Symphorema Roxb.

Symphorema Roxb., Corom. Pl. II (1798) 46 t. 186 & Fl. Ind. II (1832) 262; Endl., Gen. Pl. (1836) 638, no. 3716; Meisner, Gen. Pl. I (1836) 292 & II Comment. (1843) 200; Walp., Repert. Bot. IV (1844) 116; Schauer in DC, Prodr. XI (1847) 621; Wight, Ic. Ind. Or. IV, 3 (1849) 13 & Ill. Ind. Bot. II (1850) 216; Pfeiffer, Nomencl. Bot. II, 2 (1874) 1326; Benth & Hook., Gen. Pl. II, 2 (1876) 1159 p.p. (excl. *Decadontia* Griff.); Kurz, For. Fl. Burma, II (1877) 253 p.p. (altera parte *Sphenodesme*); Clarke in Hook. f., Fl. Br. Ind. IV (1885) 599; Trim., Fl. Ceyl. III (1895) 362; Briq. in Engl. & Prantl, Pflanzenf. IV, 3a (1879) 179 p.p. (excl. *Decadontia* Griff.); Cooke, Fl. Bomb. II (1908) 434; Lam,

Malay. Verb. (1919) 329 & Bull. Jard. Bot. Buitenz. III, Ser. III (1921) 99; Haines, Bot. Bihar & Orissa, III (1922) 724; Gamble, Fl. Madras II, 6 (1924) 1103; Dop in Fl. Gén. Indoch. IV (1936) 896; Mold., Résumé Geogr. distr. & Syn. (1959) 234, 343, 351 & 403.

Analectis Juss. in Jaume St. Hil. Expos. fam. II (1805) 362; Vahl in Danske Selsk. Skrivt. VI (1810) 90.

“*Litsaea*” sec Blanco, Fl. Philip. Ed. 2 (1845) 284 & Ed. 3, II (1878) 162.

Sczegleewia Turcz. in Bull. Soc. Imp. Nat. Mosc. 36, II (1863) 212.

TYPE SPECIES: *S. involucreatum* Roxb.

Scandent shrubs. *Stem* almost cylindrical sometimes faintly quadrangular in the older parts. *Leaves* opposite, simple, petioled, entire or irregularly crenate-toothed or serrate, reticulate, unicosate, pubescent-tomentose or completely glabrous. *Inflorescence* paniculate, consisting of pedunculate 7-flowered cymes with an involucre of 6 accrescent bracts; flower sessile. *Calyx* 3–8 lobed, almost obovoid, accrescent in fruit. *Corolla* white; tube cylindrical, glabrous, or with a villous ring in the throat; lobes 6–16, subequal, narrowly oblong. *Stamens* 6–18, exserted; filaments filiform, glabrous; anther oblong-elliptic, dorsifixed, cells parallel. *Ovary* obovoid, 2 or imperfectly 4-celled, 4-ovuled, the ovules pendulous, but only one fertile; style exserted, filiform, glabrous; stigma distinctly 2-fid. *Fruit* capsular, dry, included in the accrescent calyx, 1-seeded. *Seed* erect; cotyledons fleshy.

Distribution: India, Burma, Thailand, Philippines and Tanimbar Islands (south of the Moluccas).

Under *Symphorema*, Bentham et Hooker (1876) and Briquet (1897) have given as synonym *Decadontia* Griff. which was based on *D. coerulescens* Griff., a synonym of *Sphenodesme griffithiana* Wight. These authors, though included *Sczegleewia* Turcz. as a synonym of *Symphorema*, overlooked *Litsaea luzonica* Blanco, and so made no reference to the literature where the latter was published.

Key to the Species

- 1 (a) Leaves oblong-elliptic, entire, glabrous; calyx 3-4-lobed, with dense, long, appressed hairs within; corolla tube densely villous in the throat; ovary often covered sparingly with stellate-hairs in the upper half, glandular at apex; stigma lobes peltate: (Philippines) **S. luzonicum**
- (b) Leaves ovate or sub-orbicular, crenate to almost dentate, stellately pubescent or tomentose beneath; calyx 6-8-lobed, glabrous in the tube; corolla glabrous all over; ovary glabrous; stigma lobes cylindrical 2
- 2 (a) Leaves pubescent beneath; involucre bracts elliptic, entire, papery, deciduously pubescent; calyx-lobes 6, obtuse, glabrous within; corolla 6-8-lobed; stamens usually 6-8, rarely 9, hardly longer than the petal lobes; ovary not glandular at apex: (India, Burma and Thailand) **S. involucreatum**
- (b) Leaves densely tomentose beneath; involucre bracts obovate, usually entire, sometimes coarsely toothed, densely tomentose; calyx lobes 6-8, acute, tomentose on both sides; corolla lobes 12-16; stamens 12-18, much exserted; ovary slightly glandular at apex: (India) **S. polyandrum**

DESCRIPTION OF SPECIES

1. *Symphorema luzonicum* (Blanco) F-Vill. in Blanco, Fl. Philip. Ed. 3, IV, Novis Append. (1880) 162; Perk., Frag. Fl. Philip. (1904) 3; Merr. in Philip. Journ. Sc. I Suppl. I (1906) 112, Fl. Manila (1912) 400, Sp. Blancoanae (1918) 335 & Enum. Philip. Pl. III (1923) 406; Mold., Résumé Geogr. distr. & Syn. (1959) 185, 236, 243 & 350. — **Fig. 2.**

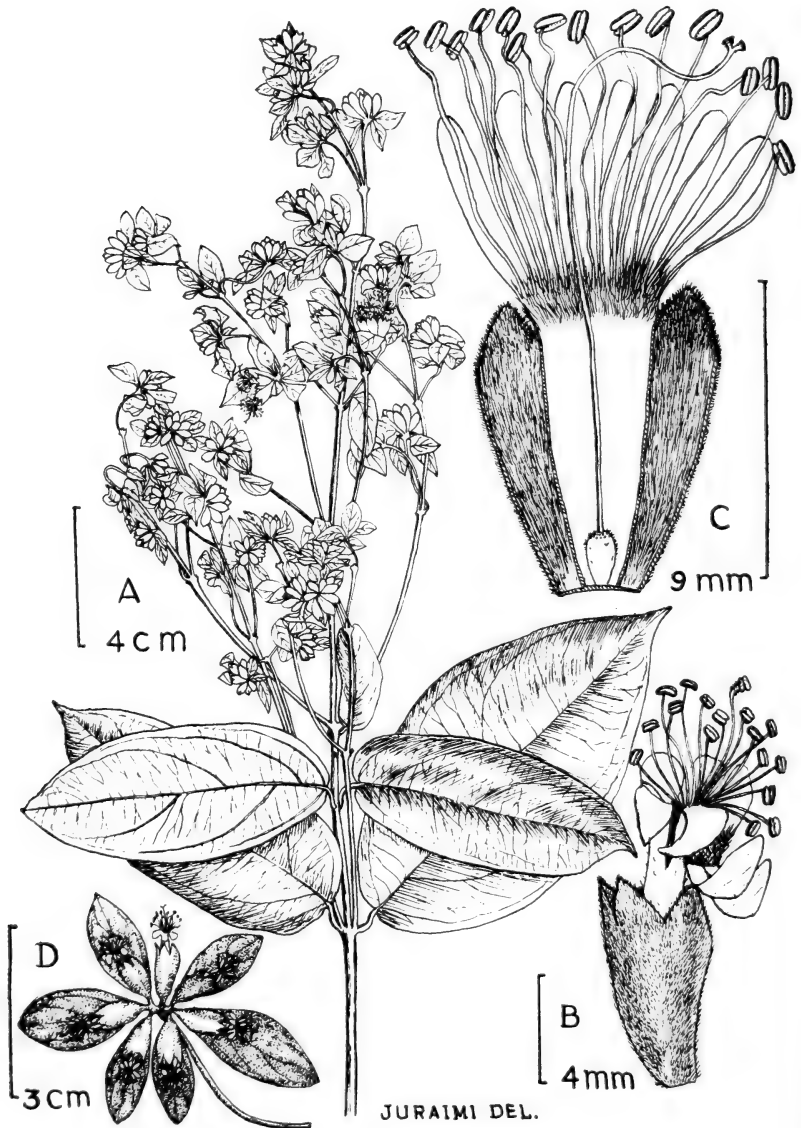


Fig. 2. *Symphorema luzonicum* (Llanos 69).
A, Fertile twig. B, Flower. C, Flower vertically cut open. D, Cyme showing flowers and bracts.

S. cumingianum Briq. in Engl. and Prantl, Pflanzenf. IV, 3a (1897) 180: nom. tantum.

S. glabrum Hassk. in Flora XLVIII (1865) 402; Lam Verb. Malay. (1919) 330 & in Bull. ard. Bot. Buitenz. Ser. 3, III (1921) 99.

“*S. involucratum* Spreng” sec. Llanos in Mem. Acad. Cienc. Madrid III, 4 (1858) 507 reprinted in Blanco Fl. Filip Ed. 3, IV, (1880) 105; Mold., Résumé Geogr. distr. and Syn. [sub *Symphorensa*] (1959) 351: pro syn.

S. luzoniense (Turcz.) Benth. and Hook. ex Vidal, Sinop. Atlas (1883) 36 t. 75, fig. F; ibid, Phan. Cuming. Philip. (1885) 135 & Rev. Fl. Vasc. Filip. (1886) 212.

Litsaea luzonica Blanco, Fl. Philip. Ed. 2 (1845) 284 & Ed. 3, II (1878) 162. **basionym.**

Sczegleewia luconiensis Turcz. in Bull. Soc. Imp. Nat. Mosc. XXXVI, 2 (1863) 212: basionym of *S. luzoniense*.

Balibai Blanco in Fl. Philip. (1837) 406: nom. vern.

Neotype: Blanos 69, in Herb. A.

S. luzonicum is an unique species of this genus not only because it is found in the Philippine and possibly also in the Tanimbar Islands, south of the Moluccas, but also because its leaves are glabrous and entire; calyx 3–4 lobed with dense, long, appressed hairs within; corolla tube densely villous in throat; stigma lobes peltate.

Branchlets almost cylindrical or faintly quadrangular in the older parts, glabrous excepting the grey-pubescent apical parts. *Leaves* coriaceous, oblong-elliptic, obtuse or obtusely acuminate at apex, sub-truncate to rounded at base, entire, glabrous, more or less nitid above, dull below, up to 24 cm long, 10 cm broad; main lateral nerves 4 pairs, the lower two pair very prominent and long; petioles 5–10 mm long, glabrescent. *Inflorescence* grey pubescent. *Cymes* 7-flowered; involucral bracts broadly obovate-elliptic, narrow towards base, obtusely rounded at apex, softly pubescent, accrescent, up to 3.5 cm long, 1.6 cm broad; peduncles thick, pubescent, 2.5–5 cm long. *Calyx* ± tubular, 7–9 mm long, slightly accrescent, almost urceolate in fruit, distinctly 3–4 lobed, somewhat 2-lipped, pubescent or minutely tomentose without, hirsute with appressedly distinct long hairs within; lobes subequal, 1–3 mm long. *Corolla* 6–7 lobed, glabrous in the tube, with a villous band in throat, sparingly puberulent without, 6.5–9 mm long; lobes oblong, softly pubescent without, glabrous within, 3–5 mm long. *Stamens* 8–16, inserted in the villous corolla throat, much exerted; filaments filiform, up to 12 mm long, often united into pairs at base; anthers oblong-elliptic, glabrous. *Ovary* almost obovoid, imperfectly 4-celled, glandular at apex, provided in the upper half with deciduous hairs, glabrous below, 2.5–3 mm long; style long exerted, filiform, up to 1.5 cm long, glabrous, bilobed at apex; lobes rarely armed with a few hairs; stigma peltate, glandular. Fruit almost globose, glabrous, enclosed in the persistent, accrescent calyx, 4–6 mm in diameter.

PHILIPPINES: Luzon, Ilocos, Pasuquin (Felix sub For. Bur. No. 30,914; SING); Burgos (Ramos sub Bur. Sc. No. 27,122: A & BRI); Mt. Quebrada (Edano sub Philip. Nat. Herb. No. 17,797: L; 17,784: A); Mt. Pico de Loro (Edano sub Philip. Nat. Herb. No. 17,960: A). *Cagayan*, Alcala (Clemens sub Bur. Sc. No. 17,534: B, BM & SING). *Pangasinan*, Bolinao (Clemens 18,176: SING). *Nueva Ecija*, Ecija (Villavicencio sub For. Bur. No. 23,654: A); Zambales, Subig (Merrill 2,075: NY). *Bataan*, Mt. Mariveles, Lamao River (Borden sub For. Bur. No. 2,549: NY & UC; Meyer sub For. Bur. No. 2,516: NY & SING; Williams 707: A & NY; Barnes 343: BM & NY; Whitford 2: NY; Pascual sub For. Bur. No. 28,766: UC). *Protacio*, Brandt's Garden (Steiner 1,011: PNH, Prob. cultivated). *Pampanga*, Arayat (Merrill 1,421: A & NY). *Tayabas*, Atimonan (Gregory 81: K); Lucena (Merrill 2,416: NY). *Laguna*, Calauan (Cuming 648: A, isotype of *Szegleewia luconiensis* Turcz & BM); Los Banos (Merrill spec. Blanco 467: A, BM, K, L & NY; Elmer 9,418: E; Tamesis sub For. Bur. No. 11,924: BM; Steiner 1,742: L, PNH & SING, Prob. cultivated); Mt. Makiling (Ilagan sub Phil. Nat. Herb. No. 35,488: PNH & SING; Mabanag sub Phil. Nat. Herb. No. 9,601: L, SING & UC; Banaga sub Phil. Nat. Herb. No. 33,398: A & L; Susara sub Phil. Nat. Herb. No. 37,313: BM & PNH; Baker 3,042: BM & SING; Sinclair 9,470: SING; Amihan sub Phil. Nat. Herb. No. 40,320: PNH; Sulit sub Phil. Nat. Herb. No. 8,320: PNH; Ebron sub Phil. Nat. Herb. No. 34,236: PNH; Abadilla sub Phil. Nat. Herb. No. 35,389: PNH; Holman 53: A). *Rizal*, Manila, San Mateo (Vidal 501 & 848: A, K & L); Montalban (Topping sub Bur. Sc. No. 5,228: A; Loher s.n.: UC; Elmer 17,419: A, BM, L, PNH & UC; 17,429: A, BM, K, L & UC; 17,467: A, BM, L, PNH & UC); Antipolo (Ahern 40: A; Merrill 1,934: A; 1,334: NY); Paningtingan (Loher 13,444: UC); Bosoboso (Ahern sub Bur. Sc. No. 1,172: NY; 4,454: CAL; 4,455: CAL & K; 4,456: CAL). loc. incert. (Ahern sub For. Bur. No. 2,654: NY & SING; Llanos 69: A, **neotype**), *Albay*, loc. incert (Cuming s.n.: L, holotype of *S. glabrum* Hassk.; BM & K, isotypes). **Mindoro**, Paluan (Merrill 954: A, NY & SING). **Busuanga** (Weber 1,546: A, E & PNH).

INDONESIA: Tanimbar Island, Jamdena, Ranarmoje River, Norkese (Borssum 3,283: L & SING).

Apparently there are two collections of Cuming; one bears No. 648 from Calauan in Laguna Province of Luzon which formed the basis of *Szegleewia luconiensis* Turcz. and the other is unnumbered which formed the basis of *Symphorema glabrum* Hassk. What appears to be the duplicate of the latter is in Kew and is recorded as being from the "Province of Albay" in Luzon. However, the No. "648, Luzon" is later added in a different handwriting. Since No. 648 is from the Laguna Province, this Albay specimen cannot be its duplicate. Apparently Turczaninow spelt the epithet of his species with *c* — cedilla, which is equivalent to *z* in Latin as shown in the combination made by Vidal.

As there is no Blanco type available Llanos 69 is taken as the **neotype**, for it is on this specimen that Blanco's *Litsaea luzonica* (1845) was correctly interpreted by Llanos in 1878.

Since Bentham and Hooker (1876) included *Sczegleewiu* Turcz. as a synonym of *Symphorema* and quoted Cuming No. 648, Vidal followed the old custom and attributed the new combination *S. luzoniense* (Turcz.) to Bentham and Hooker; but under the Code, Vidal has to be acknowledged as the actual author of the combination.

F-Villar states that the species is very common in Central Luzon and he saw a living plant on the bank of river of Mount San Francisco and at San Mateo in the Manila Province.

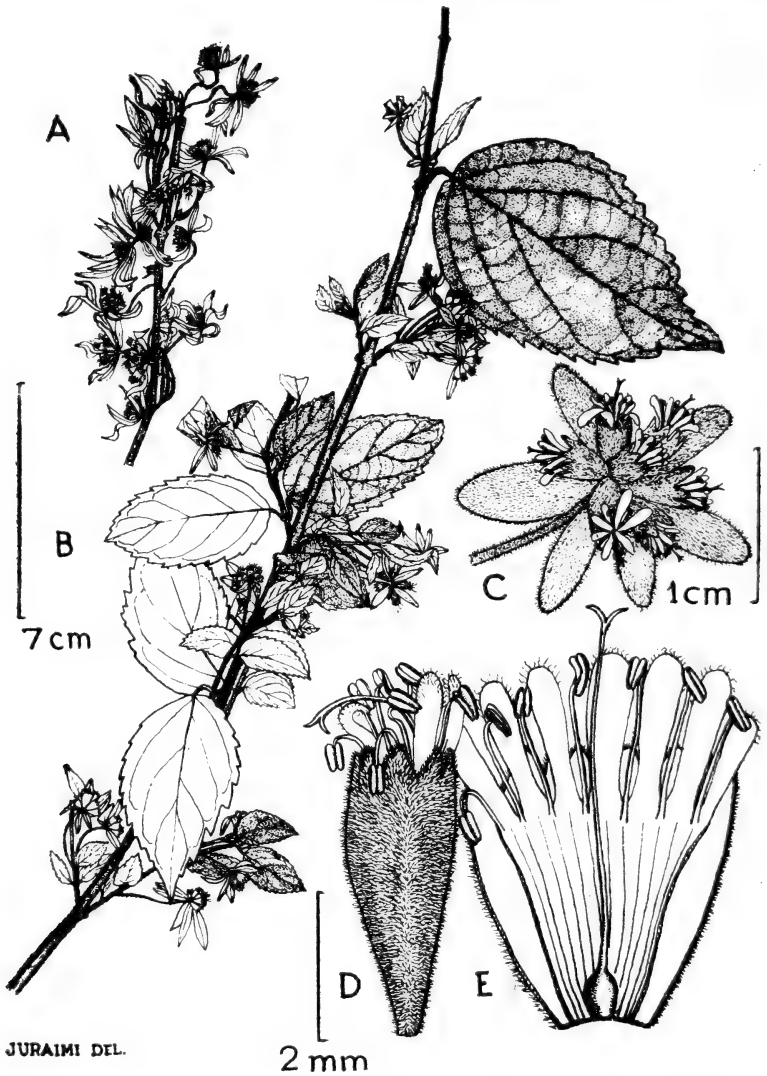
Since Lam (1919 & 1921) did not know *Litsaea luzonica* Blanco (1845) and admitted erroneously 1835 as the date of publication of Hasskarl's *S. glabrum*, he took the latter name as the correct one for *S. luzonicum* (Blanco) F-Vill. However, as shown above in the synonymy, Hasskarl's species was published only in 1865, twenty years after Blanco's species and as such the latter must take precedence.

Merrill (1923) credits the species for Palawan but the only specimen I found is from Paluan in the Mindoro island, collected by Merrill himself.

Moldenke (1959) erroneously gives *Symphorema* (*Symphorensa*) *involutratum* as having been published by Sprengel for the Philippine plants, though the latter merely recorded Roxburgh's species of India. Similarly Moldenke retains *S. grossum* Kurz as a good species of the genus, but as shown in my previous paper it is a later synonym of *Sphenodesme eryciboides* Kurz.

Borssum 3,283 from Tanimbar islands, south of Moluccas, is the only record of this species or even of the genus collected so far outside the Philippines. Since the collector has not given any indication of its being cultivated or wild, a further investigation is necessary to confirm this unusual distribution.

2. ***Symphorema involucratum*** Roxb. Corom. Pl. II (1798) 46 t. 186 & Fl. Ind. II (1832) 262; Spreng., Syst. Veg. II (1825) 208; Wight, Ic Ind. Or. II, 1 (1840) 5 t. 362; Walp., Repert. Bot. IV (1844) 116; Voigt, Cat. Pl. Calc. (1845) 470; Schauer in DC., Prodr. XI (1847) 621 exclud. descript. et Wall. No. 1740; Dalz. & Gibs., Bomb. Fl. (1861) 199; Thwaites, Enum. Pl. Zeylan. (1861) 242; Kurz, For. Fl. Burma, II (1877) 254; Clarke in Hook. f., Fl. Br. Ind. IV (1885) 599; Trim., Fl. Ceyl. III (1895) 363; Briq. in Engl. & Prantl, Pflanzenf. IV 3a (1897) 180; Cooke, Fl. Bomb. II (1908) 434, Craib in Kew Bull. (1911) 445; Haines, Bot. Bihar and Orissa III (1922) 724; Gamble, Fl. Madras II, 6 (1924) 1104; Dop in Fl. Gén Indoch. IV (1936) 898 fig. 93/2 to 5; Fletcher in Kew Bull. (1938) 441; Mold., Résumé Geogr. distr. & Syn. (1959) 164, 166, 167, 178 & 234. — **Fig. 3.**



JURAIMI DEL.

2 mm

Fig. 3. *Symphorema involucreatum* (A Roxburgh s.n.; B-E Wight 2,586). A, Part of an inflorescence. B, Flowering twig. C, Cyme with its bracts and flowers. D, Flower. E, Ibid. longitudinally cut open to show the internal organs.

Analectis speciosa Vahl in Danske Selsk. Skrivt. VI (1810) 90 (fide Moldenke).

This species is easily recognized by its leaves being pubescent beneath; involucre bracts elliptic, entire, papyraceous; calyx-lobes 6, glabrous within; corolla 6–8 lobed; stamens usually 6–8, hardly longer than the petal lobes and ovary non-glandular.

Branchlets cylindrical, stellately sub-tomentose when young, later pubescent. *Leaves* ovate or almost elliptic, sub acute at apex, usually cordulate at base, sometimes almost rounded, irregularly crenate-serrate or toothed, puberulent above when young, later almost glabrous, densely and stellately pubescent beneath, 10 by 6

cm on fertile twigs; main lateral nerves 4–5 pairs; petioles usually 5–15 mm long, pubescent. *Cymes* 7-flowered; involucre bracts 6, elliptic, entire, papyraceous, deciduously pubescent, 1–1.7 by 0.2–0.5 cm at anthesis of the flower, later accrescent, up to 3.5 by 1.5 cm; peduncles up to 7 cm long, stellately pubescent. *Calyx* tubular, 6-lobed, slightly accrescent, 4–5 mm long, stellately tomentose without, glabrous within; lobes \pm 1 mm long, obtuse, glabrous within. *Corolla* 6–8 lobed, white, glabrous except at few villous hairs outside at the tip of its lobes, 6–8 mm long; lobes linear oblong, obtuse, 2–3 mm long; tube 4–5 mm long. *Stamens* 6–8, rarely more, hardly longer than the corolla lobes; filaments filiform, glabrous; anthers oblong-elliptic. *Ovary* obovoid, glabrous, non-glandular; style exerted, filiform; stigma distinctly 2-lobed, lobes porrect, cylindrical. *Fruit* subglobose, glabrous, 4–6 mm in diameter, enclosed in accrescent, papyraceous, persistent calyx.

INDIA: **Maharashtra**, Khandala (Herb. Blatter No. 6,112: K); loc. incert. (Dalzell s.n.: DD). **Mysore**, North Kanara; near Yellapore (Fernandes 220: A; Talbot 52: K & s.n.: DD). **Konkan** (Stocks & Laws s.n.: A, BM, CAL & L). **Kerala**, Travancore (Bourdillon 537: CAL). **Madras**, coromandel (Roxburgh s.n.: E, **holotype**); Naggur hills (Wight 2,586 & 2,587: E; Cleghorn s.n.: CAL & E); loc. incert. (Wight 909: E & NY; 2,303: A, CAL, K & L); Shevaroy hills (Perrottet 487: CAL). **Andhra Pradesh**, Cuddapoh hills (Beddome 6,520 & 6,522: BM; 6,521 & 6,523: SING; 39: CAL; s.n.: CAL); Godavari (Beddome 6,519: BM & SING); Vishakhapatnam, at Ragupalien (Barber 1,573: K). **Bihar & Orissa**, Ganjam Distr., Mahendragiri (Fischer & Gage 83: CAL); Barkuda (Carter 1,507: CAL); Valiki (Gamble 13,745: CAL); Kuaduli (Haines 4,944: K); Puri (Haines 2,542: DD); Seeta-koondl (Madden 663: E). **Madhya Pradesh**, Chanda Distr. (Duthie 9,687: DD); Jabalpore (Leg. ? s.n.: BM). **Nagaland** (Beddome s.n.: BM).

CEYLON: **Trincomali** (Glenie sub Thwaites C.P. No. 3,645: BM, probably cultivated).

BURMA: **Shan State**, Mong Noi, near Salween, alt. 3,000 ft. (Robertson 316: K); Taunggyi (Khalil s.n.: CAL); loc. incert. (Collect 435: CAL). **Magwe**, by the Kinmondaing (Rogers 910: CAL & E). **Minbu**, Chichaung, Mon Chaung (Parkinson 15,733: DD & E); Mezali (Parkinson 15,750: DD & E); Nwamadaung hills (Aubert & Gage s.n.: CAL). **Pegu**, loc. incert. (Brandis 881: CAL; Kurz 1,040; 2,392 & 2,399: CAL). **West Central Burma**, loc. incert. (Kingdon-Ward 21,796: BM). **Tharrawaddy**, Myaung Waingale (Lace 2,794: CAL, E & K); Taungnyo Reserve, alt. 100 m. (Rogers 274: CAL).

THAILAND: Northern regions, Muang Lamphun, (Larsen & Hansen 861: A; Smitinand 4,169: BKF); Muang Phrae, at Hooey-Kamin (Kerr 991: K); Muang Fang, alt. 700 m. (Kerr 5,234: E); Chawn Fong, alt. 270 m. (Kerr 2,932: E & K).

Roxburgh's type specimen was apparently collected by a Telugu man "Moodu" (= Muthu?), under vernacular name "ceroodiddu" which Roxburgh rendered as "Suroodoo".

Thwaites (Enum. Pl. Zeylaniae, 1861 p. 242) records *S. involu-cratum* Roxb. from Trincomalee, Ceylon, which was brought to him by one Glenie, but so far no one has found it indigenous there. The specimen was probably from a cultivated plant. Moldenke who has recorded it as wild in Ceylon, has apparently followed Thwaites.

Dop (1936) included *Congea paniculata* Wall. as synonym of *S. involu-cratum* Roxb. However, this binominal was a *nomen nudum* for *Sphenodesme involu-crata* (Presl) Robinson var. *paniculata* (Clarke) Munir (see my paper on *Sphenodesme* in *Gard. Bull. Sing.* Vol. 21 Part III).

3. *Symphorema polyandrum* (*polyandra*) Wight, Ic. Ind. Or. II, 1 (1840) 5 t. 363 & III. Ind. Bot. II (1850) 217 t. 173/b-7; Voight, Cat. Pl. Calc. (1845) 470; Schauer in DC., Prodr. XI (1847) 621; Clarke in Hook. f., Fl. Br. Ind. IV (1885) 599; Briq. in Engl. & Prantl, Pflanzenf. IV 3a (1897) 180; Cook, Fl. Bomb. II (1908) 434; Haines, Bot. Bihar and Orissa III (1922) 728; Gamble, Fl. Madras II, 6 (1924) 1104; Mold., Résumé Geogr. distr. & Syn. (1959) 164 & 222. — **Fig. 4.**

S. involu-cratum Roxb. sensu Wall. Cat. (1828) No. 1740; Schauer in DC., Prodr. XI (1847) 621 pro parte non typica.

Allied closely to *S. involu-cratum*, but is distinguished easily by its leaves being densely tomentose beneath; involu-crals bracts obovate, usually entire, sometimes coarsely toothed, densely tomentose; calyx lobes 6-8, tomentose on both sides; corolla-lobes 12-16; stamens 12-18, much exserted; ovary slightly glandular at apex.

Branchlets almost cylindrical, thickly and stellately tomentose when young, later pubescent. *Leaves* suborbicular or broadly ovate, obtuse or sub-acute, almost rounded at base, irregularly crenate or dentate, densely tomentose on both sides when young, later remotely hirtellous and scabrous above, up to 15.5 cm long, 12 cm broad; main lateral nerves 4-5 pairs; petiole thick, 1-2.5 cm long, tomentose. *Cymes* 7-flowered; involu-crals bracts 6, obovate, usually entire sometimes coarsely toothed, densely tomentose, accrescent, up to 4 by 2.5 cm in fruit; peduncles thick, densely tomentose, 2.5-4.5 cm long. *Calyx* campanulate infundibuliform at anthesis, somewhat urceolate in fruit, 6-8 lobed, stellately tomentose outside,

glabrous in the tube, accrescent, 1–1.3 cm long; lobes somewhat triangular, acute, tomentose on both sides, 1.5–3 mm long. *Corolla* white, glabrous, usually 12–16 lobed, rarely less, up to 1.8 cm long; lobes lanceolate, acute, up to 8 mm long; tube almost as long as the calyx. *Stamens* 12–18, exserted; filaments filiform; lower parts of the filaments often connate in pairs; anthers oblong-elliptic. *Ovary* obovoid or somewhat sub-globose, glabrous, scarcely glandular at apex; style long exserted, filiform; stigma distinctly bilobed; lobes cylindrical. *Fruit* 8–10 mm in diameter, sub-globose, glabrous, enclosed in the persistent accrescent calyx.

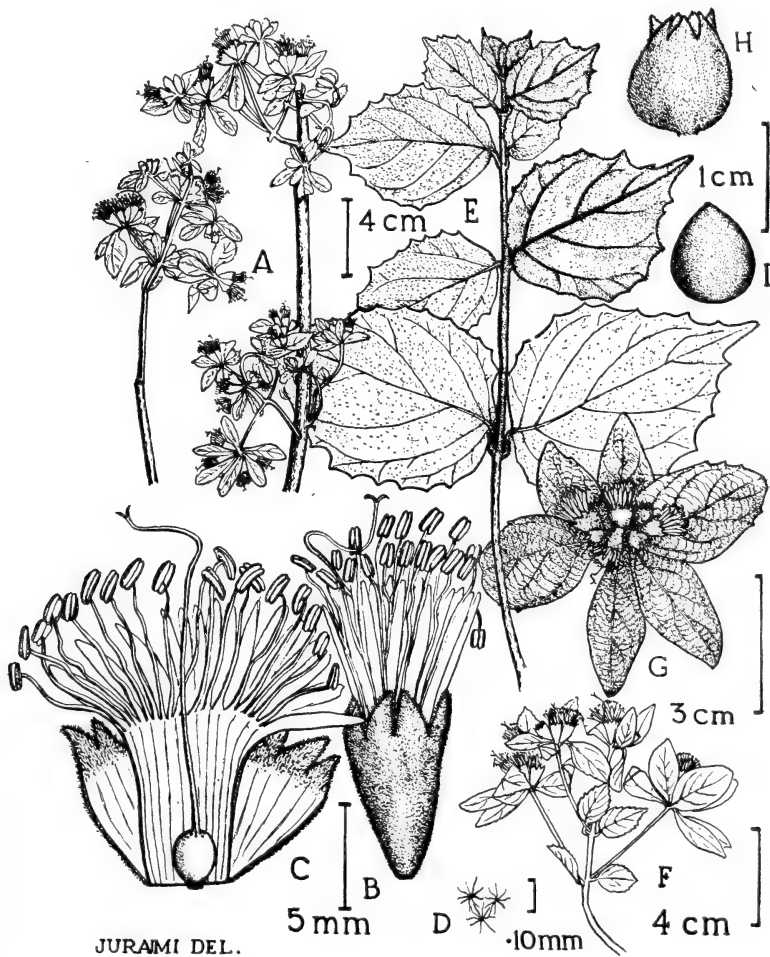


Fig. 4. *Symphorema polyandrum* (A-D Wight 2,304; E-G Talbot 362; H-I Haines 109).

A, Parts of an inflorescence. B, Flower. C, Vertically dissected flower. D, Stellate hairs from twigs. E, Non-fertile twig with leaves. F, Fertile branchlet showing its dichotomous divisions. G, Cyme. H, Fruit enclosed in the accrescent calyx. I, Fruit without the calyx.

INDIA: Uttar Pradesh, N. Chanda (Dowitt 1: DD; Ramrao 1,370: DD); Raipura (Marten s.n., DD). **Bihar & Orissa**, Singbhum (Haines 109: CAL & K); Chota Nagpur (Gamble 9,149: K); Mayurbhanj, at Dhobinisol (Econ. Pl. Surv. No. 677: DD). **Madhya Pradesh**, [Prob. from Balaghat] (Wight 2,304: K, prob. **holotype**; A, CAL & L). **Andhra Pradesh**, Godavari (Leg. ? s.n.: CAL; Beddome 6,516: BM; s.n.: SING); Kurnool hills (Gamble 10, 932: CAL; Beddome 8,181: K; 6,512: BM); Cuddapah hills (Beddome 40: CAL, 6,513: SING; 6,514 & 6,515: BM; s.n.: CAL & SING). **Madras**, Pondicherry (Perrottet 410: L & K; 326 & 530: K). **Maharashtra**, Belgaum near Gokak (Ritchie 925: E; s.n.: NY). **Mysore**, N. Kanara (Talbot 362: (E).

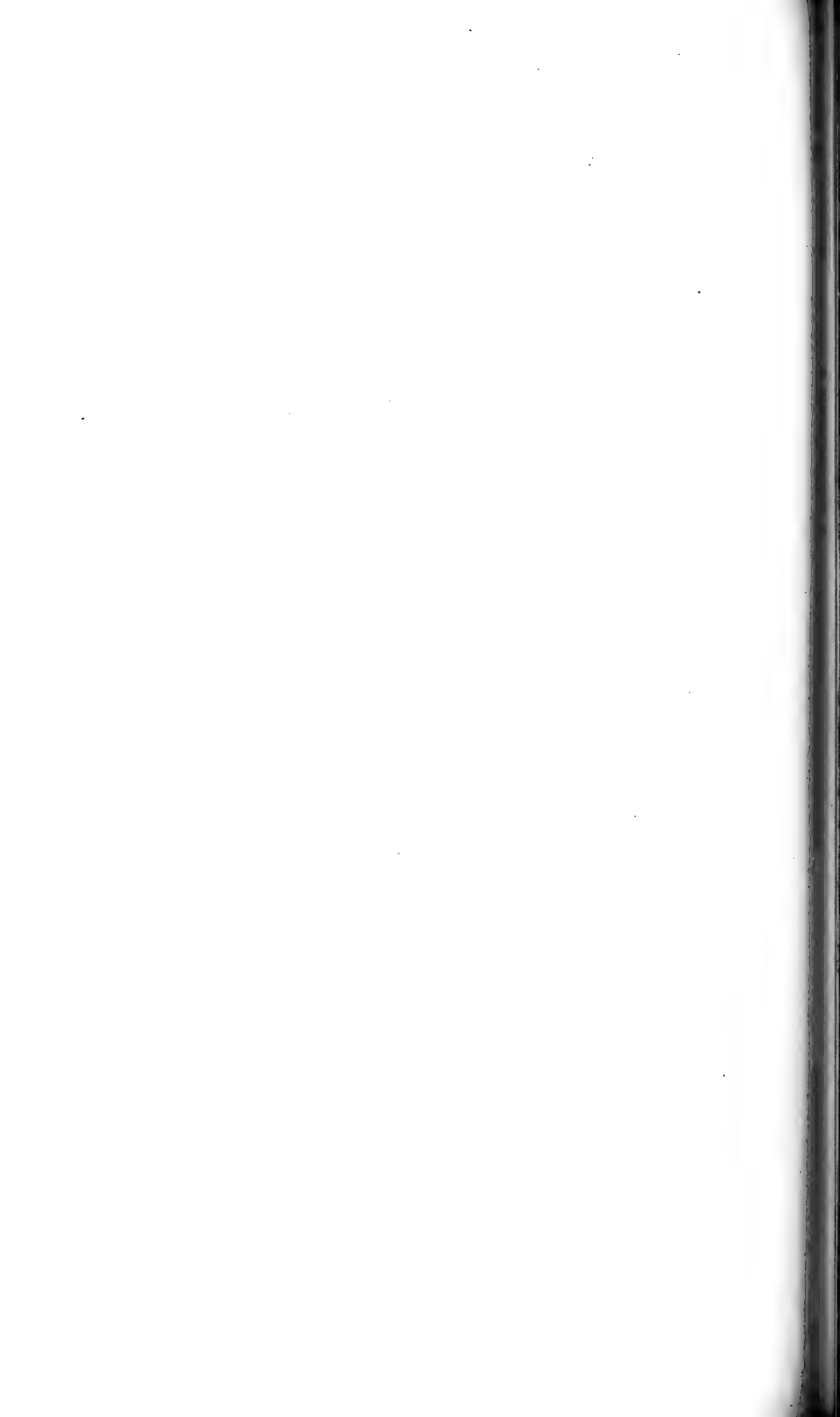
CULTIVATED: Hort. Bot. Calc. (Wallich 1,740: BM; Kurz 56 & s.n.: CAL; Leg. ? [Prob. K.d. No. 6,007]: CAL; s.n.: CAL, E & L).

In 1828 Wallich distributed under his Cat. No. 1,740 as *S. involucratum* Roxb. specimens from a plant cultivated in the Botanic Gardens, Calcutta. Schauer who had with him a specimen of this collection, used it to give a detailed description under Roxburgh's species, but stated that the specimen differs in many respects from the description of Roxburgh's type; but failed to identify with *S. polyandrum* Wight of which he had seen only a plate but no specimen. This error was noted by Clarke (1885) who made the correct reduction.

Index to Collectors' Numbers

Collectors' names are in alphabetical order and their collections are in numerical order. The number in brackets refers to the number given to each taxon.

- ABADILLA PNH 35,389 (1).
 AHERN 40, Bur. Sc. No. 1,172, 4,454, 4,455, 4,456 & For. Bur. No. 2,654 (1).
 AMIHAN PNH 40,320 (1).
 AUBERT & GAGE s.n. (2).
 BAKER 3,042 (1).
 BANAGA PNH 33,398 (1).
 BARBER 1,573 (2).
 BARNES 343 (1).
 BEDDOME 39 (2); 40 (3); 6,512, 6,513, 6,514, 6,515, 6,516 & s.n. (3); 6,519, 6,520, 6,521, 6,522, 6,523 & s.n. (2); 8,181 (3).
 BLATTER 6,112 (2).
 BORDEN For. Bur. No. 2,549 (1).
 BORSSUM 3,283 (1).
 BOURDILLON 537 (2).
 BRANDIS 881 (2).
 CARTER 1,507 (2).
 CLEGHORN s.n. (2).
 CLEMENS Bur. Sc. No. 17,534 & 18,176 (1).
 COLLET 435 (2).
 CUMING 648 & s.n. (1).
 DALZELL s.n. (2).
 DOWITT 1 (3).
 DUTHIE 9,687 (2).
 EBRON PNH 34,236 (1).
 ECON. Pl. Surv. No. 677 (3).
 EDANO PNH 17,748, 17,797 & 17,960 (1).
 ELMER 9,418, 17,419, 17,429 & 17,467 (1).
 FELIX For Bur. No. 3,914 (1).
 FERNANDES 220 (2).
 FISCHER & GAGE 83 (2).
 GAMBLE 9,149 & 10,932 (3); 13,745 (2).
 GLENIE sub Thwaites C.P. No. 3,645 (2).
 GREGORY 81 (1).
 HAINES 109 (3); 2,542 & 4,944 (2).
 HOLMAN 53 (1).
 LLAGAN sub Phil. Nat. Herb. No. 35,488 (1).
 KERR 991, 2,932 & 5,234 (2).
 KHALIL s.n. (2).
 KINGDOM-WARD 21,796 (2).
 KURZ 56 & s.n. (3); 1,040, 2,392 & 2,399 (2).
 LACE 2,794 (2).
 LARSEN & HANSEN 861 (2).
 LLANOS 69 (1).
 LOHER 13,444 & s.n. (1).
 MABANAG PNH 9, 601 (1).
 MADDEN 663 (2).
 MARTEN s.n. (3).
 MERRILL 954, 1,334, 1,421, 1,934, 2,075 & 2,416 (1); sub. spec. Blanco No. 467 (1).
 MEYER For. Bur. No. 2,516 (1).
 MILL s.n. (3).
 PARKINSON 15,733 & 15,750 (2).
 PASCUAL For. Bur. No. 28,766 (1).
 PERROTTET 326 & 410 (3); 487 (2); 530 (3).
 RAMOS Bur. Sc. No. 27,122 (1).
 RAMRAO 1,370 (3).
 RITCHIE 925 & s.n. (3).
 ROBERTSON 316 (2).
 ROGERS 274 & 910 (2).
 ROXBURGH s.n. (2).
 SINCLAIR 9,470 (1).
 SMITINAND 4,169 (2).
 STEINER 1,011 & 1,742 (1).
 STOCKS & LAWS s.n. (2).
 SULIT PNH 8,320 (1).
 SUSARA PNH 37,313 (1).
 TALBOT 52 & s.n. (2); 362 (3).
 TAMESIS For. Bur. No. 11,924 (1).
 THWAITES C.P. No. 3,645 (2).
 TOPPING Bur. Sc. 5,228 (1).
 VIDAL 501 & 848 (1).
 VILLAVICENCIO For. Bur. No. 23,654 (1).
 WALLICH 1,740 (3).
 WEBER 1,546 (1).
 WHITFORD 2 (1).
 WIGHT 909 & 2,303 (2); 2,304 (3); 2,586 & 2,587 (2).
 WILLIAMS 707 (1).



Malayan Fern Notes. V

by

BETTY MOLESWORTH ALLEN*

Dryopteris hirtipes (Bl.) O. Kuntze, Rev. Gen. Pl. 2; 813. 1891.

Basinyum: *Aspidium hirtipes* Blume, En. Pl. Jav. 148. 1828.

Synonyms: *Lastrea hirtipes* (Bl.) Moore in Beddome, Ferns of S. India, tab. xcvi. 1863-64.

Nephrodium hirtipes (Bl.) Hooker in Hk. & Bak. Syn. Fil. 261: 1883.

Malaya. Slopes of Gunong Palas, Cameron Highlands, Pahang. 23. 4. 63, ca. 1870 m. Coll. no. 4946.

This is a widespread species found from south China through Burma and north India to Ceylon, Borneo and Indonesia, and to some Polynesian islands. It does not appear to have been recorded in Malaya previously, but occurs in Siam where it bears a local name, Ta-ku-khu'i-do.

Description of living plants: Rootstock stout but flat, with tufted fronds. Scales to about 20 mm. long by 7 mm. wide at the base, tapered, midbrown with a dark base; margins entire. Scales become sparse on the upper part of the stipe, and also on the rachis where some are dark, almost black. Stipe approximately $1/3-1/2$ the length of the lamina; base black for about 3 cm. then green (stramineous when dry), the base is usually densely scaly for about 5 cm. Lamina simply pinnate and to about 54 x 30 cm. or more, widest at the basal or penultimate pair of pinnae. Rachis green, grooved above and usually rounded below. About 12-15 subopposite to alternate pairs of pinnae, the basal ones on stalks 1-2.5 mm. long, gradually becoming sessile about the middle pinnae and adnate or slightly decurrent in the upper ones; apex of lamina lobed. Pinnae commonly 14 x 2.5 to 30 x 3.5 cm., ascending and widest just above the base; shallowly lobed for 1-1.5 mm.; lobes falcate especially when dry, entire with a blunt tip. Acroscopic basal lobe overlapping the rachis, but not the basioscopic one. Colour deep green and shiny above, but pale below, texture firm, thick and brittle, and pinnae glabrous except on the veins. Veins obscure, becoming visible when dry, ending just short of the margins; 4-5 veinlets in each group, sometimes 6 on the basioscopic side; very narrow hairlike brown scales scattered along the veins. Sori when immature, pale cream in colour with a whitish indusium which is persistent when mature or dry. Sori vary from one either side of the costule, to several uneven rows which are always nearer the costae than to the pinnae margins. Indusia reniform, maturing medium-brown in colour.

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The first plants found were growing on steeply sloping ground amongst tea bushes (*Camellia sinensis* Kze.) on the Sungei Palas Tea Estate. These had very small infertile fronds not more than 15 cm. long, but had very large thick rootstocks, and were probably old plants which were frequently cut back by the weeding carried out around the tea bushes, so they produced no larger fronds. The edge of the estate was a few metres from here, and was bordered by a steep and narrow forest-clad gully. In the secondary growth bordering the forest I found five more plants of the *Dryopteris* growing where the soil was loose (see plate 1). They were larger and were partly in shade, and their roots were protected by other growth. Only one fertile frond was found and this was immature. Associated plants noted besides grasses and small herbs were *Thelypteris uliginosa* (Kze.) Ching, *T. brunnea* (Wall.) Ching, *T. beddomei* (Bak.) Ching (which was very common), *Athyrium japonicum* (Thbg.) Copel., *Cyclosorus ecallosis* Holtt., tall *Cyathea contaminans* (Hk.) Copel., and the introduced *Passiflora edulis* Sims, which was scrambling all over plants at the forest edge. Just inside the forest in dark wet places, were seven more plants of *D. hirtipes*; these were smaller but were fertile, the sori being mature. No more were found in the remainder of this narrow strip of forest. On all the fertile fronds the indusia showed clearly, even when past maturity.

D. hirtipes is the only simply pinnate *Dryopteris* so far found in Malaya, the other three having much more deeply divided fronds.

Through the courtesy of the Director of the Botanic Gardens in Singapore I was able to compare the Cameron Highland material with specimens from other countries, and they were almost identical with some from Mt. Kinabalu, and very close to a sheet labelled *D. atrata* (Wall.) Ching, from the Khasi Hills in India, except that on my specimens the basal scales are larger and paler. In Beddome's description (1892) the stipe and rachis are densely scaly.

Dryopteris hirtipes (Blume) O. Ktze. var. ***exinvolucrata*** (C. B. Clarke) B. Allen comb. nov.

Synonym: *Nephrodium hirtipes* (Bl.) Hooker var. *exinvolucrata* C. B. Clarke, Journ. Linn. Soc. Bot. xxv: 93. 1889.

Malaya: In clearing in forest at filter tanks, Cameron Highlands, Pahang, 1-5-1963, ca. 1,700 m. Coll. no. 4980.

Differs from the species in having the basal scales very dark brown, almost black, and narrower (less than 3 mm. wide at the base), and being quite black at the base. Pinnae are slightly smaller and narrower the widest measured being 2 cm. wide by 10 cm. long, and the fertile fronds are slightly contracted. Lobing is very shallow and the apex of the lobes is frequently toothed. Fronds are about the same length so that the pinnae are wider apart and the acroscopic lobe does not overlap the rachis. Sori are naked, there being no sign of indusia at any stage.

This variety was collected near a stream in a small open space surrounded by tall forest, and just above where the water filter tanks are (previously the trout hatcheries). This is about two miles from where *D. hirtipes* was found. The ground was flat and rocky and had been cleared of forest before the war and periodically cut since, but a few *Cyathea contaminans* grew on the stream edges and gave slight shade. Here several plants of the variety were growing amongst plants of similar height and about 1–2 metres from the stream bank. Two other ferns were growing with them; they were small specimens of *Athyrium amplissimum* (Bak.) Holtt., and a *Cyclosorus*, possibly *C. megaphyllus* (Mett.) Ching. The *Dryopteris* bore fertile fronds at all stages of maturity, and the indusia was clearly missing.

That the species and the variety should turn up together is interesting. Also that the two localities, although not far apart and both in disturbed areas, are quite different from each other. They are large enough ferns not to be easily overlooked, and surrounding areas and similar places were searched but no more of either was found, so appear to be very restricted in their distribution. This suggests to me that they may be comparatively new arrivals in Cameron Highlands as is *Thelypteris beddomei*. (This fern was first recorded for Malaya in 1949 when I collected it from Maxwell's Hill in Perak, where tea had been grown about 50 years ago. The only other Malayan locality I know of, is at Camerons where tea is commonly grown today.) *Dryopteris hirtipes* was not growing near water, but on sloping ground both in the open and in the shade. The variety, on the other hand was near a stream on flat ground which well may be flooded, but was not found in real shade.

I saw neither in Camerons when I was there in 1948, although I collected ferns from the exact area of the variety. Nor did Dr. Holttum record them during his collecting, prior to 1949 (after that it was virtually closed for 11 years). Christensen and Holttum (1934) reported both kinds from Mt. Kinabalu area and stated (about the Lobang specimens) "H. 25557 has conspicuous indusia, but no indusia can be found on the Tenompok specimens, which thus agree with the Himalayan-Chinese *Phegopteris scottii* Bedd."

I believe that *Dryopteris scottii* (Bedd.) Ching (1933a), syn. *Phegopteris scottii* is identical with var. *exinvolucrata*, and thus would become a synonym of it. The illustration in Beddome (1892) shows almost elliptic pinnae, but he states in the text that it is "perhaps an abnormal form of *Lastrea cuspidata* or *hirtipes*". Dr. Holttum writes (in a letter to me) that the differences between *D. hirtipes* and *D. scottii* as given by Ching, agree with my description of var. *exinvolucrata*. He points out however, that after comparing many specimens of *D. hirtipes* and the variety, he finds that the toothing on the edges of the pinna-lobes is variable and does not seem to be a good distinctive character.

Dryopteris atrata is a species very closely related to *D. hirtipes* and in fact was cited as a synonym by van Alderwerelt van Rosenburgh (1908) and Backer and Posthumus (1939) but considered a variety by C. Christensen (1931) and retained as a distinct species by Ching (1938). He states that the true *D. hirtipes* occurs in south India and Siam, but not in north east India and S. China.

Microsorium superficiale (Bl.) Ching, Bull. Fan Mem. Inst. Biol. 4:299. 1933.

Basynym: *Polypodium superficiale* Blume Flor. Jav., 11; 136. 1828-29.

Synonyms: *P. normale* Don, var. *sumatranum* Bk. Journ. Bot. XVIII, 215.

P. nigricans v.A.v.R. Bull. Btz., VII: 24. 1912.

Pleopeltis superficialis (Bl.) Bedd. Handb. 350. 1885.

Pl. nigricans (v.A.v.R.) v.A.v.R. Bull. Btz. XX: 22. 1915.

Pl. rupestris var. *nigricans* v.A.v.R. VII: 24. 1912.

Distribution: From Japan and India to Indonesia.

Malaya: Slopes of Gunong Batu Brinchang, Cameron Highlands district; Pahang. altitude, 1960 m. upwards for at least 200 m. Both epiphytic and terrestrial. Coll. nos. 4024 and 4685. There appear to be no previous Malayan records.

Description. Rhizome long-creeping, dark brown, about 4 mm. wide when dry. Rhizome scales conspicuously iridescent, cell walls dark brown and forming a clear network, edges irregularly toothed. Scales spreading, overlapping, gradually tapered from a wide base to a pointed apex; apices often breaking off on old scales. Fronds well spaced on rhizome and stipes from 4 to 10 cm long or more, glabrous when mature, usually paler than the lamina. Lamina varying greatly in size according to habitat; mature fronds from 15-30 cm. long or more, by 3-5 cm. wide with tapered base and apex, usually widest just below the middle; edges slightly thickened, entire, often sinuate when dry. Fronds deep green and shiny above and paler below and glabrous. Veins indistinct but visible by transmitted light, especially the more or less parallel side veins. Sori numerous, in 3-5 irregular rows between the midrib and margin (or in 1-2 irregular to fairly regular rows between the slightly parallel veins. Sori round, but varying in size from 1.5-2.5 cm. in diameter.

In general appearance this fern resembles *M. normale* (Don) Ching, but does not have the curious scales of this species, but copious shiny scales which are most conspicuous. *M. superficiale* is in fact closer to *M. sarawakense* (Bak.) Ching, and at a distance may look like a large form of it.

I have found *M. superficiale* only in one (large) area, on the slopes of Batu Brinchang, in both disturbed and more or less intact rain forest. It seems to favour the outskirts of tall wet jungle, on both living and dead tree trunks, on horizontal logs, and on one occasion on the trunk of a *Cyathea* sp. Where it is

common, it seems to have become established on the ground around the host trees, where it produces large fronds; these I have never found fertile. In no cases were the ferns growing very near streams.

There was tall second growth, with a small rotan, probably *Calamus* sp., rather effectively sealing this area from the road. The ground was flat and damp with patches of *Athyrium dilatatum* near the terrestrial *M. superficiale* which was very common here. It was also epiphytic on the trunks of small trees and on the remains of trunks of larger cut trees, and the long thin rhizomes frequently reached the top of a stump, twisting itself around, making a conspicuous bunch of rhizomes and fronds, which hung away from the trunk.

Other ferns noted in this area included *Cyathea contaminans* (on the outside edge), *C. latebrosa*, *Cyclosorus ecallosis*, *C. stipellatus*, *Bolbitis simplicifolia*, and occasional *Athyrium subintegrum*; these were terrestrial. Epiphytic ferns were *Asplenium tenerum*, *A. nidus*, *Elaphoglossum callifolium*, *Grammitis hirtella* var. *major*, *G. reinwardtii* and one *G. holttumii* (very low on a branch of a sapling). *Xiphopteris hieronymusii* and *Ctenopteris obliquata* often grew with the *Grammitis* spp. on the mossy trunks.

Other places where the fern grew near the above habitat were on trees in tall forest on sloping ground and some others were seen in full sun on stumps; the fronds of the latter were small and pale green. It was so common here on the eastern slope of the mountain that I feel sure it must grow in similar places on other parts of the Main Range, and may even have been collected previously for it is stated to occur in Malaya by both Beddome and van Alderwerelt van Rosenburgh although no herbarium material appears to exist.

Specimens of *Microsorium superficiale* have been distributed to the following institutions: Royal Botanic Gardens, Kew; Smithsonian Institution; Chicago Natural History Museum; Gray Herbarium; Singapore Botanic Gardens; Sarawak Museum, and Swedish Museum (Nat. Hist.).

Tectaria decurrens (Presl) Copeland, Phil. Journ. Sci. 2C: 412 1907.

Synonyms: *Aspidium decurrens* Presl; *A. mamillosum* C. Chr.; *A. pteropus* Kze.;

Nephrodium decurrens (Presl) Bak.; *Sagena decurrens* (Presl) Houltst.;

S. mamillosa (C. Chr.) Moore; *S. pteropus* (Kze.) Beddome. van Alderwerelt van Rosenburgh calls the Malayan form var. *mamillosum* as this seems to have the sori deeply impressed, but it is doubtful whether it is really sufficiently distinct to maintain the variety.

Known collections in Malaya: Batu Kurau, Perak. 1911; coll. G.C. Matthew. Foothills of the Main Range behind Gopeng. 1960; coll. B. Molesworth Allen nos. 4486, 4555.

Distribution: widespread from south China, N. India to Polynesia.

Holttum (1954) does not include *Tectaria decurrens* as a Malayan fern for the existence of Matthew's specimen was not then known. Admittedly Ridley (1921) does record it from Pahang, Trengganu and Perak, but it appeared there was no material in herbaria from these States. As I will show, it is a fern that is easily mistaken for two other Malayan *Tectaria* which grow in similar places. So, Dr. Holttum who was fully aware of this, being unable to find any collection from Malaya rightly omitted it from the Flora. I think now that Ridley did collect it himself from near Bujang Melaka mountain in Perak, and I believe that *T. decurrens* was far more common before the lowland jungle was greatly milled or destroyed for cultivation, for it prefers tall wet jungle, usually near streams.

It does seem strange that no other herbarium material from Malaya is known; Matthew's collection only came to light recently when Dr. Holttum was kindly examining *Tectaria* for me at Kew.

Description of the Malayan plants: Stock stout, built-up with supporting rootlets; scales dull, medium-brown, stiff, entire and tapered, commonly 10×2 mm. Stipes medium-brown to 50 or 60 cm long, commonly about 45 cm. long, and winged to within 3–4 cm. of the base, then ceasing abruptly. Wing fairly even but usually widest near the lamina, where it may be over 3 cm. (across both wings) on sterile fronds. Scales are present only on the base of the stipe, the underside being glabrous for the remainder (it is always scaly in *T. vasta*). Fronds erect, glabrous medium-green and shiny above, drying olive brown. Lamina, simple when very young; adult deeply lobed with 3–4 pairs of lobes and a basal pair which often have a lobe each. Apex large, usually with a pair of small lobes at the base. Lamina length commonly about 45–55 cm. long and about as wide (across the lobes) as long. Fertile fronds slightly contracted; the upper 16 cm. of the wing of the stipe bearing scattered sori. Sori similar to that of *T. crenata* on a receptacle, very deeply impressed so that the upper surface of the lamina is strongly papilliform. Sori placed on free terminal veins within aeroles in two, more or less even rows, between the costules. Indusium large, reniform and persistent.

When I first saw *T. decurrens* in Malaya (and I was familiar with it in Borneo) in July 1959, it was sterile, and I noted that it was possibly young *T. vasta*. Later, however, in August I found a fertile plant in the same area and not expecting *T. decurrens*. I was careless enough to pass it off as *T. crenata*, but did not collect it then, only adding that the stipe was winged to its base as in *T. vasta*. I mention this to illustrate how easy it is to mistake this fern, and if records are not backed by herbarium material, they should be treated with caution.

Tectaria decurrens was growing on the floor of tall mixed jungle, which lies in the foothills of the Main Range between Gopeng and Jor Camp. The forest here has remained more or less intact as it is a water catchment reserve. Next to a large *Pteridys* sp., it was the commonest fern within an area of about 30 square metres, at an altitude of about 100 m., and higher up in the continuation of the forest, it became rare and was not seen above 300 m. The ground where it was common was generally sloping, but with a flat area just above a rocky stream. The soil was black and sticky, the undergrowth fairly sparse, and in a few places some trees had fallen and exposed a few *Tectaria* to direct sun. These seemed to be surviving when I last saw them (1963), but were continually fertile whereas the others in shaded places, in what is probably their natural habitat, produced new growth in December and January, and sori from January to April. During August — September only sterile plants, or those with very old sori were noted.

Associated floor plants included *Tectaria maingayi* which was very common, a very large form of *Pteridys* which approached *acutissima*, as well as normal *P. australis* (which was not very common here), *Tacca cristata* and several small ginger, *Globba auranticea* and *G. variabilis*, and large ones, *Achasma* sp. and *Hornstedtia* sp.; *Forrestia* sp., *Curculigo latifolia*, *Angiopteris evecta*, and some dwarf palms including *Pinanga* (probably *disticha*), and some aroids *Anadendrum* sp. and *Schismatoglottis* sp. in the dryer parts, also *Tectaria singaporeana* on sloping ground. Juvenile *Lomariopsis cochinchinensis* was frequent at tree bases, and taller growth in this area included *Cyathea latebrosa*, *Baccaurea lanceolata* and *B. brevipes*. Growing in and on the sides of the stream were noted, *Saraca thaipingensis*, *Salmalia valetonii* and a huge Annonaceous tree in the stream with large cauliferous flowers borne low on the trunk, and *Laportea stimulans*; on wet rocks were *Bolbitis diversifolia* which was very common. *B. heteroclita*, *Egenolfia appendiculata* and a possible hybrid between two of these; *Microsorium pteropus*, *Abacopteris meniscii-carpa*, *Trichomanes maximum* and one *Athyrium simplicivenium* (which commonly occurred higher up), *Stauranthera grandiflora*, and a *Begonia* sp. which was very common. On large rocks by the stream were *Polypodium papillosum* and *Phymatodes nigrescens*. Lianes were common over the stream, one was a *Vitis* sp. others were *Calamus* spp.

The only other place I have seen the fern in Malaya was at Klian Intan in Upper Perak. It was growing on the floor of tall rather similar forest at about 300 m. There was scant undergrowth on flat ground near a stream. Again, the *Tectaria* was found in only one small area, but as I did not collect it then (intending to return later), I can only make a note of it in here.

Cyclosorus papilio (Hope) Ching, Bull. Fan Mem. Inst. Biol. 8:214. 1938 syn. *Nephrodium papilio* Hope, Journ. Bombay Nat. Hist. Soc. 12: 625 t. 12.1899.

Distribution: N. India, Ceylon.

In 1958 I found *C. papilio* on the borders of Pahang and Perak, by the side of a small stream under tall trees, growing alongside some large gingers (*Achasma macrocheilos*). This was just below Ringlet at about 1,000 m. It was identified by Dr. Holttum. Later I found it in several areas lower down, on the same part of the Main Range, where in places it is quite common. The second area was all within the Tapah Hills Forest Reserve, from about 670–1,000 m. in altitude. Coll. nos. 3913, 3986, 4312, 4449, 4949.

In the past *C. papilio* was included under *Nephrodium molle* var. *major* Bedd. (as was *C. sumatranus* (v.A.v.R.) Ching). Then the specimens from north India and Ceylon were removed by Hope and called *N. papilio* (see Holttum (1954) p. 275).

Extreme forms of the Malayan species do appear to be quite distinct, especially in the remarkable auricles on the stipes (always about 5 or 6 pairs) which have such enlarged and pointed acroscopic lobes that they resemble the Malayan Dragontail butterfly (*Lamproptera megas virescens*), thus the specific name is most apt. There are oblong glands on the underside of the lamina, sometimes copious, which I have not seen on *C. sumatranus*. There are, however, specimens which I consider are intermediate between the latter and *C. papilio*. I have found *C. sumatranus* growing together with *C. papilio* at about 700 m. which is a high altitude for this normally lowland fern.

I have not yet seen any other specimens of *C. papilio* with which to compare mine. If this species has already been collected in Malaya, it will most probably be found under *C. sumatranus*, for there appear to be no other records of it.

I am grateful to the Director of the Royal Botanic Gardens, Kew, for assistance in checking specimens and to Dr. R. E. Holttum who has spent much of his valuable time on my behalf checking my identifications, and especially for the information on the status of *Dryopteris hirtipes* and the var. *exinvolutrata*.

Literature Cited

- BACKER, C. A. & Posthumus, O., 1939: Varenflora voor Java.
 BEDDOME, R. H. 1892: Handbook to the Ferns of British India.
 CHING, ., 1933: Bull. Dept. Biol. Sunyatsen Univ. no. 6. 3.
 CHING, ., 1938: Bull. Fan Memorial Institute, Botany vol. 8.
 CHRISTENSEN, C., 1931: Contributions to the U.S. National Herbarium, 26.
 CHRISTENSEN, C. & HOLTUM, R. E., 1934: Gardens Bull. Straits Settlements, 7, pt. 3.
 HOLTUM, R. E. 1954: Flora of Malaya. Vol. 2. Ferns of Malaya.
 RIDLEY, H. N., 1926: Malayan Branch, Royal Asiatic Soc. 4, pt. 1, p. 79.
 VAN ALDERWERELT VAN ROSENBURGH, C.R.W.K., 1908: Malayan Ferns Handbook.



1. *Dryopteris hirtipes* on forest edge, Cameron Highlands, Pahang.



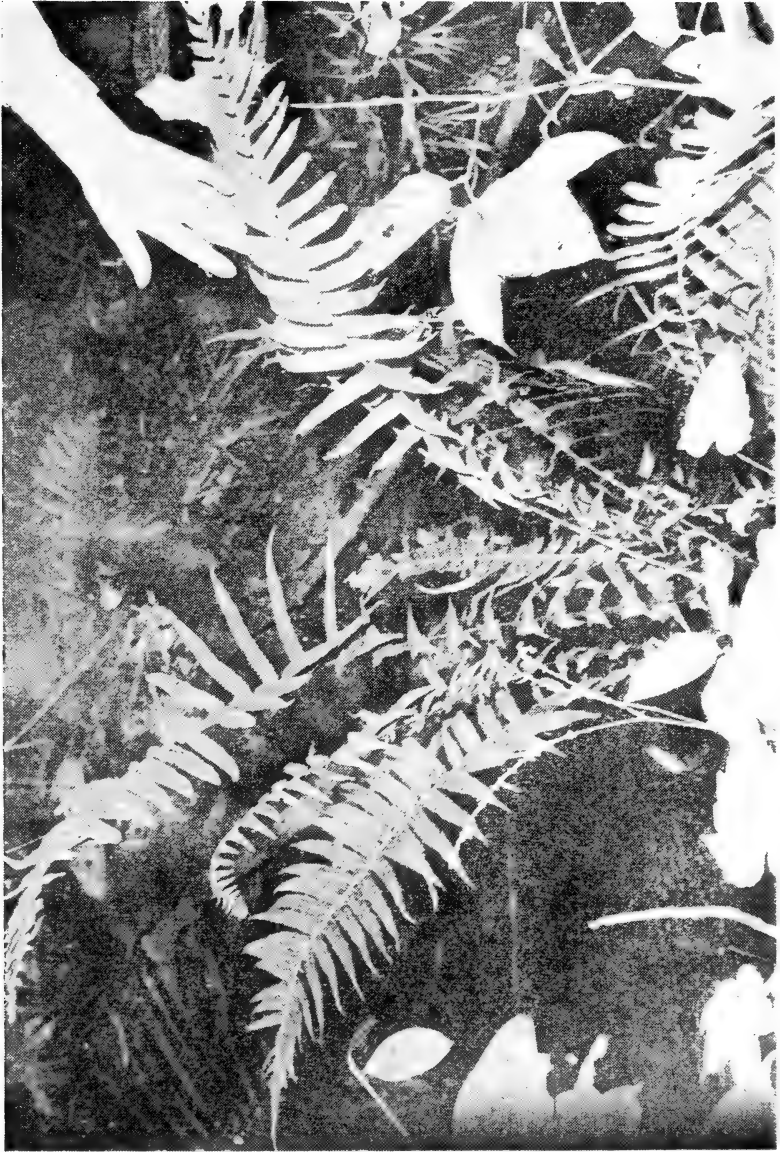
2. *Microsorium superficiale* from the slopes of Batu Brinchang. Pahang.



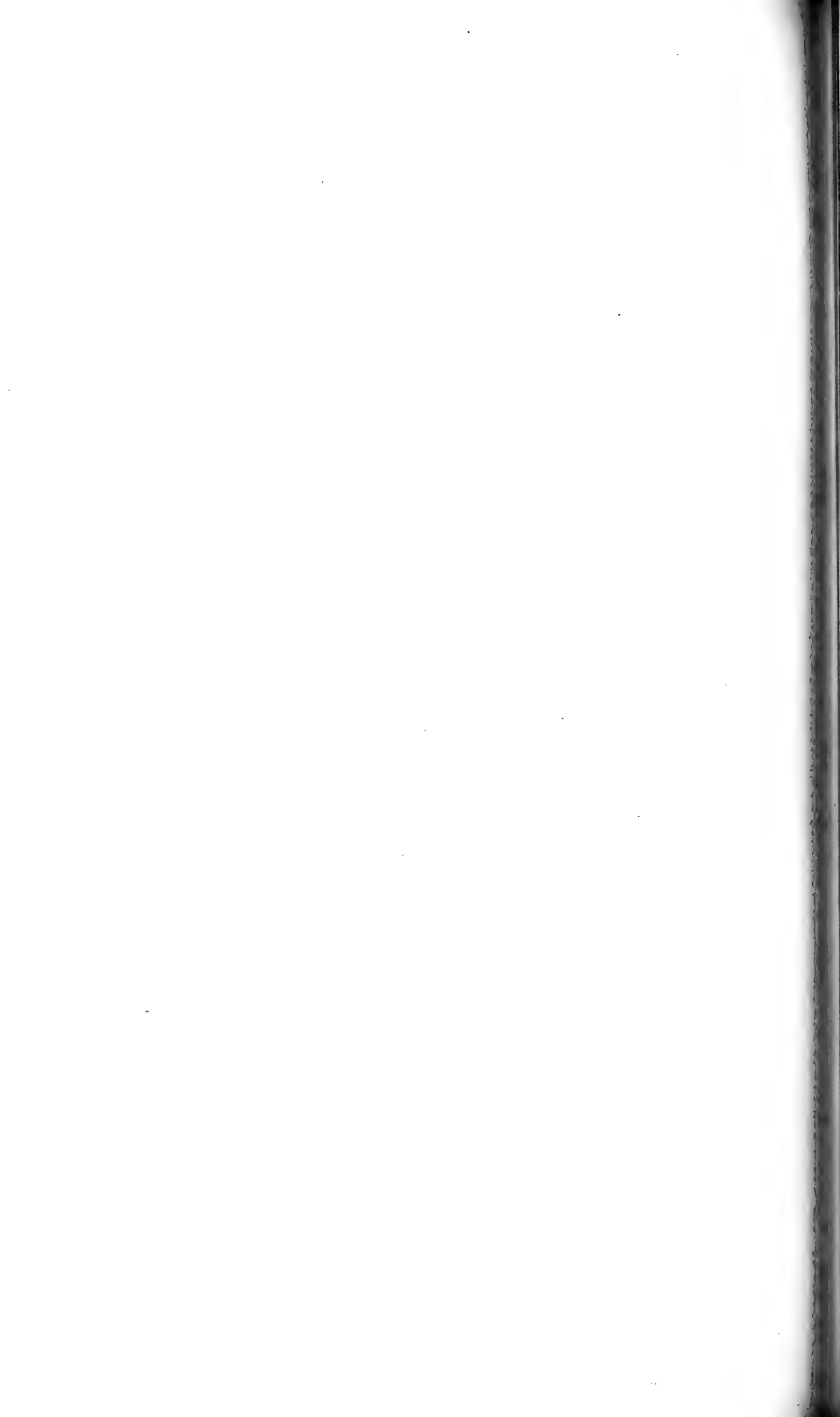
3. *Tectaria decurrens* growing in forest near Gopeng. Perak.



4. *Tectaria decurrens*; a fertile frond showing the deeply immersed sori.



5. *Cyclosorus papilio*, Tapah Hills forest, Perak.



Notes on the Flagellata of Hongkong.

by

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1. Species of the genus *Chlorogonium* Ehr. (Chlorophyceae, Volvocales, Chlamydomonadaceae) from polluted waters in Hong Kong.

Notulae ad floram Flagellatarum Hongkongensis 1. Species generi *Chlorogonium* Ehr., Chlorophyceae, Volvocales, Chlamydomonadaceae in Hongkong aquae impurae inventae cum 8 fig.

Abstract

In the present note the author describes 7 species of the genus *Chlorogonium* Ehr. from polluted waters of Hong Kong, recorded from materials received in January 1966 and studied in the Botanical Institute of Sao Paulo, Brazil. The collection from Hong Kong has been received through the kindness of Professor Thomas B. Widdowson of the Botanical Department of Hong Kong University. Samples of mud cultured in glass vessels were collected in Hong Kong by Mr. S. T. Chan of the Botanical Department of the University.

Preface.

Green flagellata of the genus *Chlorogonium* Ehr. form a typical algal component of polluted waters. The genus was proposed by Ehrenberg in 1830 to cover such forms. Cells of *Chlorogonium* are almost fusiform in shape and have 2 flagella at the anterior part of the cell. The chloroplast is entire, massive, green and not laminate in the specimens from Hong Kong. According to the species, the chloroplast contains one, two, or several pyrenoids or may lack them entirely. The nucleus is almost centrally located. Some species have an eyespot, while others lack one. Asexual reproduction is by transverse division of the protoplast and by the production of zoospores. Sexual reproduction is by fusion in pairs of equal sized (isogamous) biflagellate gametes.

Seven species of *Chlorogonium* are recorded from the cultures of polluted mud collected near Hong Kong. One has been identified as *Chlorogonium euchlorum* Ehr., but the remaining appear to be new to science and are so designated.

Key to the Species.

- A. A single pyrenoid present.
- a. Eyespot present, cell fusiform 1. *Chlorogonium chanii*
sp. nov.
 - b. Eyespot lacking, cell fusiform
 - 1. Pyrenoid central. 2. *Chlorogonium astigmatae*
sp. nov.
 - 2. Pyrenoid posterior (rarely 2) 3. *Chlorogonium subtropicale*
sp. nov.

- B. Two pyrenoids present.
- a. Eyespot lacking ... 4. *Chlorogonium widdowsonii* sp. nov.
 - b. Eyespot present, apical and very small ... 5. *Chlorogonium aberdeenii* sp. nov.
- C. Numerous pyrenoids.
- a. Eyespot lacking ... 6. *Chlorogonium stentoni* sp. nov.
 - b. Eyespot present ... 7. *Chlorogonium euchlorum* Ehr.

1. **Chlorogonium chanii** sp. nov. [Fig. I: 1.]

Cellula brevi vel longi-fusiformis cum apicibus attenuatis et cum flagella $\frac{1}{2}$ -plo cellulae paulo longiore; chromatophoris parietalis; stigma elongatum prope vacuolae parte anteriore cellulae; pyrenoide centralis prope nucleus; cellulae 9–15 x 4 μ . Differt a *Chlorogonium fusiforme* Matv. in stigmate fere apicale. Dedicavi hanc species in honorem Do. S. T. Chan collectoris algarum Hongkongensis. Hab. Hong Kong, in orysetis cum aqua impura, lg. S. T. Chan, 12th August, 1965.

2. **Chlorogonium astigmatae** sp. nov. [Fig. I: 2.]

Cellula brevi-fusififormis cum apicibus brevi acutis, lateribus plusminusve rotundatis; flagella $2\frac{2}{3}$ -plo cellulae longioribus; stigmate nullo; pyrenoide et nucleus centrales; vacuola parte anteriore prope flagellis; cellula 9–14 x 4–5 μ . Differt a *Chlorogonium obliquum* Skv. 1946, *Ch. uinutum* Skv. 1957, *Ch. leiostrectum* Str. et *Ch. tetragamum* Bohl in stigmate nullum. Hab. Hong Kong, in rivularis et orysetis cum aquae impurae, lg. S. T. Chan, 12th August, 1965.

3. **Chlorogonium subtropicale** sp. nov. [Fig. I: 3 & 4.]

Cellulae fusiformis cum apicibus attenuatis et acutis; flagella 2, apice, $\frac{3}{4}$ -plo cellulae longioribus; vacuola contractilis pone; nucleus centralis; pyrenoide 1 rarior 2, inter nucleus et parte posteriore cellulae; cellulae 18–30 x 7.4 μ . Differt per totem species in 1–2 pyrenoidibus. Hab. Hong Kong, in rivularis montanis cum aqua impura, lg. S. T. Chan, 12th August, 1965.

4. **Chlorogonium widdowsonii** sp. nov. [Fig. I: 5.]

Cellula perfecte lanceolata vel spatulata cum parte posteriore late cuneata; flagella $2\frac{2}{3}$ -plo cellulae longiora; nucleus centralis; stigmate nullo; pyrenoide 2; cellulae 14–18 x 7.4 μ . Differt a *Chlorogonium aculeatum* (Korsch.) Pascher, *Ch. acuminatum* Skv. 1957, *Ch. elongatum* Dang., in stigmate nullo. Dedicavi hanc species in honorem Dom. Prof. Thomas B. Widdowson, Botan. Depart. Hong Kong University. Hab. Hong Kong, in rivularis montalis cum aquae impurae, lg. S. T. Chan, 12th August, 1965.

5. **Chlorogonium aberdeenii** sp. nov. [Fig. I: 6.]

Cellula fusiformis cum apicibus attenuatis et acutis, parte mediane cellulae cum lateribus conversis; flagella 2, 4-plo cellulae paulo brevioribus; stigma minor fere apice; nucleus centralis; vacuoles contractiles nonnihil; cauda hyalina sine chromatophoris. Differt a *Chlorogonium elongatum* Dang. in stigmate mintae

apicale et in margines cellulae protractis. Hab. Hong Kong, prope Aberdeen, in rivularis montanis cum aqua impura, lg. S. T. Chan, 12th August, 1965.

6. **Chlorogonium stentoni** sp. nov. [Fig. I: 7.]

Cellulae elongato-fusififormis cum apicibus elongatis et protractis; flagella 4-5-plo cellulae brevior; stigma nullo; nucleus fere centralis; pyrenoide 5-10; cellulae 37-74 \times 9-5 μ . Differt a *Chlorogonium euchlorum* Ehr. (see Pascher 1927, p. 314-315, fig. 281-282) in cellulis astigmatiis. Dedico hanc species in memoriam Dom Prof. O. H. Stentoni Universitatis Hongkongensis Hab. Hong Kong, Aberdeen, in rivularis montanis cum aquae impurae, lg. S. T. Chan, 12th August, 1965.

7. **Chlorogonium euchlorum** Ehr. [Fig. I: 8.]

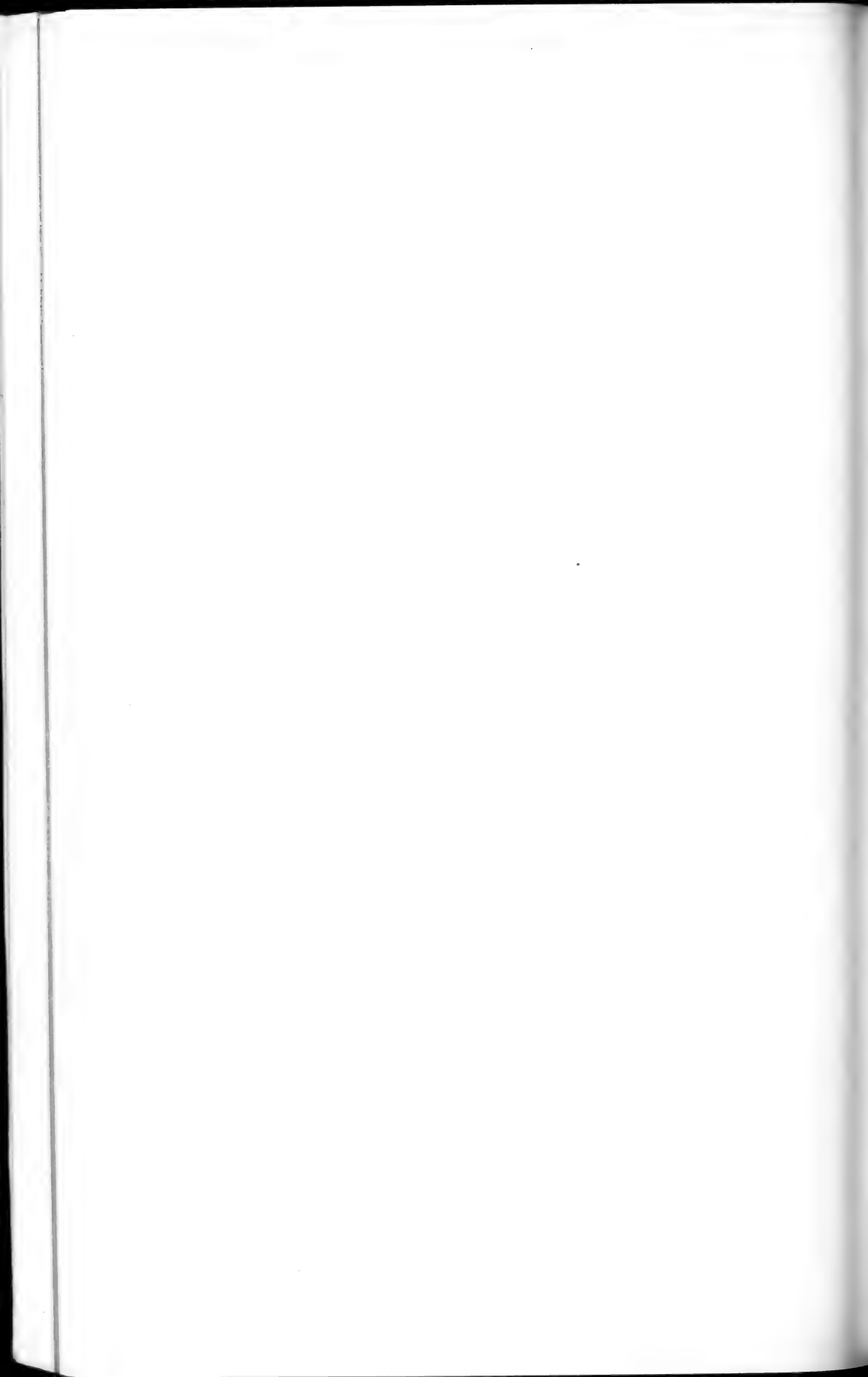
Cells lanceolate and acute at both ends. Flagella 2, about $\frac{1}{3}$ the length of the cell. Chromatophores in the form of a green plate close to the periplast. Stigma large, long, in the anterior part of the cell. Pyrenoids 6. Nucleus central and large. Contractile vacuoles small and numerous. Hab. Hong Kong, in a polluted stream, collected by S. T. Chan, 19th August, 1965. Reported from Europe and N. America.

Acknowledgments.

I wish to express my gratitude to the Foundation of Science (Fundaso de ampera a Pesquisa, Sao Paulo) which is supporting my research work, to the Director of the Botanical Institute of Sao Paulo, Dr. Alcides Ribeiro Teixeira and the leaders of the Cryptogamic Section of the Botanical Institute, Dr. Oswaldo Fidalgo, Dr. Joao Salvador Furtado, Dr. Carlos Eduardo de Mattos Bicudo and the secretaries of the section Aparecida de Castle Miccoli and Mallene Ocana Orlane for help in the work. I am indebted to Prof. Thomas B. Widdowson and Mr. S. T. Chan of the Department of Botany, Hong Kong University, for collecting and sending to Sao Paulo, Brazil the algological collection for my studies. I wish to express my gratitude to the Director, Botanic Gardens, Singapore, for permission to publish these notes in the Gardens' Bulletin, Singapore.

Literature.

- Dedusenko-Stzegoleva, N. T., A. M. Matvienko & L. A. Schkovatov. 1959. Chlorophyta. Volvocineae. Key of freshwater algae of U.S.S.R. Vol. 8. Moscow 1959.
- Pascher A. 1927. Volvocales—Die Süßwasserflora Deutschland Oesterreich und der Schweiz.
- Skvortzov, B. 1946. Species novae et minus cognitae Algarum, Flagellatarum, et Phycomycetarum Asiae, Africae, Americae et Japonae nec non Ceylon anno 1931-1945 descripto et illustrato per tab. 1-18.
- Proc. Harbin Soc. Nat. Hist. and Ethnogr. 2. Botany, Harbin 1946.
1957. New and rare flagellatae from Manchuria, Eastern Asia. Philipp. J. Sc. 86. Manila.



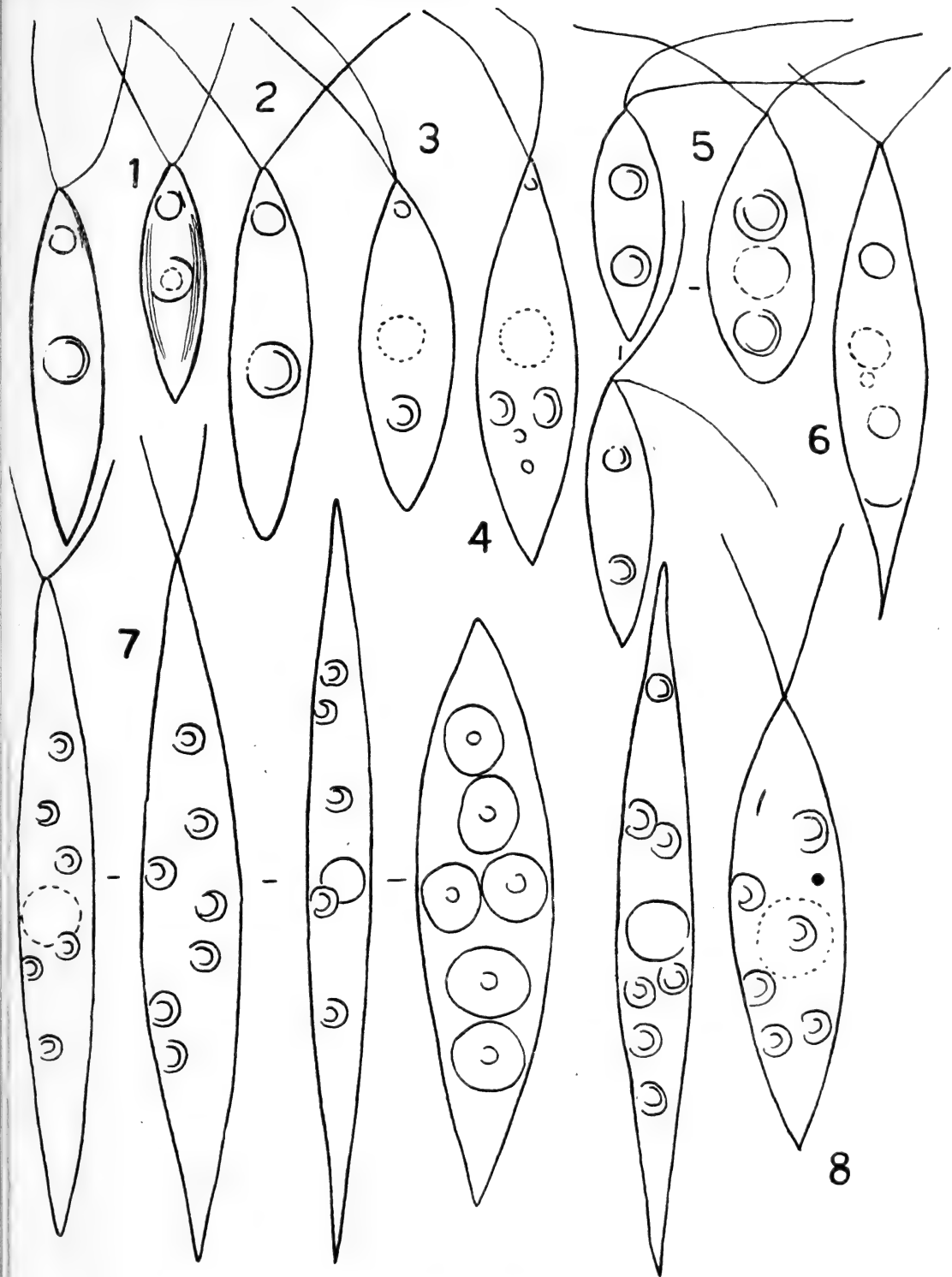


Figure I

1. *Chlorogonium chanii* sp. nov.
2. *Chlorogonium astigmatae* sp. nov.
- 3 & 4. *Chlorogonium subtropica* sp. nov.
5. *Chlorogonium widdowsonii* sp. nov.
6. *Chlorogonium aberdeenii* sp. nov.
7. *Chlorogonium stentoni* sp. nov.
8. *Chlorogonium euchlorum* Ehr.



Sclereids in *Fagraea*

(*Loganiaceae*)

by

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INTRODUCTION

Caspary (1865) was one of the early workers to realize the taxonomic value of sclereids in distinguishing species within the genus. Van Tiegham (1891) used this character when he observed sclereids in the mesophyll of a number of species of *Mouriria* and *Memecylon* which led him to group both the genera in the sub-tribe "Mouririées" under the subfamily "Melastomacées". Since Van Tiegham in his work included neither the author-names of the species of *Mouriria* studied nor citations to specific herbarium specimens, it led Foster (1946) to do a complete re-examination of the foliar sclereids of *Mouriria*, utilising an extensive series of herbarium collections and he saw that throughout the sixty-nine species investigated, the sclereids were restricted in position to the ends of the veinlets, regardless of their form. He thus considered the presence of terminal foliar sclereids as an important generic character of *Mouriria* which could be utilized in the identification of "sterile" and doubtful materials. Since then, many workers Morley (1953), Rao (1957), Barua and Wight (1958), Tomlinson (1959) and Carlquist (1961) have used sclereid characters to assess the taxonomic positions of certain angiosperms.

In the family Loganiaceae, Metcalfe and Chalk (1950) have recorded the presence of 'sclerenchymatous idioblasts' in the mesophyll of *Anthocleista*, *Fagraea*, *Potalia* and *Strychnos*. More recent work by Rao (1965) on the genus *Fagraea* showed that the size and arrangement of the sclereids was different in each of three species examined. Preliminary studies on foliar sclereids in *Fagraea* revealed great morphological variation in the structure of the sclereid and it was this that led the writer to the present investigation of all the species of *Fagraea* with a view to study the anatomy of sclereids and to ascertain their systematic value in this genus.

Materials and Methods:—

The genus *Fagraea* though distinctly centered in Malaysia is found distributed from Ceylon and the Malabar coast through SE continental Asia to South China, Hainan and the southern peninsula of Formosa, in the Northern Territory and NE Queensland,

and in the Pacific from the Marianas to the Marquesas and the Tubuai Islands and New Caledonia in the southwest. (Plate 1). The materials for the present investigation were derived partly from fresh and partly from herbarium specimens. Fresh material was available for four of the species. Of these, *F. auriculata*, *F. fragrans* and *F. ridleyi* are growing in the Botanic Gardens, while material of *F. crenulata* was collected from trees growing at Farrer Road and in the campus of the University of Singapore. Material for the rest of the species was taken from herbarium sheets at the Singapore Botanic Gardens Herbarium and material for ten of the species, was very kindly sent from the herbarium at Leiden by Dr. P. W. Leenhouts (see below for details).

The following specimens were used in the study: —

1. *F. acuminatissima* Merr., Ngadiman SFN. 36671 at Pengkalan Raja, Pontian, Johore, Malaya. June 1939. SING.
2. *F. annulata* Hiern., Versteeg G. 1237. Between Zandroot and Sabang, W. New Guinea. June 1907. LEIDEN.
3. *F. auriculata* Jack, Fresh specimens, Singapore Botanic Gardens.*
4. *F. heteriana* Benth., Barrett J.H. N.G.F. 4231 at Rouna Gorge, Sogeri Central District Papua. August 1951. SING.
5. *F. blumii* G. Don, Wray L, 1992. SING.
6. *F. bodenii* Wernh., Carr C.E. 14132 at Alola, Papua. January 1936. SING.
7. *F. calcarea* Henders, Henderson M.R. 25036 at Bukit Chintamani, Pahang, Malaya. October 1931, SING.
8. *F. carnosa* Jack, Sinclair J. 7948 at Belara Forest Reserve, Trengganu, Malaya. July 1953. SING.
9. *F. carstensensis* Wernh., van Royen P. et Sleumer H. 7755, Tamran Mts., W. New Guinea, November 1961. LEIDEN.
10. *F. ceilenica* Thunb., Burkill H.M. 2421 at Fraser's Hill, Pahang, Malaya. August 1960. SING.
11. *F. crenulata* Clarke, Fresh specimens. Singapore.*
12. *F. curtisii* K & G, Curtis 1676 at Tanjong Tirie Kedah, Malaya. September 1890. SING.
13. *F. elliptica* Roxb., Henderson M.R. 19658 at Sungei Kete, Kelantan, Malaya. October 1927. SING.

14. *F. eymae* Baker, Versteeg Chr. BW. 3070, Wissel Lakes, West New Guinea. September 1955. LEIDEN.
15. *F. fastigiata* Bl. L. 908. 127-208, Java ? 18—. LEIDEN.
16. *F. fragrans* Roxb., Fresh specimens, Singapore Botanic Gardens. *
17. *F. gardenioides* Ridl., Burkill H.M. 2384 at Fraser's Hill, Pahang, Malaya. August 1960. SING.
18. *F. gitingensis* Elm., Lam. H.J. 3264, P. Karakelang, Talaud Islands, Celebes. April 1926. LEIDEN.
19. *F. gracilipes* A. Gray, Kostermans A. 371 at Manokwari, Momi, New Guinea. September 1948. SING.
20. *F. involucrata* Merr., Sinclair J. 8996 at Mt. Kinabalu, Borneo. June 1957. SING.
21. *F. longiflora* Merr., Conklin H.C. et Buwala PNH. 80440 Mt. Province, Luzon, Philippines. April 1963. LEIDEN.
22. *F. macroscypha* Baker, Ashton P.S. BRUN. 5203 at Kuala Belatong, Brunei. February 1959. SING.
23. *F. racemosa* Jack, Nur Md. 25168 at Bukit Sagu, Pahang, Malaya. October 1931. SING.
24. *F. resinosa* Leenh., Asah v. BRUN 3083 at Bukit Belatong, Brunei. June 1958. Sing.
25. *F. ridleyi* K & G, Fresh specimens. Singapore Botanic Gardens.*
26. *F. salticola* Leenh., Saunders J.C. 777, Eastern Highlands District, Terr. of New Guinea. August 1957. LEIDEN.
27. *F. tacapala* Leenh., Eyma P.J. 2473 at W. Ceram, Moluccas. December 1937. SING.
28. *F. truncata* Bl., de Vriese W.H. et Teijsmann J.E. L. 908. 127-616 Celebes 1859-60. LEIDEN.
29. *F. tubulosa* Bl., Ridley H.N. 9738 at Bujong Malacca, Perak, Malaya. 1898. SING.
30. *F. umbelliflora* Gilg & Bened., Ledermann 9614, Sepik Region, E. New Guinea. LEIDEN.
31. *F. woodiana* F v M, Womersley J.S. NGF. 15313, Morobe District, E. New Guinea. September 1962. LEIDEN.

(*) A herbarium specimen was made for the Singapore Herbarium.

The procedures outlined previously by Foster (1955) and Arnott (1959) were followed to obtain the leaf clearings and macerations. The leaf clearings were used to study the density and mode of distribution of the sclereids and the macerations were used for the study of the form, shape and size of the individual sclereid. Transverse and paradermal sections were cut to study the structure of the leaf and the positional relationship of the sclereids, and these were stained with Safranin and Fast Green, while clearings and macerations were stained with Safranin alone.

To obtain the length of the sclereid, the two distant points of the arms of the sclereid oriented in opposite directions were measured; while for the width, the widest portion of the central axis was measured. An average of ten such measurements was taken. Sclereid density was assessed by visual observations.

Observation and Discussion

Of the thirty-one species investigated, sclereids were present in the mesophyll tissues of all the species except *Fagraea annulata*. However a transverse section did show the presence of four or five sclereids in the midrib region of the leaf, which was also confirmed with leaf clearings. In the remaining thirty species, a single type of sclereid was seen in eleven of them, while sixteen others had two types of sclereids and three species were found to have three types of sclereids. (see Table 1).

The sclereids found in the various species could be grouped together based on their morphology into types like the ASTER, COLUMNAR, T-SHAPED and the DENDROID form.

1. *Aster type*: —

This type of sclereid displayed a central body with radiating arms and a central lumen. The arms of the sclereid were branched or unbranched, with or without spicules and had either short thick arms with a lamellated cell wall or long, slender arms having a homogenous cell wall.

For the convenience of description, the aster type sclereids can be further classified into different sub-types: —

Aster Type A has few, short arms which are rarely branching. Here the cell wall is thick and lamellated but the central lumen is not prominent. This type of sclereid is seen in *F. acuminatissima*, *F. carnosae*, *F. crenulata*, *F. fragrans*, *F. gitingensis*, *F. involucrata* and *F. racemosa*, (Figs. 1–12).

Aster Type B has a greater number of arms that are commonly branching. The cell wall is thick and lamellated and the central lumen is again not prominent. Such sclereids are seen in *F. blumii*, *F. bodenii*, *F. calcarea*, *F. carnosae*, *F. eymae*, *F. gardenioides*, *F. resinosa*, *F. ridleyi* and *F. tubulosa*, (Figs. 13–26, 69, 70, 74, 75).

Aster Type C has unbranched, short, radiating, slender arms. The cell wall is homogenous. The relatively large central axis encloses a very large central lumen which extends into the tips of the arms. This type of sclereid is seen in *F. curtisii*, *F. longiflora* and *F. umberliffora*, (Figs. 27–31).

Aster Type D has a relatively small central axis with extremely long, slender arms. Relative to the size of the central axis, the lumen which it encloses is prominent and extends to the tips of the arms. The cell wall is thin and homogenous. Occasional branching of the arms does occur. This type of sclereid is seen in *F. acuminatissima*, *F. betariana*, *F. calcarea*, *F. carstensis*, *F. ceilenica*, *F. fastigiata*, *F. gracilipes*, *F. tacapala*, *F. truncata*, *F. salticola* and *F. woodiana*, (Figs. 32–49, 68, 71, 81).

Thus, the aster type sclereid with its radiating arms was seen in twenty-seven species and this group was further divided based on size and mode of branching into four sub-types. The smallest and largest sclereids were seen in this group. The small sclereids were seen in *F. carnosa*, *F. curtisii*, *F. fragrans*, *F. resinosa* and *F. umbelliflora* while the larger ones were seen in *F. acuminatissima*, *F. calcarea*, *F. fastigiata* and *F. woodiana*, (see Table 1).

2. Columnar type:—

This type of sclereid was very prominent being at times very long and wide. Here the body of the sclereid varied from being short to extremely long. In these sclereids the cell wall is thick and lamellated while the central lumen is prominent. This columnar type of sclereid could be further divided into *Subtype A* where the arms were short and restricted to the very ends of the sclereids, and the cell body had an extremely prominent columnar form. Such sclereids were seen in *F. auriculata*, *F. macroscypha* and *F. resinosa* (Figs. 50–54, 72, 85). In a transverse section of the leaf of *F. resinosa*, the pillar-like sclereids can be seen as vertical columns connecting the upper to the lower epidermis, (Fig. 86). *Sub-type B* has arms which arise more or less from the entire length of the cell body and hence a prominent pillar-like form is not seen. Also these sclereids are much smaller than those placed in sub-type A. Such sclereids are seen only in *F. ridleyi*, (Figs. 55–56, 74).

3. 'T'-shaped type:—

In these sclereids, the cell wall lying next to the upper epidermis develops a number of outgrowths that grow in between the tangential walls of the epidermal or hypodermal cells. The vertical arm of the 'T'-shaped sclereid extends for varying distances into the mesophyll tissue and occasionally it produces a number of branches. The cell wall of the sclereids could be thick and lamellated or thin and homogenous. The central lumen is usually prominent. 'T'-shaped sclereids are found in *F. acuminatissima*, *F. auriculata*, *F. betariana*, *F. blumii*, *F. bodenii*, *F. carnosa*, *F. fastigiata* *F.*

gardenioides, *F. gracilipes*, *F. macroscypha*, *F. ridleyi*, *F. salticola*, *F. tacapala*, *truncata* and *F. umbelliflora*, (Figs: 57–63, 73). This type of sclereid though seen in sixteen of the species was not very prominent since relatively few such sclereids were seen in the leaves. In species where other types of sclereids were found besides the 'T'-shaped form, the latter exhibited characters common to the other types of sclereids with regard to the nature of the arms, cell wall and lumen.

4. *Dendroid* type: —

This type of sclereid has no typical shape nor a definite pattern of branching. The branches of the sclereids appear as tube-like filaments with a rather uniform thickness along their length. This type of sclereid is seen in only three species, namely *F. elliptica*, *F. involucrata* and *F. racemosa*, (Figs. 64–67, 76).

Foster (1946) working on *Mouriria*, recognised four types of sclereids, namely Parenchymatous, Stellate, Columnar and Filiform. Though the parenchymatous and filiform types are not seen in *Fagraea*, the aster type which is alike the stellate type and the columnar type are present. In *Mouriria*, the majority of the species showed conspicuously branched polymorphic sclereids as also seen in the genus *Fagraea* and in marked contrast to this, Rao (1957) working on *Memecylon*, recognised three major types of sclereids of which the filiform type predominated in eighty-two of the ninety-five species investigated. Foster (1946) did record in one species — *Mouriria cauliflora*, the presence of two types of sclereids namely columnar and parenchymatous. In *Fagraea* however, this phenomenon of having more than a single type of sclereid in a species appears to be very common and in some species like *F. acuminatissima*, *F. carnosa* and *F. ridleyi*, three different types of sclereids are present, (see Table 1). Also Rao (1957) did observe in *Memecylon cuneatum*, thick columnar sclereids alternating with fusiform branched sclereids.

In most of the species the sclereids are rather crowded but in the following, *F. beteriana*, *F. crenulata*, *F. curtisii*, *F. fragrans*, *F. gardenioides*, *F. gitingensis* and *F. involucrata* they are sparsely distributed, (Figs: 77–80, 83). There appears to be no correlation between the sclereid density and the thickness of the leaves. Though in some thick leaves like *F. bodenii* and *F. ridleyi* the sclereids are densely distributed (Fig. 84) there are also those species with thick leaves having sparsely distributed sclereids as seen in *F. curtisii*, *F. gardenioides* and *F. involucrata*. Again in certain species with thin leaves the sclereids were densely distributed as seen in *F. ceilenica*, *F. fastigiata* and *F. umbelliflora* (Fig. 82). As has been revealed by the present studies, unless more studies are made with other angiosperm species, one cannot make any definite inference regarding the relationship between thickness of leaves and sclereid density.

Distribution of sclereids is predominantly diffuse except in *F. heteriana*, *F. crenulata*, *F. fragrans*, *F. gardenioides*, *F. gitin-gensis* and *F. involucrata* where the sclereids were seen in both the diffuse and terminal positions. This predominantly diffuse condition is alike that found in *Memecylon* (Rao, 1957) but contrasts to that seen in *Mouriria* (Foster, 1946) where the sclereids were observed to be mainly in a terminal position. Foster (1955) working on *Boronella* observed that though the sclereids were predominantly terminal in *B. crassifolia* and *B. verticillata*, they were predominantly diffuse in *B. pancheri* and *B. francii* though some collections of *B. pancheri* showed a predominantly terminal position of the sclereids.

Leenhouts (1962) revised the genus *Fagraea* and recognised thirty-one species distinguishing them by using vegetative and floral characters like the form of leaves, being crenulate or entire, rounded or acute, with or without auricles, the inflorescence being axillary or terminal, the flowers being small or large and with a tubular or funnel shaped corolla tube. Leenhouts work has been used as the basis for names of the species investigated. Leenhouts divided the genus into three subgroups but the sclereid types of the different species placed by him within the same subgroup vary tremendously. In the section *Cyrtophyllum* which includes *F. elliptica*, *F. fragrans* and *F. umbelliflora*, *F. elliptica* has a single type of sclereid which is dendroid in form. *F. fragrans* has also a single type of sclereid which is aster shaped while *F. umbelliflora* has two types of sclereids, one being aster shaped while the other is the 'T'-shaped type. Also the aster type seen in *F. fragrans* is unlike that found in *F. umbelliflora*. It is also observed that the only three species having dendroid type sclereids, namely *F. elliptica*, *F. racemosa* and *F. involucrata*, have been each placed in a different section. It therefore appears that the sclereid characters of the different species of this genus do not seem to be helpful in further substantiating the taxonomic classification of Leenhouts based on the criteria already mentioned.

Summary:

Sclereids were seen to be present amongst the mesophyll tissues of the leaf in thirty of the species of *Fagraea* investigated. Due to the great variation in form of the sclereids, these were classified into four distinct types namely, aster, columnar, 'T'-shaped and dendroid forms. Presence of more than a single type of sclereid in a species was commonly seen and some species like *F. acuminatissima*, *F. carnosa* and *F. ridleyi* had three different types of sclereids.

Most of the species had densely distributed sclereids though no correlation was seen between the sclereid density and the thickness of the leaf. Distribution of the sclereids was predominantly diffuse and only in a few species was the terminal position seen together with the diffuse sclereids. The sclereid characters do not appear to be helpful in substantiating the taxonomic classification of Leenhouts.

The writer is grateful to Mr. H. M. Burkill, Director Botanic Gardens, for his encouragement, Dr. A. N. Rao, Department of Botany, University of Singapore, for his constant guidance and the use of the university facilities, Mr. Raymond Tay for assistance in the practical work, Mr. Douglas Teow for the photographs and Mr. Juraimi bin Samsuri for help in the drawings.

Literature Cited:

- ARNOTT, H. J., Leaf Clearings, *Turtox News*, 1959, 37, 192.
 BARUA, P. K. and WIGHT, W., *Phytomorphology*, 1958, 8, 257.
 CARLQUIST, S., *Comparative Plant Anatomy*, Holt, Reinhert and Winston, New York, 1961.
 CASPARY, R., *Miq. Ann. Musei Bot. Legd. Bat.*, 1865, 2, 241.
 FOSTER A. S., *J. Arn. Arboretum*, 1946, 27, 253.
 FOSTER, A. S., *J. Arn. Arboretum*, 1955, 36, 189.
 LEENHOUTS, P. W., *Flora Malesiana*, 1962, 6, 293.
 METCALFE, C. R., and Chalk, L., *Anatomy of the Dicotyledons*, Clarendon Press, Oxford, 1950.
 RAO, T. A., *Phytomorphology*, 1957, 7, 306.
 RAO., A. N., *Curr. Sci.*, 1965, 34, 509.
 TOMLINSON, P. B., *New Phytol.*, 1959, 58, 253.
 TIEGHAM, P. van, *Ann. Sci. Nat. vii. Bot.*, 1891, 13, 23.

TABLE I

Species	Leaf thickness	SCLEREID				
		Types	Length	Width	Positional R	Density
1. <i>F. acuminatissima</i>	512 μ	Aa Ad T	256 μ 426 μ 454 μ	52 μ 35 μ 32 μ	1, 3, 4	N2
2. <i>F. annulata</i>	128 μ	—	—	—	—	—
3. <i>F. auriculata</i>	611 μ	C T	302 μ 530 μ	52 μ 50 μ	1, 3	N2
4. <i>F. beteriana</i>	398 μ	Ad T	226 μ 220 μ	32 μ 28 μ	1, 2, 3, 4	N3
5. <i>F. bodenii</i>	511 μ	Ab T	355 μ 284 μ	35 μ 25 μ	1, 3, 4	N1
6. <i>F. blumii</i>	284 μ	Ab T	213 μ 255 μ	35 μ 19 μ	1, 2, 3, 4	N1
7. <i>F. carstensensis</i>	327 μ	Ad	372 μ	38 μ	3, 4	N2
8. <i>F. calcarea</i>	284 μ	Ab Ad	369 μ 431 μ	36 μ 30 μ	3, 4	N2

TABLE 1 — *continued*

Species	Leaf thickness	SCLEREID				
		Types	Length	Width	Positional R	Density
9. <i>F. carnos</i> a	412 μ	Aa	142 μ	32 μ	1, 2, 3, 4	N2
		Ab	196 μ	60 μ		
		T	347 μ	27 μ		
10. <i>F. ceilenica</i>	199 μ	Ad	309 μ	22 μ	2, 3, 4	N1
11. <i>F. crenulata</i>	341 μ	Aa	239 μ	29 μ	3, 4	N3
12. <i>F. curtisii</i>	525 μ	Ac	173 μ	38 μ	2, 3, 4	N3
13. <i>F. elliptica</i>	270 μ	D	364 μ	22 μ	2, 3, 4	N2
14. <i>F. eymae</i>	497 μ	Ab	338 μ	35 μ	3, 4	N2
15. <i>F. fastigiata</i>	241 μ	Ad	830 μ	38 μ	1, 3, 4	N1
		T	300 μ	35 μ		
16. <i>F. fragrans</i>	256 μ	Aa	173 μ	35 μ	3, 4	N3
17. <i>F. gardenioides</i>	682 μ	Ab	393 μ	47 μ	1, 3, 4	N3
		T	369 μ	35 μ		
18. <i>F. gitingensis</i>	340 μ	Aa	255 μ	41 μ	2, 3, 4	N3
19. <i>F. gracilipes</i>	327 μ	Ad	312 μ	16 μ	1, 3, 4	N1
		T	291 μ	16 μ		
20. <i>F. involucrata</i>	426 μ	Aa	227 μ	32 μ	3, 4	N3
		D	358 μ	16 μ		
21. <i>F. longiflora</i>	284 μ	Ac	269 μ	43 μ	2, 3, 4	N2
22. <i>F. macroscypha</i>	341 μ	C	213 μ	26 μ	1, 3, 4	N2
		T	324 μ	29 μ		
23. <i>F. racemosa</i>	241 μ	Aa	200 μ	32 μ	2, 3, 4	N2
		C	426 μ	13 μ		
24. <i>F. resinosa</i>	511 μ	Ab	196 μ	32 μ	1, 3, 4	N2
		C	350 μ	42 μ		
25. <i>F. ridleyi</i>	525 μ	Ab	200 μ	54 μ	1, 2, 3, 4	N1
		C	315 μ	22 μ		
		T	300 μ	22 μ		
26. <i>F. salticola</i>	600 μ	Ad	398 μ	49 μ	1, 3, 4	N2
		T	284 μ	32 μ		
27. <i>F. tacapala</i>	284 μ	Ad	335 μ	29 μ	1, 3, 4	N2
		T	213 μ	16 μ		
28. <i>F. truncata</i>	369 μ	Ad	332 μ	22 μ	1, 3, 4	N2
		T	426 μ	16 μ		
29. <i>F. tubulosa</i>	256 μ	Ab	244 μ	49 μ	2, 3, 4	N2
30. <i>F. umbelliflora</i>	213 μ	Ac	184 μ	16 μ	1, 3, 4	N1
		T	210 μ	32 μ		
31. <i>F. woodiana</i>	200 μ	Ad	437 μ	42 μ	3, 4	N2

N1 = Dense
 N2 = Numerous
 N3 = Few

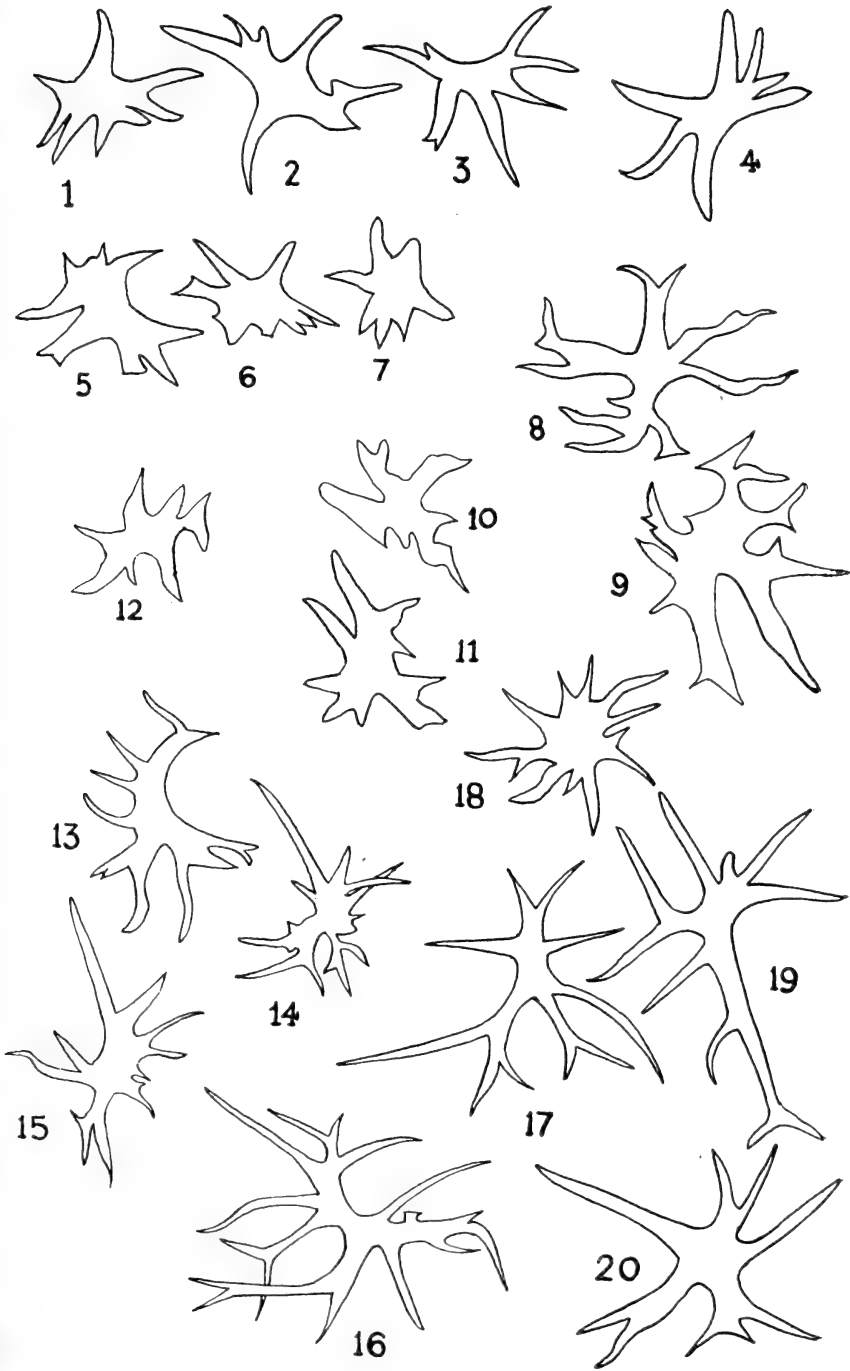


Plate II.

Sclereid forms: Fig. 1—*F. carnosa*, Figs. 2-4—*F. crenulata*, Figs. 5-7—*F. fragrans*, Figs. 8-9—*F. gitingensis*, Figs. 10-11—*F. involucreta*, Fig. 12—*F. racemosa*, Figs. 13-15—*F. blumii*, Fig. 16—*F. bodenii*, Fig. 17—*F. calcarea*, Fig. 18—*F. carnosa*, Figs. 19-20 *F. eymae*. Camera lucida drawings, magnification x 100.

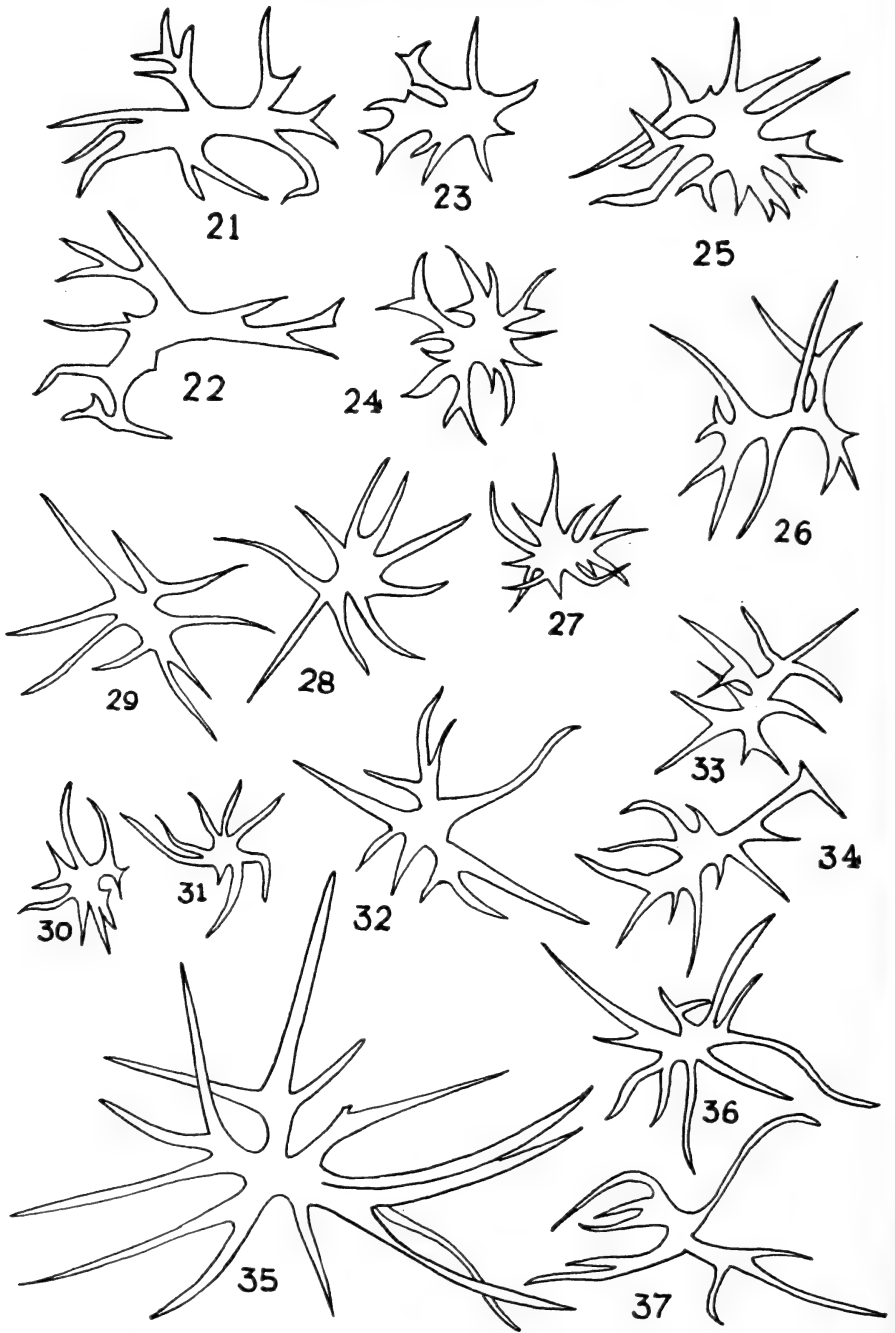


Plate III.

Sclereid forms: Figs. 21-22—*F. gardenioides*, Fig. 23—*F. resinosa*, Fig. 24—*F. ridleyi*, Figs. 25-26—*F. tubulosa*, Fig. 27—*F. curtisii*, Figs. 28-29—*F. longiflora*, Fig. 30—*F. acuminatissima*, Figs. 31-32—*F. beteteriana*, Fig. 33—*F. calcarea*, Figs. 34-37—*F. carstensensis*. Camera lucida drawings, magnification x 100.

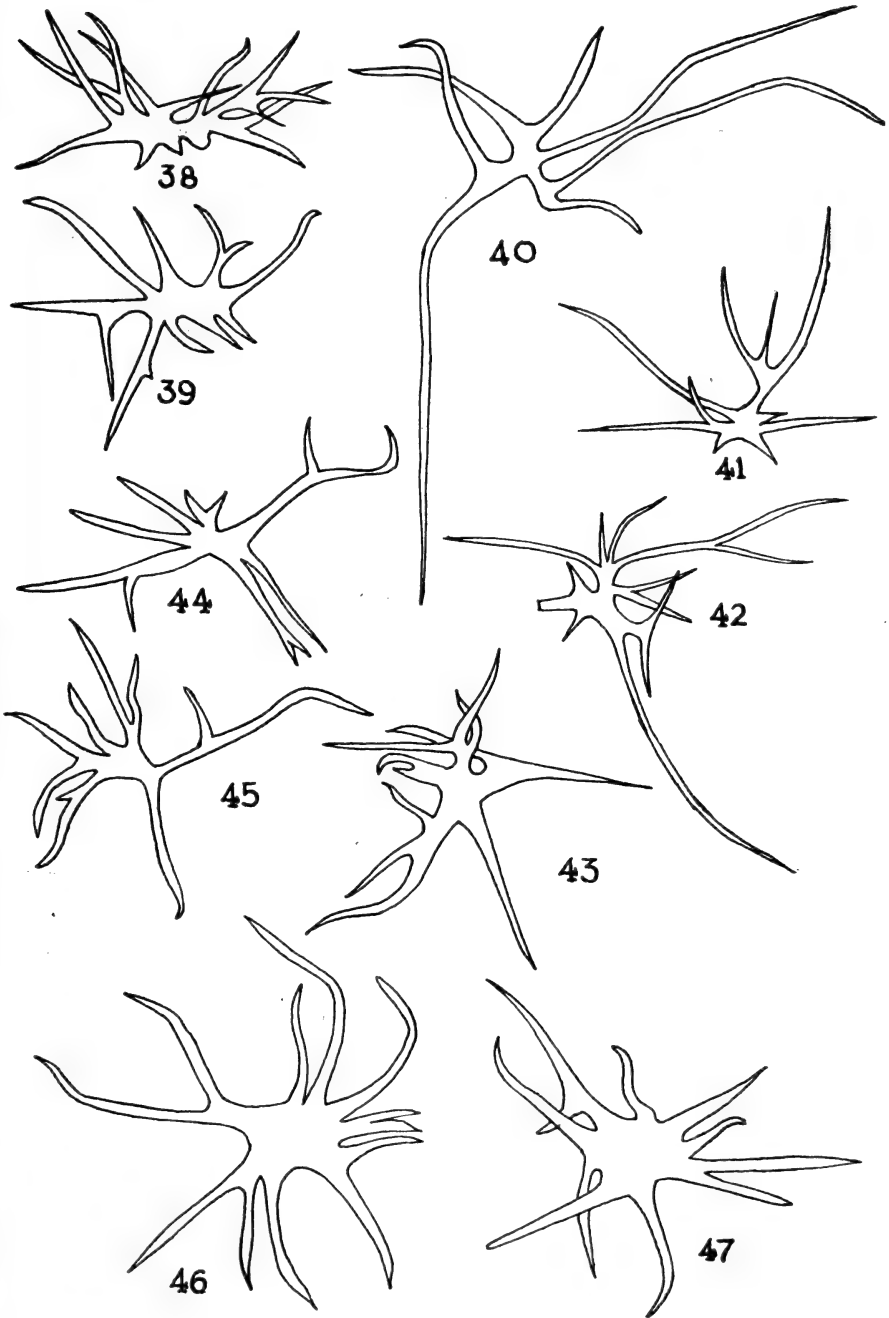


Plate IV.

Sclereid forms: Figs. 38-39—*F. céilenica*, Figs. 40—*F. fastigiata*, Figs. 41-42—*F. gracilipes*, Fig. 43—*F. tacapala*, Figs. 44-45—*F. truncata*, Figs. 46-47—*F. salticola*. Camera lucida drawings, magnification x 100.

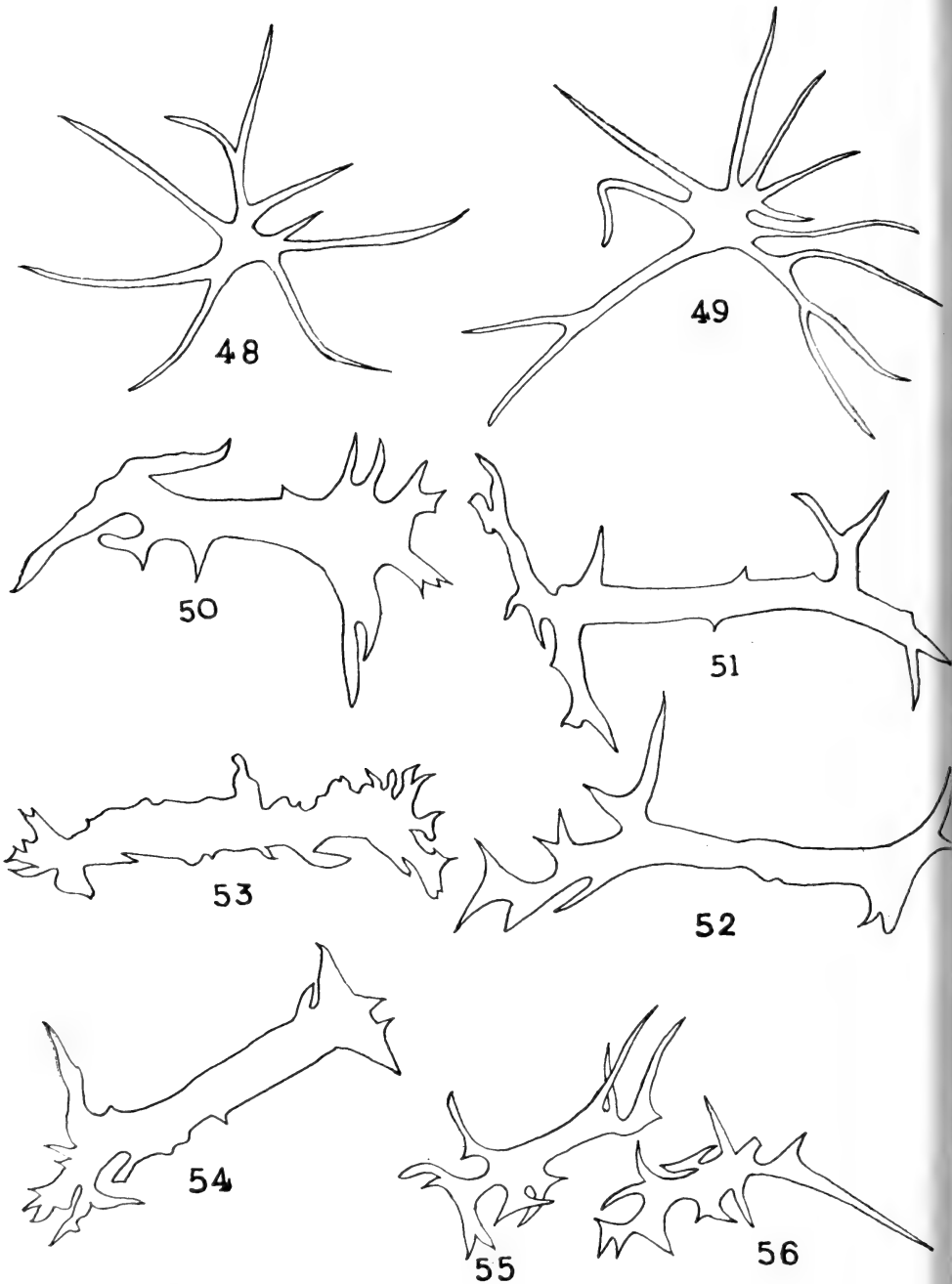


Plate V.

Sclereid forms: Figs. 48-49—*F. woodiana*, Fig. 50—*F. auriculata*, Figs. 51-52—*F. macroscypha*, Figs. 53-54—*F. resinosa*, Figs. 55-56—*F. ridleyi*. Camera lucida drawings, magnification x 100.

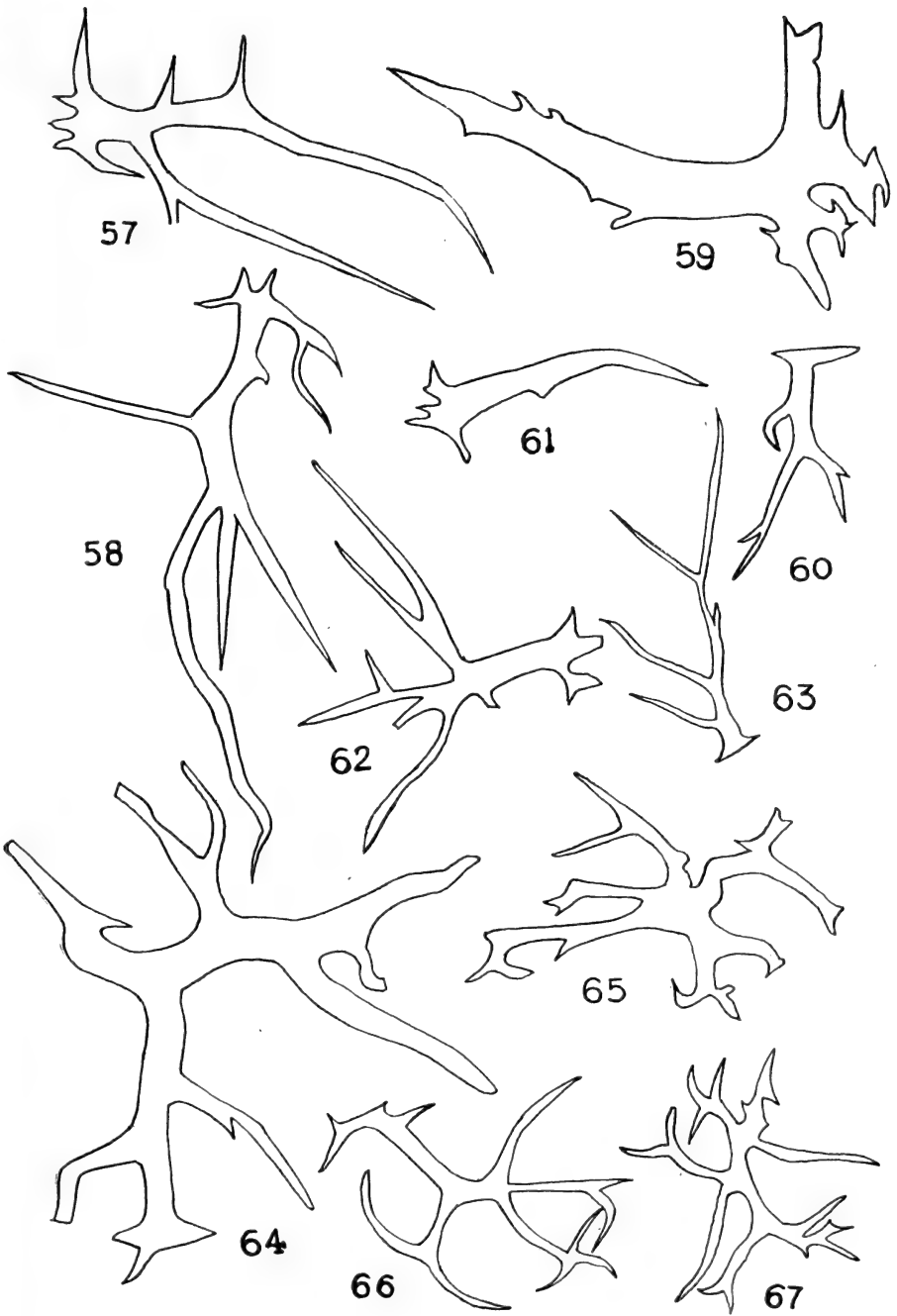


Plate VI.

Sclereid forms: Figs. 57-58—*F. acuminatissima*, Fig. 59—*F. auriculata*, Fig. 60—*F. blumii*, Fig. 61—*F. bodenii*, Fig. 62—*F. carnosia*, Fig. 63—*F. gracilipes*, Fig. 64—*F. elliptica*, Fig. 65—*F. involucreta*, Figs. 66-67—*F. resinosa*. Camera lucida drawings, magnification x 100.

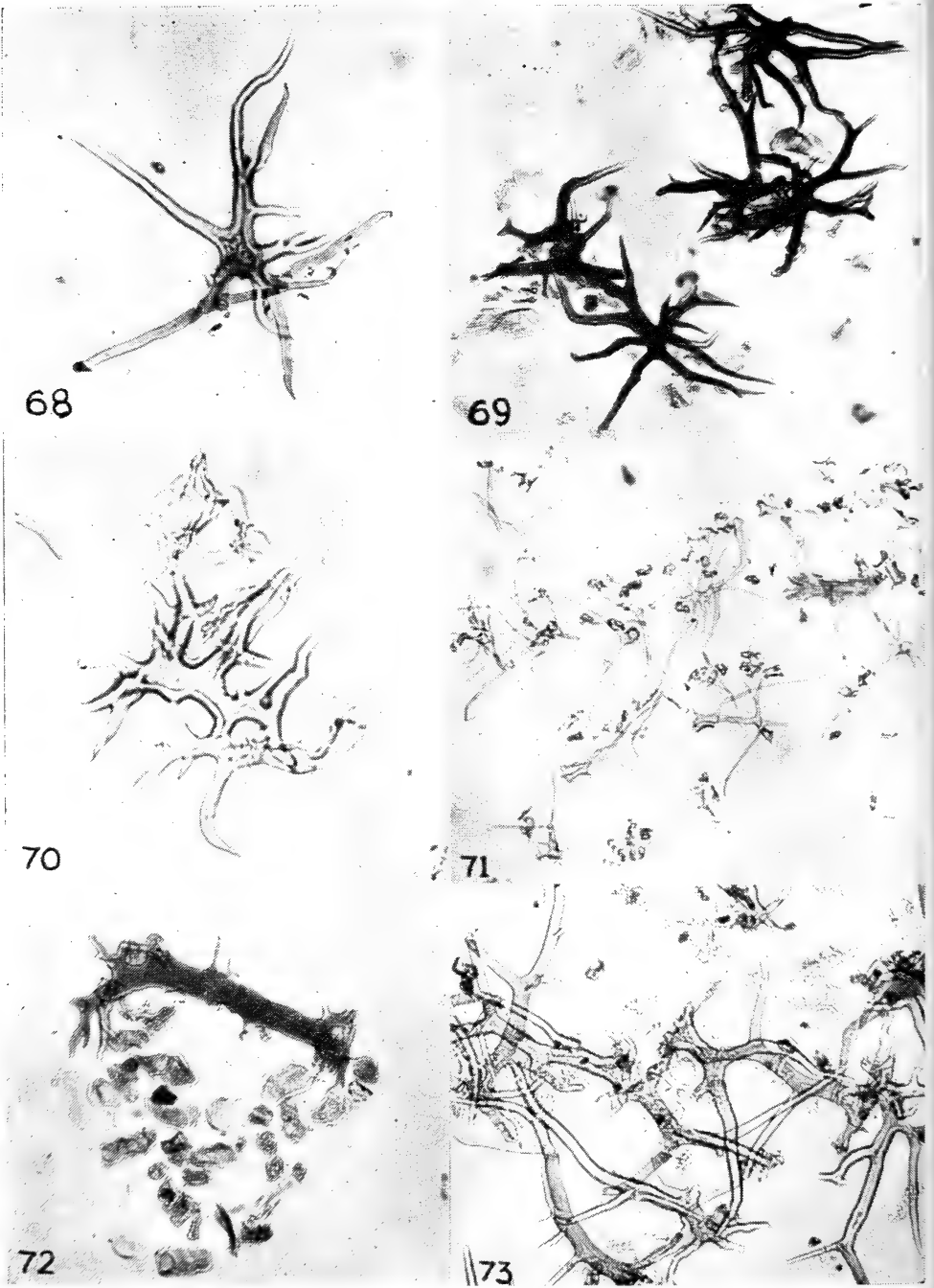


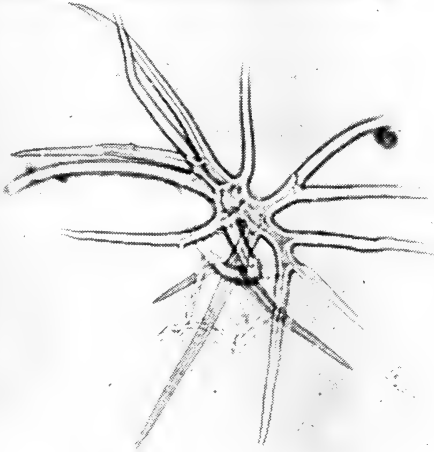
Plate VII.

Sclereid forms: Fig. 68—*F. tacapala* x 105, Fig. 69—*bodenii* x 61,
 Fig. 70—*F. tubulosa* x 136, Fig. 71—*F. gracilipes* x 71, Fig.
 72—*F. macroscypha* x 92, Fig. 73—*F. acuminatissima* x 65.

74



75



76



Plate VIII.

Sclereid forms: Fig. 74—*F. ridleyi* x 109, Fig. 75—*F. calcarea* x 95, Fig. 76—*F. elliptica* x 97.

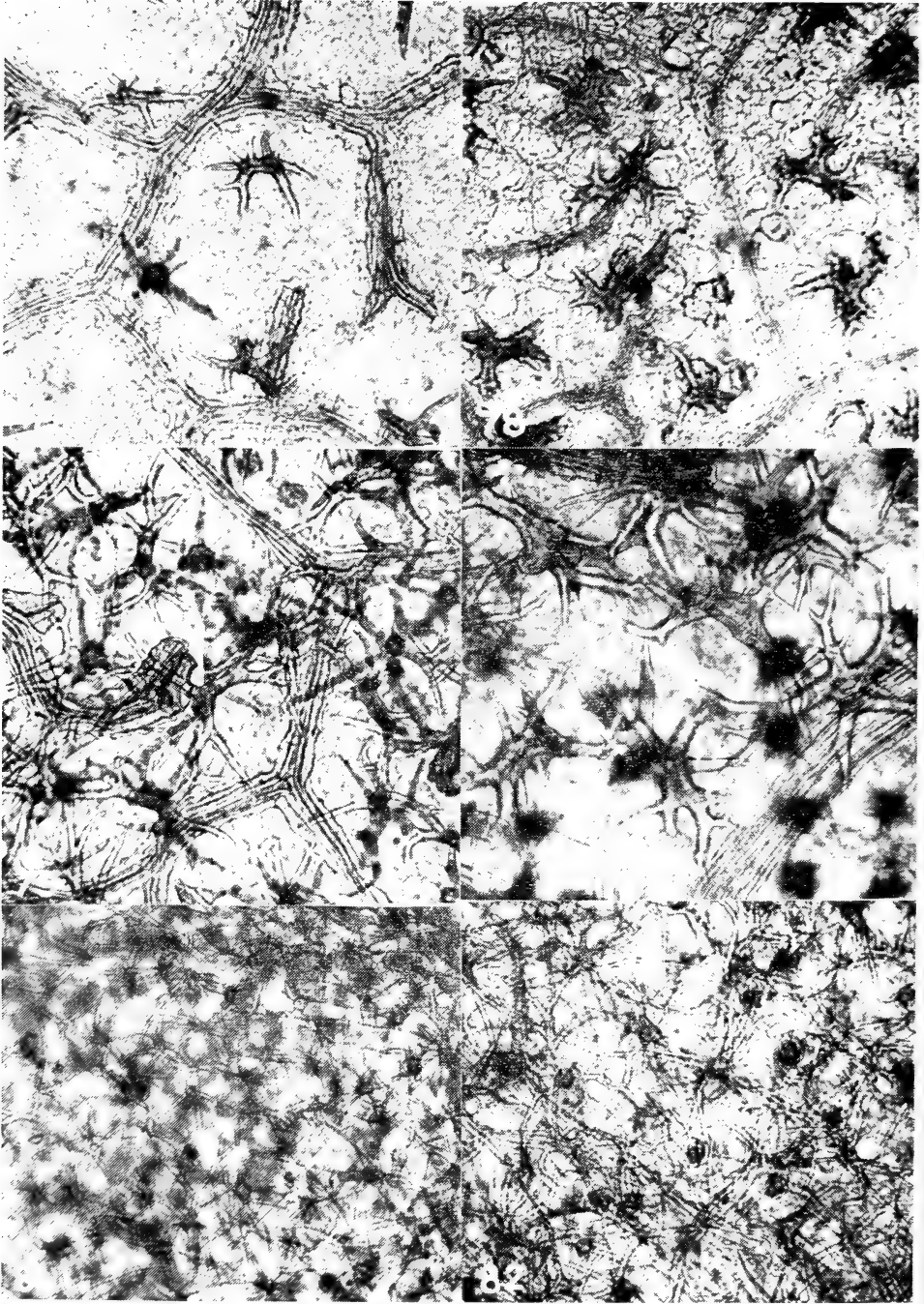
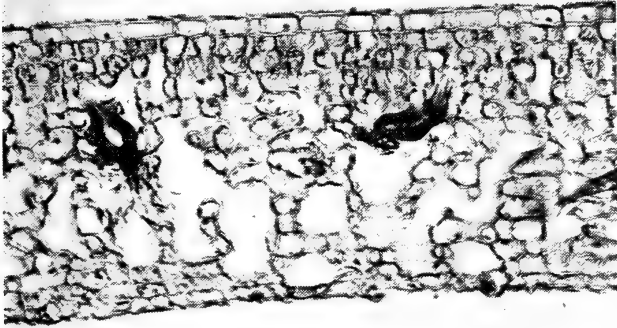


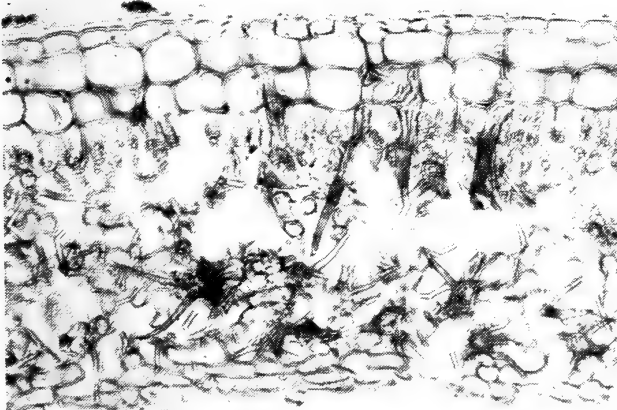
Plate IX.

Leaf clearings showing sclereid densities. Fig. 77—*F. crenulata* x 67, Fig. 78—*F. fragrans* x 71. Fig. 79—*F. beteriana* x 71, Fig. 80—*F. gardenioides* x 67, Fig. 81—*F. gracilipes* x 63, Fig. 82—*F. ceilenica* x 80.

83



84



85

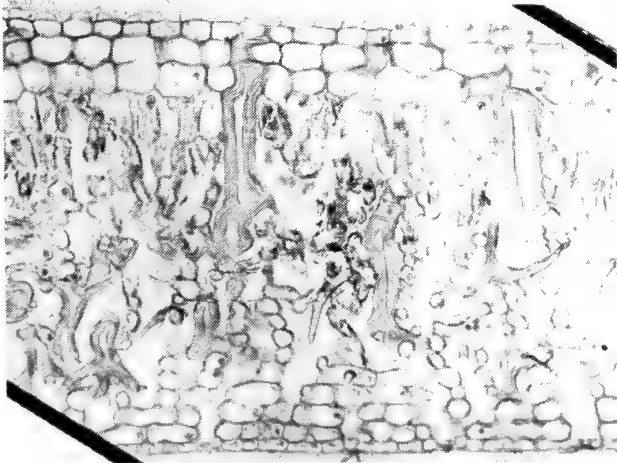
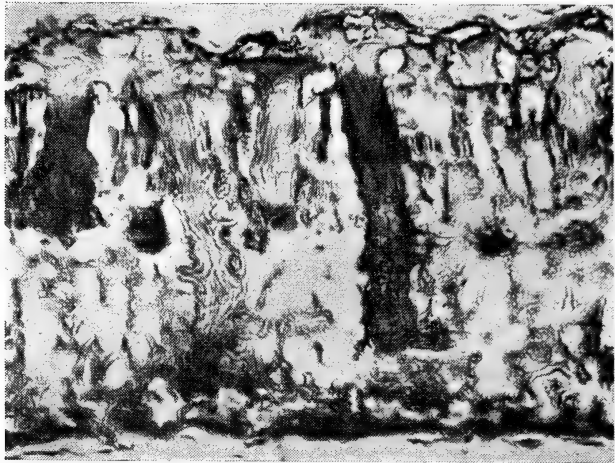


Plate X.

Transverse sections of leaves showing sclereid densities. Fig. 83—*F. fragrans* x 105, Fig. 84—*F. ridleyi* x 189, Fig. 85—*F. auriculata* x 73.

86



87

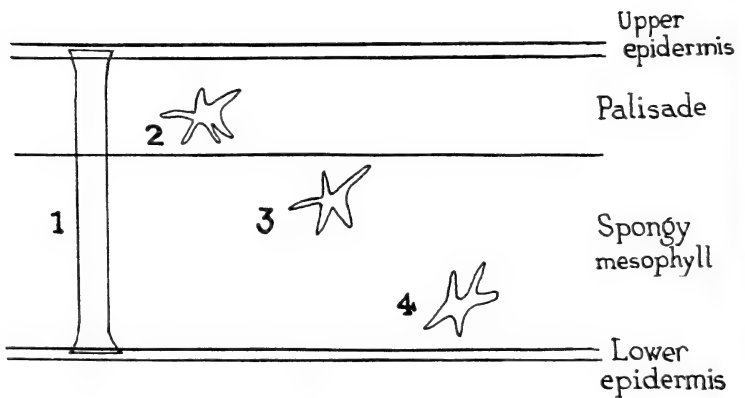


Plate XI.

Fig. 86—*F. resinosa*—T.S. leaf showing columnar sclereids x 214,
 Fig. 87—Diagram indicating the positional relations of sclereids.

Notes on Sapotaceae

(Written July 1965)

by

JAMES SINCLAIR

Botanic Gardens, Singapore.

It was through the misidentification by Leiden for a certain Malayan species of *Sapotaceae* and the rather unusual circumstances connected with it that the following notes came to be written. In trying to identify it myself later, I had to consult the *Precursores* for this family to some extent and as a result noticed a number of minor details with which I cannot agree. I have, however, to acknowledge the good work that has been accomplished by the authors of these *Precursores*.

I. A Misunderstood Species of Sapotaceae

On 21st May 1953 I collected at Tanjong Gul, Singapore, a sterile *Sapotaceae*, Sinclair S.F.N. 39640, and also numbered Sinclair 7446 in my own series. It was growing by the sea-shore at the foot of the grassy wooded sea-cliffs. Incidentally Tanjong Gul is the station for a number of rare plants in Singapore such as *Vatica wallichii*, *Casearia capitellata*, *Adinobotrys erianthus*, *Rhizophora stylosa*, *Diospyros styraciformis*, *Urceola torulosa*, *Ipomoea digitata*, *I. illustris*, *Knema corticosa* (*globularia*), *Ficus consociata* var. *murtoni*, *F. xylophylla*, *Athyrium prescottianum* and *Dipteris conjugata*. Haji Mohamed Nur, herbarium assistant at that time, made various suggestions as to its identity. The sheets bear the names *Payena*, *Planchonella obovata* and *Madhuca sericea* but I deleted them all in turn, not being satisfied. It was eventually sent on loan to Leiden with the rest of the *Sapotaceae* when they were being revised for *Flora Malesiana* and returned in due course with the remarks *cf. Myristicaceae*. Dr. P. van Royen had also seen it as his initials and the date 8-4-61 were inscribed on the sheet. As it happened I had revised and published the Malayan species of *Myristicaceae* by 1958 and would not have mistaken the present plant with its white sap for one of the *Myristicaceae*. Perhaps the person who wrote *cf. Myristicaceae* on the sheet was not looking at collectors' names but was more concerned with the appearance of the specimen itself.

On looking among the named *Sapotaceae* then back from loan, I noticed that it resembled two sheets, both named *Payena grandiflora* Ridley by van Royen — (1) Ridley 6497 from Sungei Morai, Singapore and (2) Ridley 11371 from? Sumatra, but cultivated in the Botanic Gardens, Singapore.

I picked out these two sheets and my own sterile specimen and sent them again to Leiden so that van Royen could see them side by side. I wrote on the species cover "Dr. v. Royen — Please return these three mounted sheets to Singapore. The two specimens

collected in Singapore near the sea-shore are obviously the same as the Sumatran one. I think you overlooked them and did not see the connection. I cannot at present check if you have kept *Payena grandiflora* as a good species since our copy of your publication has gone to the binders and they usually keep such things for a long time. Can you please re-examine and annotate?"
— J. Sinclair.

This material was returned later with other *Sapotaceae* but without any comments or further annotations. I do not think van Royen saw it at all. It was about that time he left Leiden to take up an appointment with the Forestry Department at Lae. In fact I can recall receiving a letter from someone at Leiden informing me of his departure and of the fact that he had not been able to examine a duplicate of *Palaquium beccarianum* which I had sent to him for checking. Our own specimen of this was sent to him later at Lae and I only came across it the other day in the herbarium when writing this article. But returning to the subject of the unidentified plant I had nothing further to expect until the 3rd of November 1963 when it eventually flowered at Tanjong Gul.

The Tanjong Gul specimens are indeed *Payena grandiflora* Ridley and Ridley cites the following specimens with his description — (1) *Ridley 6497* (SING) Sungei Morai, Singapore; (2) *Goodenough 1268* (SING) Panchur, Malacca and (3) *Ridley 113711* (SING) cultivated in Botanic Gardens, Singapore, believed to have come from Sumatra. The last mentioned specimen actually bears the number *11371* on the label of the Singapore sheet and not *113711* as stated in the publication. Ridley says that the species is described mainly from the tree in the Botanic Gardens, i.e. *Ridley 11371* and adds that this fine species has been confused with *Payena maingayi* by King and Gamble in the *Materials*. But there are four sepals in its flowers and not five as stated by him.

In the revision of *Payena* in *Blumea* 9, 1 (1958) 89–138, the author A.C. van Bruggen has sunk *Payena grandiflora* Ridley under *P. maingayi* Cl. On page 107 he states that on account of Ridley's erroneous remark about the sepals (*Ridley loc. cit.* 29) "Sepals ovate, subobtus, nearly half an inch long 5, . . ." Lam transferred *P. grandiflora* to the genus *Diploknema*. In our opinion it is evident that this species is quite identical with *P. maingayi*. I must point out now that van Bruggen annotated most of our specimens of *Payena* while van Royen, who wrote up *Madhuca*, annotated most of the latter. There are, however, occasional sheets of *Payena* which van Royen named. Lam was in a way nearer to the truth when he regarded it as a good species and also when he removed it from *Payena*; the sepals are, indeed, half an inch long. One of the syntypes, *Goodenough 1268*, is actually *Payena maingayi*, but the other two are one species, namely *Payena grandiflora* of Ridley which was based, as pointed out above, mainly on *Ridley 11371*. It was not the custom then to choose a holotype and so I have now to make *Ridley 11371* the lectotype of *Payena grandiflora* and to exclude *Goodenough 1268*.

I was not, however, satisfied that *Payena* was the correct genus and after investigation found that the specimens really belong to *Madhuca* chiefly because of the structure of the flower and the number of its parts. I cannot call the species *Madhuca grandiflora* because a *Madhuca grandiflora* Fletcher already exists. A new name must therefore be chosen so I have adopted the epithet *Madhuca decipiens* J. Sinclair.

Madhuca decipiens J. Sinclair, **nom. nov.**

Basionym: *Payena grandiflora* Ridley in J. Roy. As. Soc. Str. Br. 61 (1912) 28 *excl. spec. Goodenough 1268*; Ridley, Fl. Mal. Pen. 2 (1923) 262 *excl. Goodenough 1268 = P. maingayi* Cl.

Isonym: *Diploknema grandiflora* (Ridley) H.J. Lam in Bull. Jard. Bot. Btzg 7, 1 and 2 (1925) 185 *excl. Goodenough 1268* et in Bull. Jard. Bot. Btzg 8, 4 (1927) 463.

Shrub (6–10 ft) 2–3 m high with copious white sap. *Leaves* dark green and glossy above with a paler midrib, pale yellowish green and dull beneath, drying greyish brown to dark brown above and pale yellow beneath, becoming greyish when old. *Sepals* 4, greyish tomentulose outside, glabrous inside and on the margins of the two inner ones as well, the outer two ovate, 1 cm long and 8 mm broad, the inner two narrower, 1 cm long and 7 mm broad and distinct from the outer in having a carinate midrib on the outside. *Corolla* white, thin in texture, 1 cm long in bud and 1.5 cm long when mature (i.e. it protrudes 5 mm beyond the calyx when mature) split down $\frac{3}{4}$ -way into the 9–12 acuminate lobes, tomentulose except for the free parts of the lobes. *Stamens* 26–31 and in three rows, the very short filaments only 0.75 mm long, densely hirsute, the anthers 2 mm long, their slender appendages 1.5 mm long, both sparsely covered with 0.5–1 mm long whitish hairs. *Ovary* densely tomentose with 10 loculi and one ovule in each loculus; style 1 cm long, its basal third with short adpressed, greyish white hairs, the rest glabrous; pedicels 1.5–2.5 cm long and 1.5–2 mm thick, minutely pubescent.

- JOHORE: Gunong Pulai, Md Nur & Kiah S.F.N. 7785 (SING) not "*Md Mutkiah*" as stated by Lam l.c. 186.
- SINGAPORE: Sungei Morai, Ridley 6497 (SING); Tanjong Gul, Sinclair 7446, also numbered Sinclair S.F.N. 39640 (SING) sterile and Sinclair 10761 (A, E, G, K, L, LAE, SING) in flower.
- CULTIVATED: Cultivated in Bot. Gard. Sing. probably from Sumatra, Ridley 11371 (SING) quoted as 113711.
- TYPE MATERIAL: Lectotype of *Payena grandiflora* Ridley = Ridley 11371 (SING).

The above description is taken from *Sinclair 10761* and duplicates of it are being distributed. Three shrubs were seen in all. Lam is right when he says that the Johore specimen cited above is not *Payena maingayi* but probably belongs to the present, i.e. Ridley's species. He, however, did not read the handwriting on the label correctly, see above under JOHORE. I at first thought that this species might be confined to the sea-shore as both Tanjong Gul

and Sungei Morai are sea-shore localities. Apparently this is not the case as Gunong Pulai is a mountain. The present species is very different from *Payena maingayi*, the latter a tall forest tree, reaching at least 70 feet high and which I have seen in Bukit Timah Nature Reserve, Singapore. The leaves of *P. maingayi* are much thinner in texture, dry blackish above, and have a dark rusty, scaly, powdery pubescence on the under-surface like those of *Chrysophyllum cainito*. Those of the *Madhuca* are much paler beneath, a pale yellow which becomes greyish when old and tends to disappear; furthermore they are finely reticulate on both surfaces with longer and stouter petioles. There is a number of differences also in the flowers, especially in the larger number of petals, stamens and loculi. But it will be seen without dissecting them that those of the *Madhuca* are slightly larger with stouter pedicels and more coriaceous sepals.

I was not so interested, however, in comparing this *Madhuca* with *P. maingayi* as in trying to find out its proper place among the other *Madhuca* species. It soon became apparent that it did resemble one other species and this investigation led to further unexpected discoveries as I had then to consult rather closely the *Precursores* on *Payena* and *Madhuca*. From this consultation I found also that there were some minor points in which I cannot quite agree with all that has been written in the *Precursores*. It seems best to discuss the relationship of *Madhuca decipiens* under the next heading since some name changes result.

II. On the Relationship of *Madhuca decipiens*; A New Combination in *Madhuca* and *Madhuca dubardii*

H. J. Lam redefined

I soon found a near relative to the above species in *Payena selangorica* King and Gamble, the type being Ridley 7387 (SING) from Bukit Kutu, Selangor, Malaya (young fruiting material). In fact this is a miniature edition of *Madhuca decipiens*, a very similar but more elegant species. The rather similar leaves are smaller and their petioles are also reduced proportionately in length and thickness. Ridley 7387 is the only authentic specimen in the Singapore herbarium named *P. selangorica*, the only one quoted under the original description by King and Gamble in the *Materials*, page 175 and also the only one quoted in the *Precursores*, page 131. But if *P. selangorica* is so like *Madhuca decipiens* then it must surely be a *Madhuca* and this can indeed be seen from a comparison of the actual specimens. Van Bruggen in the *Precursores*, page 133 states that its status is still doubtful and that according to the present material it could belong to *Madhuca* or *Ganua* as well, . . . etc. A search was then made among our *Madhuca* material to see if any other specimens of it could be located under some other name. Four sheets were found and the specimens were in flower. From these I am able to confirm that it is a *Madhuca*. Two of these sheets are named *Madhuca dubardii* H. J. Lam var. *dubardii*, namely Strong 11115 and Strugnell 11116 and the other two Abdul Rahman 10527 and Symington

24097 *Madhuca dubardii* var. *lanceolata* H. J. Lam. The *Abdul Rahman* specimen 10527 (SING) is the type of the var. *lanceolata*. In my opinion, however, these specimens are all very uniform and represent only one species which should not have been divided into two varieties. The leaves are narrowly elliptic and acute at the apex; those with the apex damaged tend to be obovate and obtuse at the apex. I find the same thing applies in my specimens of *Madhuca decipiens*. A Penang specimen, *Paul s.n.*, named by van Royen and quoted by him in the *Precursores*, page 105 under *M. dubardii* var. *dubardii* is, however, not that species but *Palaquium curtisii* (K. & G.) H. J. Lam instead. The leaves are slightly juvenile and match those of a similar specimen of *P. curtisii* from Penang wrongly named *P. gutta* (Hooker f.) Baillon by van Royen. This is *Curtis s.n.* date 25th October, 1900.

The type of *M. dubardii* H.J. Lam (1925) was based on material from Suan Lamba, Sabah (British North Borneo) namely *Agama 538* (BO holotype, K). Suan Lamba is not in Sarawak as is stated by van Royen. I then got together all the named and unnamed sheets of this species in our herbarium from all the Sabah localities which I could find. Two of these are quoted under *dubardii* by van Royen himself in the *Precursores*, page 105, namely *Cuadra A2148* and *Puasa 10076*. The former bears the *determinavit* slip of van Royen who saw this sheet; the latter, the SING duplicate, was not sent to him as it was discovered later among unmounted material, but he has seen its K and L duplicates. I found two other sheets of *dubardii* namely *Castro 3793* and *Sales 4311* which had been wrongly named and quoted as *Payena acuminata* var. *acuminata* by van Bruggen on page 103 of his *Precursores* on *Payena*. Having made a careful comparison of the Sabah material of *M. dubardii* with that of the Malay Peninsula I find that they represent two distinct species. The Malay Peninsula material is not different from *Payena selangorica* but the latter is a *Madhuca* and a new combination is necessary.

***Madhuca selangorica* (King & Gamble) J. Sinclair, comb. nov.**

Basionym: *Payena selangorica* King & Gamble, Mat. Fl. Mal. Pen. 17 in J. As. Soc. Bengal 74, 2 Extra Nr. (1906) 175; *idem* Addenda-Corrigenda (1908) 873; Ridley, Fl. Mal. Pen. 2 (1923) 264; Lam in Bull. Jard. Bot. Btzig 7, 1 and 2 (1925) 132 et *l.c.* 8, 4 (1927) 439; van Bruggen in Blumea 9, 1 (1958) 131 f. 11.

Synonyms: *Madhuca dubardii* (non H. J. Lam 1925) H.J. Lam in Bull. Jard. Bot. Btzig 8, 4 (1927) 444 f. 18; van Royen in Blumea 10, 1 (1960) 104 *quoad spec. selangorenses tantum*.

M. dubardii var. *lanceolata* H. J. Lam in Bull. Jard. Bot. Btzig 8, 4 (1927) 446 f. 18; van Royen in Blumea 10, 1 (1960) 105 — **syn. nov.**

Sepals 7 mm long and 5 mm broad, medium brown tomentulose to tomentose outside, rugose when dry, the inner two with glabrous margins and carinate on the outside like those of *M. decipiens*. *Corolla* 5 mm long and split down $\frac{3}{4}$ -way into 8 lobes, the latter acute at the apex, adpressed sericeous on the outside and at the

base inside. *Anthers* 16, hirsute with an acute apex (not produced into a slender process as in *decipiens* but the flowers examined were in a slightly younger stage). *Ovary* tomentose with 8 loculi and a 5 mm long style; pedicels sulcate, 2 cm long and 1 mm thick.

SELANGOR:

Bukit Kutu, Ridley 7387 (SING); Ayer Hitam Reserve, Kajang, Abdul Rahman 10527 (SING); Bukit Tunggul Reserve, Strong 11115 (SING); Ampang Reserve, Selangor, Strugnell 11116 (SING); Sungei Lalang, Kajang, Symington 24097 (SING).

DISTRIBUTION:

Selangor in Malaya. Van Royen in *Blumea* l.c. 105 mentions a specimen from West Coast, Sumatra. This is not in Herb. Sing. and I have not seen it at the time of writing.

TYPE MATERIAL:

Payena selangorica K. & G., Ridley 7387 (SING holotype). *M. dubardii* var. *lan-ceolata* H.J. Lam, Abdul Rahman 10527 (SING holotype).

As pointed out *M. selangorica* is smaller in all its parts than *M. decipiens*. The colour of the under-surface of the leaves is of a paler yellow in *decipiens*, that in *selangorica* being more rusty. Later on when the scales tend to fall off the colour changes to an ashy grey in both. There are 9–12 corolla lobes in *decipiens* as against 8 in *selangorica*. The lobes are acuminate at the apex in the former and acute in the latter. The anthers are more numerous also, 26–31 as against 16 in *selangorica*. In *decipiens* they are produced at the apex into a slender filiform process; in *selangorica* they are simply acute and not produced. The anthers were not quite mature in the flowers of *selangorica* which I examined, but I do not think they will increase very much more at the apex.

Madhuca dubardii H.J. Lam in Bull. Jard. Bot. Btzg 7, 1 and 2 (1925) 162 f. 43 [non *M. dubardii* Lam et vars Lam l.c. (1927) 444 f. 18=*M. selangorica* (K. & G.) Sinclair]; van Royen in *Blumea* 10, 1 (1960) 104 *quoad spec. borneenses tantum*.

Sepals 5 mm long and 4 mm broad, pale brown-tomentulose when dry, the two inner ones with a groove on the outside in place of the mid-vein. *Corolla* 4 mm long and split down $\frac{3}{4}$ -way into about 9 lobes, the latter obtuse at the apex, pubescent at the base inside but not outside and not on the free lobes. *Anthers* 16–19 with a few scattered hairs, acuminate at the apex, some with a slender process. *Ovary* densely tomentose with 10–11 loculi; style 4 mm long; pedicels sulcate, 1.5–1.8 cm long and 1 mm thick.

SABAH (BRITISH NORTH BORNEO):

Suan Lamba, Agama 538 (BO, K); Balaching River, Sandakan, P. Castro 3793 (SING); Sekong River valley, Sales 4311 (SING); the remainder Kinabatangan:—Kori timber camp, Austin Cuadra A2148 (SING); Supu Forest Reserve, Puasa 10076 (SING); Daramakud timber camp, Kadir bin Abdul SAN 16864 (SING).

DISTRIBUTION:

So far confined to Sabah.

TYPE MATERIAL:

Madhuca dubardii H. J. Lam, Agama 538 (BO holotype, K) not seen by me at the time of writing.

I hereby exclude all the Malay Peninsula, Selangor specimens of *M. dubardii* and *M. dubardii* var. *lanceolata* from this species. They are, as has been pointed out *M. selangorica*. The differences between *M. selangorica* and *M. dubardii* are here expressed in tabular form.

	<i>Madhuca selangorica</i>	<i>Madhuca dubardii</i>
Leaves	Mostly narrowly elliptic, less often obovate; upper surface finely reticulate with raised veins and reticulations, mostly glossy when dry; lower surface when young a rusty brown colour due to scales, the veins very faint	Mostly obovate, less often elliptic; broader at the middle; upper surface smooth and dull without the veins and reticulations being visible or if present then very faint, the veins sunk; lower surface paler and more yellowish, the veins more prominent
Petioles	2–2.3 cm long, proportionately longer than in <i>dubardii</i> depending on the size of the blade	1–1.5 cm long, the blade-petiole ratio proportionately less than in <i>selangorica</i>
Flowers	Larger, 7 mm long and 5 mm broad, medium brown, tomentulose to tomentose	Smaller, 5 mm long and 4 mm broad, paler brown, tomentulose, the tomentum less
Pedicels	2 cm long	1.5–1.8 cm long
Calyx	7 mm long and 5 mm broad, rugose, the inner two with a carinate mid-vein on the back (outside)	5 mm long and 4 mm broad, smooth and not rugose, the inner two with a sulcate mid-vein on the back
Corolla	5 mm long, densely pubescent at the base inside and adpressed-sericeous outside except towards the apices of the lobes; lobes acute at the apex	4 mm long, pubescent only at the base, glabrous outside and inside higher up; lobes obtuse at the apex
Anthers	2 mm long, hairy, acute at the apex but not produced into a filiform appendage	2.5 mm long, much less hairy, the apex acuminate or sometimes produced into a slender appendage
Ovary	8 loculi observed (probably 10 also)	10–11 loculi

III. On the Identity of *Payena ridleyi* Gandoger

It was, when trying to identify my specimens of *Madhuca decipiens* from Tanjong Gul, that I noticed a doubtful species *Payena ridleyi* Gandoger at the end of A.C. van Bruggen's *Precursores* on *Payena* in *Blumea* 9, 1 (1958) 133. The type of that species is there stated to be *Ridley 6698*, Singapore, and van Bruggen adds: —“Not having seen the type specimen we can not refer it to one of the known species; moreover, the description is quite insufficient. There is a possibility that it is identical with *P. maingayi* (1882) according to the remark that the leaves are twice as long as those of *P. costata*=*P. lucida*.” As I did not then know the identity of my Tanjong Gul specimens there was the possibility that they might be identical with Gandoger's species if that could be found. By some kind of intuition and remembering that I had once written *Madhuca sericea* on the sterile sheet, *Sinclair S.F.N. 39640* and scored it out later, I went straight to the genus cover of *Madhuca sericea* in the herbarium and found the missing Ridley's number there. It had been identified and labelled as *Madhuca sericea* (Miq.) Lam by van Royen who revised *Madhuca*. I do not know whether van Bruggen, the author of *Payena* in the *Precursores*, saw it or not. However, the collector is not Ridley himself but Mat, his collector. All inscriptions on the label are in Ridley's handwriting. Mat is Ahmad bin Hassan M.B.E. who is still alive and probably nearly ninety years old. He collected this specimen, “a big tree”, according to the label, on 15th May 1894, some 71 years ago at Chan Chu Kang, Singapore. Sometimes we find on labels of plants collected in the past in Malaya the names of native collectors instead of those of the botanists with whom they worked, e.g. Alvins = Cantley's collector, Haniff = Curtis, and Mohamed Nur or Haniff = I. H. Burkill's collectors. The specimen in Singapore will be the isotype of *Payena ridleyi* Gandoger, the holotype will be a duplicate of this at Lyons. I have thus to record this species as a new synonym of *Madhuca sericea*.

Madhuca sericea (Miquel) H.J. Lam in Bull. Jard. Bot. Btzg 7, 1 and 2 (1925) 163 and 264 f. 44; Ridley, Fl. Mal. Pen. 5 (1925) Suppl. 319; Lam, l.c. 8, 4 (1927) 446; van Royen in *Blumea* 10, 1 (1960) 70.

Basionym: *Payena? sericea* Miq. Fl. Ind. Bat. 2 (1859) 1039.

Synonym: *Payena ridleyi* Gandoger in Bull. Soc. Bot. France 65 (1918) 56; van Bruggen in *Blumea* 9, 1 (1958) 133 —
syn. nov.

SINGAPORE:

Chan Chu Kang, *Mat 6698* (LY, SING).

TYPE MATERIAL:

Payena sericea Miq., *Horsfield s.n.* (BO).
Payena ridleyi Gandoger (*Ridley Mat 6698* (LY holotype, SING)).

IV. On Other Missing Specimens

There are other cases of missing specimens which could not be located. The reason again seems to be that mentioned above where it was not realized that the collections of certain botanists could also be that of their native collectors.

In the *Precursores* for *Ganua* by J. van den Assem in *Blumea* 7, 2 (1953) 380 is stated:—"Of some specimens from British North Borneo (*Apostal* 22, *Wood* 1261, 1889) and from Sarawak (*Garaman* 2311, 2789), annotations by Lam were found in the Rijksherbarium. Unfortunately, however, the specimens themselves could not be traced anymore, which is the more regrettable since they would mean new localities. Merrill . . . etc."

Garaman was a collector of Haviland and the Singapore specimen labelled *Haviland* 2311 was sent to Leiden for revision and determined personally by van Royen as *Payena havilandii* King and Gamble. *P. havilandii* is a synonym of *P. obscura* Burck, but it is certainly not that species. It is probably quite correctly determined as *Ganua monticola* by Lam. It is very similar to a sterile specimen, *Anderson SAR* 2683 wrongly named *Payena lucida* by van Royen and quoted by van Bruggen. Both have the under-surface of the leaves very pale when dry. The locality of the *Haviland* or *Garaman* specimen 2311 now required is Sk near Kuching, Sarawak, 10th June 1893. Tree. Pedicels pink, calyx yellowish.

V. Some Notes on *Payena* species

When trying to solve the identity of the Tanjong Gul species mentioned previously I had to look through the other *Payena* species in the Singapore Herbarium. I sometimes found that the species in certain covers did not always form a uniform series. I extracted those which appeared wrongly named and after a little manipulation and rearrangement got a clear picture. The changes are only minor ones but I feel they ought to be recorded.

1. *Payena acuminata* (Blume) Pierre in Bull. Mens. Soc. Linn. Paris (1885) 528; van Bruggen in *Blumea* 9, 1 (1958) 100 f. 2.

var. *acuminata*

MALAY PENINSULA PAHANG: Sungei Mai Estates, *Kadim & Mahmood Nos. 15* (K, L, SING) and *32* (A, BO, K, L, SING).

This species has not been recorded previously from Pahang so the above collections appear to be the first records. They were collected in March 1959 after the revision of *Payena* appeared in *Blumea*.

I must point out that a sheet *Corner S.F.N. 30276* from Keman, Trengganu is identical with *Moysey & Kiah S.F.N. 33749* from Ulu Brang, Trengganu. One can see at a glance that they are the same, yet the first has been incorrectly identified and quoted by van Bruggen as *Payena lucida* when it should have been *P. acuminata* var. *acuminata*.

2. **Payena lucida** (G. Don) A. DC. Prodr. 8 (1844) 197; van Bruggen in *Blumea* 9, 1 (1958) 111.

I have added to our collections of *Payena lucida* another sheet, *Derry 937* from Malacca, wrongly named and quoted as *Madhuca sericea* by van Royen. I spotted it as out of place among the specimens of *M. sericea* by its very obtuse, almost orbicular sepals in contrast to the sharply acute ones of this *Madhuca*. It was in young flower-bud with as yet very short pedicels, but in *P. lucida* these seem to lengthen rapidly as the flowers mature. There are many specimens of this very distinct species in Herb. Sing. and they form a very uniform series throughout the covers marked "Malay Peninsula" in our collection. I am afraid I cannot say this about the specimens named *lucida* from the Malay Islands, especially Borneo. In fact I do not see any specimens either from Borneo or Sumatra in our collection which I can identify with *lucida* and it may be that *lucida* is not found in Borneo at all. I have sorted out a series from Borneo which looks more or less uniform but differs from *lucida* in the finer and more closely spaced nerves and in the line of interarching of the nerves much nearer to the margin of the leaf than in that species. I discuss this series here below under 3. *Payena* sp. but I do not know for certain to which species it belongs.

3. *Payena* sp.

- | | |
|-----------------------------|--|
| BRUNEI: | Ulu Ropan, Belalong watershed, <i>Ashton BRUN 5245</i> (SING). |
| WEST BORNEO: | Melawi Tjatit, B. Tengkujung, <i>bb26347</i> (SING). |
| EAST AND NORTH-EAST BORNEO: | Peak of Balikpapan, Beoul, <i>Kostermans 7331</i> (SING); Loa Djanan, west of Samarinda, <i>Kostermans 6747</i> (SING); Loa Haur, west of Samarinda, <i>Kostermans Nos. 6941</i> (SING) and <i>9899</i> (SING); Pleihari, S. Alang, <i>bb14197</i> (SING); Pasir S. Ongka, <i>bb25638</i> (SING); Bulungan, <i>bb26158</i> (SING). |
| P. NUNUKAN: | Southern part, <i>Kostermans 9204</i> (SING). |
| SABAH: | Tawau Residency: —Merotai Besar, Tawau, <i>Aban Gibot SAN 31292</i> (SING).
Sandakan Residency: —Bettotan, Sandakan, <i>Puasa 4558</i> (SING). |

West Coast Residency:—Kundasan, 10 miles west of Ranau, *Wood & Kapis SAN 16392* (SING); west of Tenompok Pass by roadside, *Smythies SAR 10951* (SING); Tenompok, *Clemens Nos. 27974; 28178; 28538* and *28688* (all SING); Dallas, *Clemens 26715* (SING).

Interior Residency:—Kaingaran, 10 miles from Tambunan, *Wood & Charington SAN 17028* (SING); Bukit Tenom, *Wood & Wyatt-Smith A4392* (SING).

The above are the specimens I have sorted out as probably consisting of one species which is not *Payena lucida*. One of them, *bb14197*, is named *Payena endertii* by van Bruggen and a fruiting twig of it is figured in *Blumea* 9, 1 (1958) 125. The fruits are glabrous, black, very hard and ovoid. Most of our specimens are in flower. The only other one in fruit is *Aban Gibot SAN 31292* (immature fruit). Lam in 1925 described *P. endertii* from Sumatra with two syntypes, *For. Bur. Lab. E1051* and *For. Bur. Lab. T.B. 452* but in 1927 he included some Bornean specimens in this species. Consequently van Bruggen has chosen *E1051* from Sumatra as the lectotype. The only Sumatran specimen that we have here is one of the syntypes *T.B. 452* and it is in flower. From it I am not entirely convinced that it is the same species as *bb14197* and the rest of the Bornean specimens. Unfortunately there is no other authentic material of *P. endertii* known from Sumatra except these two syntypes and they are not in fruit. That means we do not know what the fruit of the Sumatran specimens is really like. The specimen of *T.B. 452* is very like *P. lowiana* Pierre. The type of *P. lowiana* came from Perak in the Malay Peninsula but this species is also distributed in Sumatra and Borneo. Its fruits are glabrous, hard and black but more elongate than those of *14197*. Young fruits, however, would look more like those of *bb14197*. Could the Sumatran material of *P. endertii* be *P. lowiana*? The Bornean specimens which I have sorted out are very like *Payena lanceolata* Ridley var. *lanceolata* except for their ovoid fruits and smaller flowers. If the Bornean species is not *lanceolata* and not *endertii*, could it be an undescribed species? This is a matter for the authors of the *Precursores* and perhaps they may wish to re-examine the material.

Of the above sorted material the following in my opinion are wrongly named *P. lucida* by van Bruggen:— *bb26158*; *Clemens Nos. 27974* and *28688*; *Kostermans 6941* and *Wood & Wyatt-Smith A4392*. The following are wrongly named *P. leerii*:— *Kostermans Nos. 6747* and *7331* by van Royen and *bb26347* by van Bruggen. *Clemens 26715* is wrongly named *obscura* by van Bruggen and cannot be that because the veins of the leaf are almost at right angles to the midrib. The following were returned without identification slips:— *bb25638*; *Clemens Nos. 28178* and *28538* and *Puasa 4558*. Some of the Clemens' and Kostermans' numbers had already been determined as *P. endertii* before they

were sent to Leiden either by their collectors or by those who prepared the typed labels as *P. endertii* is part of the typed script there. The remainder of the specimens quoted by me were not sent to Leiden since they were only acquired after the publication of the *Precursores*.

4. **Payena lowiana** Pierre in Bull. Mens. Soc. Linn. Paris (1885) 525; van Bruggen in *Blumea* 9, 1 (1958) 126.

BRUNEI: Kuala Belalong, Temburong, *Ashton BRUN* 462 (SING).

EAST AND NORTH-EAST
BORNEO:

Central Kutei, Belajan River, near Long Bleh, *Kostermans 10222* (SING).

SABAH:

Mostyn Estate, Lahad Datu, *Wood & Wyatt-Smith A4299* (SING).

This species has not been recorded previously from either Brunei or Sabah.

The flowers of *T.B. 452*, one of the syntypes of *P. endertii* from Sumatra, are very similar to those of *P. lowiana*. Both have rusty obtuse sepals. Once more, as has been suggested above, could the Sumatran material of *P. endertii* be the same as *P. lowiana*?

5. **Payena lanceolata** Ridley in J. Roy. As. Soc. Str. Br. 79 (1918) 93; van Bruggen in *Blumea* 9, 1 (1958) 128.

var. **lanceolata**

A fruiting specimen from Sumatra without locality collected by *Burck s.n.* is this species rather than *P. leerii* as quoted in *Blumea l.c.* page 123. The leaves are too narrow for *leerii* and the fruit agrees with that of *lanceolata*.

6. **Payena leerii** (T. & B.) Kurz in J. As. Soc. Bengal 40, 2 (1871) 69; van Bruggen in *Blumea* 9, 1 (1958) 121 f. 8.

Basionym: *Azoala leerii* T. & B. in Nat. Tijdschr. Ned. Ind. 6 (1854) 116.

Synonyms: *Isonandra microphylla* de Vriese in Nat. Tijdschr. Ned. Ind. 21 (1860) 312 — **syn. nov.** *Payena microphylla* (De Vriese) Pierre in Bull. Mens. Soc. Linn. Paris (1885) 531; van Bruggen in *Blumea* 9, 1 (1958) 120 f.7 — **syn. nov.**

When I remove the following Singapore Island specimens named and quoted as *Payena obscura* by van Bruggen from their genus cover and place them with *P. leerii* I then get a very uniform selection of the two species and can see at a glance most of their differences: — *Ngadiman S.F. Nos. 35908; 36431 and 36456; Ridley 9203* all from Bukit Timah Nature Reserve and *Ridley 4957* from Bajau. The specimens of *leerii* from Singapore Island are correctly named

and it was noticed that they are all from Bukit Timah Nature Reserve. In fact all the specimens from Bukit Timah are *leerii* and not *obscura*. The latter is not known from Singapore Island, yet both species are found in other parts of the Peninsula. It did seem rather strange having specimens named *leerii* and *obscura* which looked alike and yet both coming from a small area like Bukit Timah Nature Reserve. It seemed equally strange when *Ngadiman S.F.N.* 35800 is quoted twice in the *Precursores*, once on page 118 as *obscura* and again on page 123 as *leerii*. In the index of collectors' numbers it is given correctly as *leerii*.

Payena obscura has larger and more coriaceous leaves than *leerii*. Its flowers and fruits are larger also, the sepals being more pubescent and of a rusty colour. Juvenile leaves of *leerii* may be as large as those of *obscura* but they are not so thick and leathery. This may be seen in a specimen *Price s.n.* from Pulau Rimau, Sumatra. Another very similar sterile specimen with slightly larger leaves, *Daud 10857* from Pulau Lavau, Sumatra is cited as *lucida* but I think it should be *leerii*.

Looking through the covers of *leerii* one at first gets the impression that the flowers are slightly variable in size but this is actually due to their age more than anything else. This is well illustrated by looking at *Smythies SAR 7804* from Berakas Forest Reserve, Brunei. The material has quite young flowers. They have increased considerably in very similar material, *Anderson SAR 2163* from the same locality. Here most of the flowers have the developing ovaries now visible, protruding some distance beyond the sepals, but these flowers are still not so large as those of *obscura*. Berakas Forest Reserve covers a very small area. The Anderson material from Berakas is named *P. microphylla*. There is another sheet of *microphylla*, *bb28096* from East Borneo in the Singapore herbarium. Other specimens exactly like these two are named *leerii*. I can see no difference between *microphylla* and *leerii* and even van Bruggen himself states that the two are nearly related. I have accordingly made a formal reduction above.

7. *Payena pseudoterminalis* H. J. Lam in Bull. Jard. Bot. Btzg 7, 1 and 2 (1925) 260 et *l.c.* 8, 4 (1927) 439 f. 17; van Bruggen in *Blumea* 9, 1 (1958) 119.

A.C. van Bruggen states on page 119 of his *Precursores* that *Payena pseudoterminalis* is a close relative of *P. leerii*, a species which shows almost the same type of inflorescences; generally the tertiary nerves of the leaf are much fainter or completely invisible in the first-mentioned species. But under *P. leerii* in the key on page 98, he says "tertiary nerves of leaves faint or hardly visible below".

There is an isotype of *P. pseudoterminalis*, namely *bb7190* from Sumatra in the Singapore herbarium. This specimen is large enough but has been badly dried without pressure; its leaves are folded double and not one of them has been laid out flat. The Leiden holotype seems to have been more carefully prepared. At least one gets this impression from Lam's drawing, figure 17.

Although *P. pseudoterminalis* is close to *leerii* its leaves are much narrower and have a fine pubescence. In fact they are of the same shape as those of *lanceolata*. Could this species be synonymous with *lanceolata*? I am not able to prove this for lack of better material.

There are three sheets from Indragiri, Sumatra which are obviously similar, the leaves having dried black. The flowers are in a young stage, all rusty-tomentulose. In fact these three are not different from two other sheets also from Indragiri with sterile specimens, *Curtis 3631* and *Curtis s.n.* which have been, in my opinion, correctly named *leerii*. Yet the first three sheets have been named differently. Two of them, *bb27452* and *bb27500* are quoted as *obscura* and the other *Buwalda 6430* as *pseudoterminalis*. They are not *pseudoterminalis* as they do not have narrow elliptic leaves. I do not understand how these specimens, all from the same locality and so similar, should bear three different identifications.

8. ***Payena obscura*** Burck in Ann. Jard. Bot. Btzg 5 (1886) 60; van Bruggen in *Blumea* 9, 1 (1958) 117.

Synonyms: *P. havilandii* King & Gamble, Mat. Fl. Mal. Pen. 17, J. As. Soc. Bengal 74, 2 (1960) Extra Nr. 169. *P. longipedicellata* Brace ex King & Gamble, Mat. Fl. Mal. Pen. l.c. (1906) 169; van Bruggen in *Blumea* 9, 1 (1958) 115 f.6 — **syn. nov.**

Haviland 3035 figured on page 116 of *Blumea* 9, 1 (1958) as *Payena longipedicellata* is one of two syntypes of that species. The other syntype *King 2940* is now the lectotype. The Singapore duplicate of *Haviland 3035* is not really different from *P. havilandii* (of which there are five sheets in Singapore, these five making up two syntypes) except that its pedicels are longer. Its flowers are older than those of *havilandii* and will naturally tend to have longer pedicels just as in *lucida* where the pedicels lengthen considerably as the flowers mature. The leaves of *Haviland 3035* are not different from those of *havilandii* or from the other specimens of *obscura* from Penang and Sarawak. *Payena longipedicellata* should never have been created and I have no hesitation in reducing it to *obscura*.

I must point out that *Clemens 26329* from Dallas named *lucida* by van Bruggen is *obscura*. This specimen has pedicels about the same length as those of *Haviland 3035*.

POSTSCRIPT

(Written April 1966)

A postscript to this paper is necessary to explain why I have made no reference to Dr. Charles Baehni's "Mémoires sur les Sapotacées, III Inventaire des genres", *Boissiera*, vol. 2 (1965). This contribution had not yet appeared when I wrote my notes in July 1965. In fact it was not received in Singapore until 19th March 1966 and I did not see it before mid-April. My notes were sent to the Editor of the *Gardens' Bulletin Singapore* in July 1965 but are still with the press at the time of writing this postscript.

Their aim as pointed out in the first paragraph of the text was to draw attention to some minor details in the *Precursores* on *Sapotaceae*, stating where I did not agree with the authors on *Payena* and to find a name for a member of the same family collected at Tanjong Gul, Singapore. There was no intention there to criticise Baehni's work, then non-existent or at least not available to the public. This aim still stands for I do not intend making any alterations to what I have already written, notwithstanding the profound changes that Baehni has made in the system of classification of the *Sapotaceae*. I must, however, point out that I cannot agree with several changes that he proposes and I am inclined at present to maintain *Payena* as a distinct genus. He has included it in *Madhuca*.

I laid out a series of specimens from the genera he has included in *Madhuca* and another of the plants he calls *Isonandra* in order to test them for uniformity. Many of the *Madhuca* species in the sense of the *Precursores* and of the authors of *Sapotaceae* for *Flora Malesiana* now go into his *Isonandra*. These two lots which I laid out are, alas, far from uniform and I can never agree that they each represent one genus. Each bundle is most mixed! It is quite ridiculous putting *Palaquium obovatum* in *Isonandra* and *Palaquium obtusifolium* with very similar leaves and venation in *Madhuca*. *Payena leerii* and *P. lancifolia* are so very similar; in fact I have difficulty in separating them when sterile. They both have a long narrow scar on the seed extending from one end to the other of its length. It is true that his drawings of these two species also show similar scars, but he places *P. leerii* in *Madhuca* and *P. lancifolia* in *Isonandra*. He says in the key that the scar is narrow and long in *Madhuca* and narrow and short in *Isonandra*, but here as pointed out above both of these *Payena* species have the scars long and narrow. Most of his so-called *Isonandra* species are illustrated with short scars and on page 189 fig. 137 of his publication he depicts the well-known *Palaquium obovatum* (his *Isonandra*

obovata) with a short obovate scar extending three quarters way along the length of the seed. I checked on this species which I pass every day and collected from the tree 22 seeds. I found that every one of these has the scar extending along the entire length of the seed almost from end to end and in no case did the scar terminate three quarters way up as shown by Baehni.

It seems to me that he has laid too much stress on this character of the seed for distinguishing genera and has been carried away with it. Leaf characters are not used at all. The authors of *Flora Malesiana Precursores* often use leaf characters for the separation of species and have not neglected them for identifying genera. I feel that in this family much more attention should be paid to leaf characters.

Most of the *Payena* species mentioned here by me have rather similar leaves and appear to be a uniform lot. *Madhuca sensu* van Royen is a large genus and certain species may have to be removed from it. But the great majority of them form a very uniform series all with a distinct type of leaf which has a reddish tinge, the midrib glossy and smooth, the veins very distinct beneath and the twigs pale and angled towards the apex. Some of the species are so close that I have difficulty in distinguishing them. If they are so close surely then they must all belong to the same genus whatever name future systematists may give it. Most of these species belong to van Royen's groups 2 and 3 on pages 4-6 of the *Precursores* on *Madhuca*, thus:—*M. aristulata, burckiana, cuneata, elmeri, glabrescens, korthalsii, laurifolia, longistyla, malaccensis, mindanaensis, montana, ovata, penangiana, pedicellata, pubicalyx, sepilokensis, sericea, spectabilis, woodii* and others which are not in the Singapore herbarium and which I have not yet seen.

In the genus *Ganua* there is a group of species with fine, close, slender veins in the leaves. To this lot belong *G. curtisii*, the type of the genus, *G. motleyana* and several others. In another group the leaves have long petioles, the veins very prominent on the lower surface, there raised and arising at a wide angle, (often 90°) with bold sweeping curves, and the reticulations beneath equally prominent. Here belong *G. hirtiflora, kingiana* and *prolixa* etc., but there are similar species in a few other genera. I do think that some of them should be removed and placed in this group because of their rather different vegetative characters. Some of these species were also formerly placed in a genus *Dasyaulus*. They should be studied more carefully in relation to each other.

A Note on *Myriophyllum*

By JAMES SINCLAIR

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On looking through the material of *Limnophila* in the Singapore Herbarium I came across several sheets of a plant from Kedah and Perlis wrongly named *Limnophila heterophylla*. These actually belong to a *Myriophyllum* which I have identified as *M. tuberculatum* Roxb. The numbers concerned are *Corner S.F.N.* 37985; *Curtis 2102* and *Henderson S. F. Nos.* 22907 and 22908. The two Curtis sheets had originally been named *Myriophyllum intermedium* but this name is deleted by C. X. Furtado and *Limnophila heterophylla* substituted. The rest of the material was named by M. R. Henderson.

Under the genus *Myriophyllum* itself there is not a lot of material in this herbarium. In fact the only record from the Malay Peninsula is a sheet, *J. A. Baker s.n.* 30th October 1939 from near Alor Star, Kedah. This is named *M. tuberculatum* and is stated, on the label, to be the first definite record for the Malay Peninsula. The Curtis material, however, was collected in November 1889, the two Henderson sheets 18th November 1929 and Corner's on 14th November 1941.

Ridley in *Fl. Mal. Pen.* 1 (1922) 692 states "*Myriophyllum intermedium* DC. Malacca, Griffith, probably on Mt. Ophir. No specimen occurs in Griffith's collections at Kew, nor is it mentioned in the *F.B.I.* Mt. Ophir is a most improbable locality for this pondweed".

M. R. Henderson in *Gard. Bull. Sing.* 7, 2 (1933) 103 in a paper entitled *Additions to the Flora of the Malay Peninsula* has "*Myriophyllum* sp. Johore: Bukit Tiga, Sungai Sedili, *Corner sine num.* Common by edge of river from Kuala Bohol to a short way below Bukit Tiga. Does not grow in the salt water of the mangrove reaches. Malay name: *Rumput Ekor Kuching*. Unfortunately only the submersed stems and leaves, without flowers or fruit have so far been found, so that it is impossible to say to what species it may belong. This is the first definite record of the family from the Malay Peninsula".

At first I could not find the above specimen. It was not filed under *Myriophyllum* so I came to the conclusion that it had been removed from that genus and put elsewhere by someone who disagreed with the identification. A search was made under other likely genera and I soon located it also under *Limnophila*. It had been put there by Corner who had later deleted the word *Myriophyllum* and added *Limnophila ?sessiliflora*. These alterations are in ink of a different and fresher shade than that of his original handwriting. The specimen was collected in March 1932. It is certainly a *Limnophila* and not a *Myriophyllum*, and unfortunately, as pointed out by Henderson, is sterile. The bushy tassels of leaves resembling a cat's tail (*ekor kuching*) are covered with, and somewhat hidden

by an epiphytic green alga which is present. There are two other specimens of *Limnophila* like it but these are also sterile and unnamed at the time of writing. One is from Kedah and the other from Kota Tinggi. These may or may not be *sessiliflora*. I am unable to identify them because of my lack of knowledge about *Limnophila* in the vegetative condition. I have no doubt that they could be identified by a person with experience in cultivating them. They could easily be grown in tanks and this would make an interesting study. *Myriophyllum tuberculatum* certainly resembles *Limnophila heterophylla* and *sessiliflora* vegetatively and for this reason there has been confusion over them in the Singapore Herbarium. Some of the more important references in the literature are now given for *M. tuberculatum* with the citation of specimens in the Singapore Herbarium.

Myriophyllum tuberculatum Roxb. Hort. Beng. (1814) 12 *nomen nudum*; Fl. Ind. 1 (1820) 471; 1 (1832) 451 and (1874) 151; A.D.C. Prodr. 3 (1828) 69; Miq. Fl. Ind. Bat. 1 (1) 4 (1855) 635; C.B. Cl. in Hk. f. Fl. Br. Ind. 2 (1878) 432; Peterson in Engl. & Prantl, Pflfam. 3, 7 (1893) 234 f.104 A-C; Schindler in Engl. Pflreich 23 (4, 225) (1905) 96 f.28 A-C; Sinclair in Bull. Bot. Soc. Beng. 9, 2 (1955) 94.

MALAY PENINSULA PERLIS: Kangar, *Henderson S.F. Nos. 22907* (SING) and *22908* (SING).

KEDAH: Kuah, Langkawi, *Corner S.F.N. 37985* (SING); Langkawi in paddy fields, *Curtis 210?* (SING); near Alor Star, *J.A. Baker s.n. 30th October 1939* (SING).

MOLUCCAS HALMAHEIRA: Pajahi Road, District Weda, *G.A.L. de Haan 1788* (A, BO, K, L, P, SING) only the SING specimen seen by me.

Most of the species in this genus are confined to Australia. Some are from New Zealand, Europe, North and South America, India and the Mascarene Islands, while *M. spicatum* is of world-wide distribution. *M. tuberculatum* is an East Bengal species and I have collected it at Cox's Bazar. I am surprised that it has not, so far, been recorded from Siam where *siamense* and *tetrandrum* grow. Neither has it been seen in Indo-China where there are five species, namely *bonii*, *intermedium*, *siamense*, *spicatum* and *tetrandrum*. See M.-L. Tardieu-Blot in *Flore du Camboge du Laos et du Vietnam* 4 (1965) 124. *M. tuberculatum* is nearest to *tetrandrum* but has larger, minutely serrate, ovate bracteoles and a larger fruit which is tuberculate and not rugose-granulate. *M. tetrandrum* was first recorded in Malesia from Kendari, Celebes where it was collected by Beccari. See van Steenis in *Webbia* 8 (1952) 435. In Java, according to Backer and Bakhuizen f., *Flora Java*, 1 (1963) 266, the species are *M. brasiliense* (naturalized and locally abundant) and *M. dicoccum* (Lake Burnih, Madura). The latter was originally described from North Australia. In New Guinea there are probably several species. There is one resembling *verticillatum* from the Wissel Lake region, represented in the Singapore Herbarium by *Eyma 4733*.

Studies of Malesian Pandanaceae, I

Polymorphism in *Pandanus odoratissimus* L.f. of Asia

by

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In Ridley's Flora of the Malay Peninsula, vol. 5, (1925) the common pandan of beaches and coasts of Malaya is described under the name of *Pandanus fascicularis* Lamarck, and placed in the section Keura. That section, since it includes the type species of the genus, must now be called section *Pandanus*, and *P. fascicularis* is considered a synonym of *P. odoratissimus* L.f., which is the type species of the genus. *P. odoratissimus* has had a history of considerable confusion. It has an acknowledged list of many synonyms, but it has also been frequently misapplied to quite different species. It has at one time or another been considered as equivalent to *P. tectorius*, with now one and now the other name considered as a synonym. It has been used as a kind of receptacle for undeterminable collections and for sterile cultivars. The result of this historical confusion has been the obscuring of the real specific characters and the true distribution of the species.

Recently a considerable number of species have been described from Malaya and adjacent or nearby areas in South-east Asia by Dr. H. St. John in *Pacific Science* (1959-65). In attempting to write up the Malayan Pandanaceae, it of course became necessary to undertake a study of these species. To do so, not only have the holotype specimens in the Herbarium of the Botanic Gardens, Singapore, been examined, but travel to some of the type localities was made to study the living plants. Some types were seen at the Arnold Arboretum. In some cases I have not seen the types, but the descriptions are so full, and the illustrations so good, that little doubt as to the character of the plant was left.

The conclusion I have reached is that only one species of section *Pandanus* is wild in Malaya, but that it is represented by several forms, most of which are so minor in distinctiveness, and so clearly united by transitional forms, that it is impossible to regard them as separate species. Since this view appears to be so greatly at odds with the treatment in *Pacific Science*, it has seemed necessary, as well as valuable, to discuss the situation at length, and especially to set forth all the reasons available for the reduction of so many species to *Pandanus odoratissimus* L.f. Taxonomists often list new synonyms with a remark or two such as "indistinguishable" or "differing only in the somewhat larger

leaves", and not rarely give no remark at all, assuming evidently that none is required. On the contrary, it seems to me that listing a name as a new synonym requires explanation. Therefore I present in this paper the data which have convinced me of the need to bring the indicated species to synonymy.

Important Taxonomic Characters. The characters which are used in the discrimination of species in the whole genus are not all of use in the present case. For example, the highly important characters of *leaf-tip shape* and of *armament of ventral pleats* are of no value among the forms considered here, since they are identical (all leaves have long, narrowly attenuate, flagellate tips, and unarmed ventral pleats). The habit and habitat characters differ slightly, but far less than in other sections of the genus. The presence of a racemose or spicate female inflorescence likewise is of great importance, but in all our forms the cephalium is solitary on the peduncle. The fruits are syncarpous, with phalanges of several fused carpels, and none of the forms considered here has simple drupes. The stigmatic structure is of the same type throughout in our forms, as is evidenced by their inclusion in section *Pandanus*.

The remaining characters, which have been considered important in the original diagnoses of the species and in my own experience are as follows: (1) shape and dimensions of the cephalium; (2) length of the peduncle; (3) number and range, and median number (major carpel number) of carpels per phalange; (4) dimensions of phalanges; (5) presence or absence of fleshy mesocarp shoulders around middle of phalange; (6) color of phalanges; (7) presence or absence of lateral sutures in phalanges; (8) depth of apical sinuses between carpel apices; (9) position of endocarp within the phalange; (10) dimensions of the leaves; (11) number of veins in leaf (as counted near leaf midpoint); (12) color, size, and spacing of leaf prickles; (13) direction of midrib prickles.

The following remarks on the above characters precede a comparison of them in the species concerned.

1. Shape and dimensions of the cephalium. It should be superfluous to note that measurements of the character are useful only if full-grown cephalia are available. In addition it must be noted that (a) fruit-size decreases somewhat as the plants grow older; very old trees often produce cephalia as much as 40 per cent smaller than young, vigorous plants. Furthermore, adverse environmental conditions produce a size reduction; (b) the distinction between globose, subglobose, and ellipsoid cephalia is a very lax one; smaller cephalia are often concomitantly more globose.

2. Length of peduncle. This character appears to vary in much the same manner as cephalium size.

3. Carpel number. This is an important character, which I have discussed in another paper (1967). Briefly, it has been found that by plotting data from one cephalium in graphic form, the

carpels-per-phalange number on the horizontal axis and the number of phalanges on the vertical axis, a curve is obtained which typically begins at a relatively small carpel number, quickly rises to a peak, then more gradually descends to a relatively large number (Figure 5). Thus, of a cephalium bearing sixty phalanges, it may be found that three phalanges were composed of four carpels; 23 phalanges were composed of five carpels; 20 phalanges of six carpels; 8 phalanges of seven carpels; and 6 phalanges of eight carpels each. In this case, the "range" of carpel number would be 4–8, and the "major carpel number" would be 5. Ostensibly, cephalia showing different major carpel numbers are different in a taxonomic sense; but, as pointed out in the paper already referred to, the taxonomic function of this difference is often overestimated.

4. Dimensions of the phalanges. As pointed out above in sect. 1, size is partly a function of age and of environmental conditions, as well as of hereditary causes. Especially important is the dictum that all measurements be taken on ripe, full-grown material. For the sake of comparability, phalanges from the same part of the cephalium should be utilized; basal (peduncular region) phalanges are invariably shorter than average, as well as being curved, and have a greater than normal number of carpels.

5. Shoulders. The pulpy, firm expansion of the midregion of the phalange is conveniently termed shoulders. These are often eaten by insects on fruits still on the tree, and rather quickly "disappear" on dried or weathered phalanges. In my experience, the presence of shoulders on phalanges is a major character of *Pandanus odoratissimus*, and is correlated with other major characters such as the white color of the leaf prickles, the twin glaucous strips on the underside of the leaves, etc. Shoulders are either absent, or of a different shape and color, or are not correlated with other characters, in similar but distinct species.

6. Phalange color. Clearly, a good color terminology is required here; also it is important that fruits be fully ripe. In our species, the entire phalange becomes some shade of red-orange; but the last part to turn this color is the summit (carpel apices) of the phalange. The shoulders are often a deeper red than the rest of the phalange; and the extreme base may be yellowish.

7. Lateral sutures. By this is meant deep divisions between the carpels, visible in side view. Generally such sutures are absent in our species, though an occasional one or two occur. Phalanges with marked, deep, and regular sutures between carpels could indicate a different species.

8. Depth of apical sinuses between carpel apices. This character is a fairly important one, as it contributes largely to the overall impression one obtains when seeing a cephalium, or even loose phalanges, for the first time. Furthermore, it often is of specific importance. However, unless the depths concerned differ by more than just a few millimeters, they do not seem to merit overmuch

attention *at the species level of distinctiveness*. It must be pointed out that phalanges from the peduncular end of the cephalium will generally have shallower sinuses than phalanges from the mid-region or apex of the same cephalium.

9. Endocarp position. This too can be a significant character, as for example in discriminating such species as *Pandanus dubius* and *P. compressus*, or in the circumscription of *P. basilocularis*. Nevertheless, different positions may be attained in different ways; in some cases, extra growth of the apex of the phalange; in other cases, extra growth of the basal fibers; and both of these types of cases may be found to occur on one and the same plant at different times. More important for our discussion is the fact that since growth of the phalange continues at the base until the full length of the phalange is attained, an immature phalange will generally have an apparently sub-basal endocarp.

10. Leaf dimensions. These vary from several causes. Pandans have several categories of leaves: (a) prophylls and preliminary foliar bracts; (b) normal foliage leaves; (c) transitional leaves merging with inflorescence bracts; (d) seedling leaves; (e) juvenile leaves. It is generally useless to compare an organ of type (a) from specimen 1 with an organ of any other type from plant 2. Obviously, comparable structures must be compared. Besides this, older plants produce smaller leaves than younger plants. In general it may be stated that normal foliage leaves of unbranched juveniles may be up to four or five times as long, and half again to three times as wide, as leaves of adult plants.

11. Number of main longitudinal veins per leaf. The same cautions mentioned in sect. 10 should be heeded. Naturally, smaller leaves will have fewer longitudinal veins, even on the same individual.

12. Prickles. The underlying features of the prickles of the species under consideration is their white or very pale color. This character at once distinguishes these plants in the field. It is in marked distinction to the dark or merely pale *green* prickles of many other species, including the ones of the Eastern Pacific often lumped under the name *P. tectorius*. These white prickles are also relatively long, i.e. on the leaf bases of mature leaves they may exceed 6–7 mm. in length. Their spacing may be expressed as a range of distances between successive prickles at given positions (e.g., marginal prickles near leaf-base 6–12 mm. apart); or in terms of how many occur per unit (e.g., marginal prickles near base 3–4 per 10 cm.).

13. Direction of midrib prickles. In our species, the midrib prickles of the basal portion of the leaf are always retrorsely curved. This quickly distinguishes these plants from some related species and from some unrelated species (as well as from Cyperaceae).

Before proceeding with a comparative analysis of species, it is necessary to fix the character of *Pandanus odoratissimus*. This is no easy matter, since the description is very brief, and worst of all, it is based on the male plant. The type locality is Ceylon, so it may be expected that a collection made there of both male and female plants would establish the identity of the species. The fruit is needed, because nearly all subsequent descriptions emphasise the fruits. Luckily this has been done by Dr. St. John and we are therefore in a position to make the comparisons needed with Ceylon material.

Comparative analysis

The essential characters are set out in Table 1. In summary, it may be stated:

(1) Size range for cephalia is from 8.8 x 8.8 cm. in *P. globosus* and 9 x 8.5 cm. in *P. rubricoloratus* to 23 x 20 cm. in *P. hueensis*. Average size appears then to be about 16.8 x 14 cm. The only gap seems to be for *P. hueensis* and *P. vietnamensis*.

(2) Peduncular length varies from 9 to 40 cm., with the average length near 25 cm.

(3) Carpel number. Since the original data is not expressed in the form outlined earlier, only ranges can be given. These rarely cover more than 5 carpels difference between minimum and maximum in any one cephalium. The smallest number given is 4 (in 2 species); the largest number is 14 (in 2 species). The general range is thus 4–14, with 5–12 being far more common. A gap seems to exist between species with the "major carpel number" at 5, 6, or 7, and those at 9 or 11, but this seems uncorrelated with any other significant feature.

(4) Phalange size varies more or less continuously between 3.5 and 7 cm. long and 1.6 and 4.6 cm. wide. Phalange color is always some shade of red or red-orange, if fully ripe; if too young, yellow or green.

(5) Number of phalanges per cephalium ranges from 26 to 143, with figures between 60 and 90 apparently most common.

(6) None of these forms have regular, deep lateral sutures; most have none; a few have occasional shallow sutures.

(7) All forms have fleshy shoulders except those which are clearly immature. It is believed that these too would exhibit shoulders at full ripeness.

(8) Leaves range in length from 0.8 to 2.4 (or 3?) meters, and in width from 2.8 to 6.3 cm. All have pale or white prickles; many have dark or brownish tips on the prickles. The number of longitudinal veins in each half varies from 21 to 45 (in the known examples).

(9) Ecology. All forms are beach, coastal, or swamp species, near the sea. Geographically, they range from the Indian Ocean through S.E. Asia to Malasia.

In conclusion, it appears from this analysis that 9 species described from Malaya, one from Anamba Is., 10 from Vietnam, one from Hongkong, and four from the Maldive Is., can all be considered synonymous. Several are considered to be at least temporarily recognizable as forms. There follows a list of the synonyms and discussion of the forms and species maintained.

Description of Pandanus odoratissimus.

Pandanus odoratissimus Linnaeus fil., Suppl. Pl. 64, 1781. St. John, Taxon 12 (5): 201-204, 1963.

P. verus Rumph., Herb. Amb. 4: 139. t. 74. 1743; Kurz, J. Bot. Brit. & For. 5: 125, 1867, in part.

Keura odorifera Forsskal, Fl. Aegypt.-Arab. 172, 1775;

Pandanus odorifera (Forssk.) Kuntze, Rev. Gen. 2: 737, 1891. (Nomen dubium).

P. fascicularis Lamarck, Encycl. 1: 372, 1783.

P. leucanthus Hasskarl, Fl. Bot. Ztg. 25 (2), Beibl. 14, 1842.

Hasskarlia leucacantha Walpers, Ann. 1: 753.

Note: this is by no means all the older synonyms, but a full account of these is impossible until their exact identities have been set forth, since earlier authors, including Warburg, confounded the Indian-Malaysian species with the Polynesian-Melanesian species, and Warburg gave to this very broadly conceived species the name *Pandanus tectorius* Solander ex Parkinson, a name which is now agreed not to have been validly published (see Airy Shaw, Taxon 11 (7): 223, 1962) and therefore dates only from Warburg's publication in 1900. Neither his taxonomic nor his nomenclatural conclusions can be supported now; and the name *P. odoratissimus* L.f., though later than *Keura odorifera* Forsskal, will be the type of the genus *Pandanus*, since it has been shown by St. John to be better established. Forsskal's name must remain dubious, as it lacks a type specimen and was based only on part of a male flower. The species of the Pacific are distinctive enough to merit retention, though the number of binomials existing now is certainly too large; but even if a very widespread specific concept is adopted, it seems clear at this stage that *P. odoratissimus* is easily discriminated, both on vegetative and fruit characters, and its presently known range does not extend east of Malesia (in the sense of van Steenis in "Flora Malesiana"). The boundary is not certainly known but seems to be in the general vicinity of Wallace's Line. The Pacific species (or one of them) however appears to overlap the above area, and occurs at least in eastern Malesia; it is this occurrence which has helped to foster the confusion of the species. The plant illustrated in Rumphius' Tab. 81 seems to me to be an example of such overlapping. What name, or names, may be used for this plant and its Pacific relatives is a problem that can safely be deferred for the present.

NEW SYNONYMS: MALAYAN TYPE LOCALITIES:

- P. albibracteatus* St. John, *Pac. Sci.* 17: 10. 1963.
P. ambiglaucus St. John, *ibid.* 17: 13. 1963.
P. carnosus St. John, *ibid.* 17: 20. 1963.
P. globosus St. John, *ibid.* 17: 21. 1963.
P. inclinatus St. John, *ibid.* 17: 24. 1963.
P. incrassatus St. John, *ibid.* 17: 26. 1963.
P. obtusus St. John, *ibid.* 17: 28. 1963.
P. rubricoloratus St. John, *ibid.* 17: 32. 1963.
P. Boryi Gaud. *Voy. Bonite*, t. 22, f. 15. 1841; em. St. John, *ibid.* 17: 18. 1963.

ANAMBA ISLANDS:

- P. Hendersonii* St. John, *ibid.* 19: 116. 1965.

VIET NAM:

- P. integriapicis* St. John, *ibid.* 16: 91. 1962.
P. Phamhoangii St. John, *ibid.* 16: 96. 1962.
P. projectens St. John, *ibid.* 16: 100. 1962.
P. reversispiralis St. John, *ibid.* 16: 101. 1962.
P. semiorbicularis St. John, *ibid.* 16: 106. 1962.
P. Smitinandii St. John, *ibid.* 16: 109. 1962.
P. subcarnosus St. John, *ibid.* 16: 111. 1962.
P. subulatus St. John, *ibid.* 16: 114. 1962.
P. vietnamensis St. John, *ibid.* 16: 116. 1962.

HONG KONG:

- P. remotus* St. John, *ibid.* 16: 70. 1962.

MALDIVE ISLANDS:

- P. adduensis* St. John, *ibid.* 15: 328. 1961.
P. Hartmannii St. John, *ibid.* 15: 333. 1961.
P. Karikayo St. John, *ibid.* 15: 335. 1961.
P. maldivecus St. John, *ibid.* 15: 339. 1961.

DESCRIPTION:

(Figs. 1-6).

Habit. Coarsely branched trees with a tendency to candelabriform branching, the secondary branches sympodial by development of a lateral vegetative bud at the base of the terminal inflorescence; branching di- or trichotomous, or irregular. Main stem rarely more than 20 cm. thick, erect or more or less decumbent, usually thickest a little above the extreme base; later branches of the same or lesser diameter because of lack of cambium; leaves of three- to five-year-old vigorous juveniles often four or five times longer and twice or three times broader than leaves of senescent, much-branched adult plants. Main stem and not rarely upper stem and lower branches producing prop-roots up to 10 cm. thick, but usually more slender. Adult plant seldom over 10 m. tall; suckering from base occasional. Occurrence in groves not uncommon.

Stems green in growing stages towards apex, earliest parts white, soon discoloring on exposure, but covered by leaves; exposed part usually turned pale buff or gray-brown, grossly ringed by leaf-scars, these as much as 3-4 cm. apart on rapidly-grown parts, usually 1 cm. apart or a little less. Uppermost ultimate branches as slender as 3 cm. diameter in old trees. Base of branch at attachment to stem dorsoventrally flattened and somewhat clasping. Stems and branches usually more or less prickly because of blunt or acute adventitious roots with arrested growth, up to about 1 cm. long.

Leaves spiralled, in three rows (tristichies), clasping at base around the stem, the extreme edges just meeting there or slightly overlapping. Leaf margins of the clasping portion gradually thinner toward the edge, whitish or pale green. Blade ensiform, nearly parallel-sided, toward the apex very gradually reduced (in foliage leaves), more abruptly reduced in prophylls. Prophylls deltoid (approaching isosceles form), entire, the first one channelled on both sides, the remainder channelled ventrally, the series merging gradually to foliage-leaf form, with the last few prophylls (usually around the 9th) developing marginal prickles toward the apex; early foliage-leaves short, rather bluntly acute, marginal prickles developed; later ones with dorsal midrib prickles developed, and apices increasingly prolonged; adult foliage-leaves with the apex gradually narrowed into an elongated triquetre flagella, the margins and dorsal midrib armed with prickles. Largest leaves as much as 3 m. long and 9 cm. broad, but usually less, 1-2 m. long and 4-7 cm. broad; length : width ratio commonly between 20:1 and 30:1. Blade M-shaped in section. Apex of youngest leaves stiffly erect, but older leaves drooping from near the tip or the midpoint or even lower. Dorsal surface glaucous on each side of the midrib; ventral surface also glaucous, but less so. Prickles *white*, or the extreme tip dark, commonly 3-5 mm. long, often longer; in some forms up to 10 mm. long. slender, very sharp, very slightly curved; prickles of margins all forwardly directed; prickles of midrib forwardly directed in the

distal half (approximately) of the leaf, but the prickles of the proximal part retrorse. Spacing of the prickles rather irregular, but distally the prickles always smaller and more crowded, proximally always larger and farther apart; commonly (near the leaf base) the prickles 1–3 cm. apart. (Some forms probably for genetic reasons unarmed). Parallel veins mostly 40–160, depending on age of leaf, age of tree, etc., visible but not prominent along most of the blade but less or not so toward the base. Transverse lines not at all evident, unless under microscope. Colored pigmentation absent, i.e. leaves never reddish, purplish, etc.; white- or yellow-striped variegated forms may exist.

Female inflorescence borne only on female trees, terminal, pedunculate, the peduncle 10–30 (rarely more) cm. long, trigonal, bracteate, the lower bracts leaflike, upper bracts whitish-yellow, successively shorter, more or less navicular, the midrib and margins with reduced prickles, texture sub-fleshy, the last bracts much reduced to linear-lanceolate shape and much shorter than the syncarp; these bracts all soon withering and more or less persistent but at last fragmenting and falling. Inflorescence a cephalium, globose to ellipsoid, up to about 30 × 20 cm., slightly rounded-trigonal, mostly 15–20 cm. × 12–18 cm.; composed of a variable number (26–143, usually about 50–70) of carpellate phalanges, these in turn composed of mostly 4–10 concentrically arranged fused carpels (phalanges of only 1–3 carpels or of 11–14 carpels rarely also occur, the former only near the cephalium apex, the latter only near the cephalium base). Carpels each terminating in a single U- or V-shaped stigma; carpel apex truncate, low-rounded, or low-pyramidal, sometimes somewhat acute. Phalanges laterally mostly smooth, rarely with 1 or 2 intercarpellary grooves; apically with slight grooves between the carpel tips. At maturity the phalanges red-orange to vermilion, sometimes the carpel tips still greenish; median part of phalange rather abruptly expanded into fleshy shoulders, these not evident in dried or insect-damaged or animal-gnawed specimens, but always obvious in fresh fully ripe fruit. Phalanges mostly 3–8 cm. long, 2.5–4.5 cm. wide, pentagonal or hexagonal but sometimes slightly exceeding these measurements; phalanges from cephalium base (peduncular end) always curved, shorter, and with more carpels, than those from lateral or apical part of cephalium; phalanges from apex of cephalium usually longest and with fewest carpels, the carpel tips more expanded and sometimes more acute. Young phalanges greenish-white, later yellow, finally orange then reddish to vermilion. Phalanges free of each other but tightly crowded; eventually falling from the cephalium receptacle, apical ones first, leaving a pentagonal or hexagonal scar. Cephalium when mature more or less drooping; when young usually suberect. Phalange externally covered by a pericarp; within this the upper mesocarp is lacunose, each carpel apex with a chamber traversed around the periphery by longitudinal fibers and crossed by thin plates of pithy tissues (aerenchyma); lower mesocarp fibrous, the fibers traversing a pulpy tissue;

endocarp central, osseous, reddish-brown, unitary, each carpel represented by one ovular chamber, this fusiform, a few fibers traversing the endocarp, some central in the mesocarp and leading to the stigma, these entering the ovular chamber along one side; upper part of ovular chamber filled with soft white endosperm; embryo basal; germinating downward. Outermost seeds often not developing.

Male inflorescence only on male trees, pedunculate, bracteate, the bracts similar in color and form to those of the female, but the inflorescence a raceme of spikes (an odd number, usually 5, 7, 9, or 11), each in the axil of a bract, each consisting of a fleshy central axis from which emerge numerous lateral phalanges of stamens about 13 mm. long, bearing about 19–23 stamens on short filaments 0.5–2 mm. long, with anthers 2–3.5 mm. long, narrowly sagittate, with an apiculum 0.5 mm. long; the basal part of the phalange is about 3 mm. long up to the first filament. The phalange, and the receptacle and major axis as well, are all clearly seen to be fasciculate. The overall length of the whole inflorescence varies from about 30 to 60 cm. long; the bracts subtending the spikes are mostly less than 30 cm. long, the last ones only about 6 cm. long. The inflorescence is ephemeral and decays very rapidly after maturing, usually within a couple of days.

Citation of specimens. No attempt is made here to cite all specimens of *Pandanus odoratissimus*, since it has been collected many, many times; and indeed many specimens are not worth the paper they are mounted on, for lack of representative parts, poor labelling, and so on. The specimens cited here are simply those of the herbaria at the Singapore Botanic Gardens and at the University of Malaya. The main purpose in citing these is to mark precisely those which are in fact this species to distinguish them from the very similar plants (often in villages) which have recently been called *P. spurius* Miq., and those which represent the Pacific-Melanesian group which has been called *P. tectorius*, such as *Lam* 3285.

MALAYA. Singapore: Changi, Dec. 1892, *Ridley* (♀). Bajau, 9 May 1892, *J. S. G.* (♂). Passu Panjan, 1901, *Ridley* (♂). Same locality, 1909, *Ridley* 14157 (♂). Kranji, mangrove swamps, 10 April 1966, *Stone* 6237, 6238 (♀), KLU. — Johore: Tanjong Bungah, 1894, *Ridley* 6284 (♂). Tana Panti, 22 April 1890, *Ridley* 4594 (♂). Kukul, May 1909, *Ridley* 14169 (♂). Tana Panti, 1892, *Ridley* (♀). Jason Bay, 15 June 1934, *Corner* (♂). 3 miles west of Kuala Sendai, 7 June 1922, *Goodall* (♂). Johore Bahru, west side mangrove area, 21 Nov. 1965, *Stone* 6106 (♀, KLU). Same locality, 12 April 1966, *Stone* 6106-A (♀, obs. ♂, KLU). Mersing, 6 Jan. 1959, *Paine* (♀). — Malacca: Near Malacca, 1892, *Ridley* (♂). "Sea-shore", 1 May 1895, *Maheiros* (sterile). — Negri Sembilan: Kuala Pilah, kampong pandan, 26 Feb. 1936, *Corner* SFN 30762 (♂). — Pahang: Kuala Pahang, 17 May 1890, *Ridley* (♂); 10 May 1890, *Ridley*

(♀). — Trengganu: Kuala Trengganu, 9 May 1925, *Holttum* SFN 15169 (♂). Cherating River, 25 Aug. 1884, *Ridley* (sterile). — Perak: Dindings, Pangkor, March 1896, *Ridley* (♂). Pulau Lalang, 30 Dec. 1925, *Sermund* (♂). Langkawi: April 1892, *Curtis* (♂). Penang: Batu Ferringhi, Tanjong Bungah, 10 Feb. 1966, *Stone* 6171, (♀); 2 May 1966, *Stone* 6350 (♀) KLU. [SING unless otherwise noted].

SUMATRA. Atjeh, Troemon, 27 Aug. 1941, *Asdat* 107. (♀).

PULAU BANGKEI: 30 June 1936, *Lütjeharms* 5134. (♀).

NORTH BORNEO: SABAH: Sibubu River, Mengalong Forest Reserve, 5 miles S. W. of Sipitang, 30 July 1954, *Wood & Wyatt-Smith* SAN 'A' 4567 (♀).

Some Forms of the species:

Pandanus odoratissimus L.f. forma *vietnamensis* (St. John) B. C. Stone, comb. et stat. nov.

P. vietnamensis St. John, *Pac. Sci.* 16: 116. f. 93. 1962.

Holotype: Vietnam, 6 km e. of Mui Ne, Phan Thiet Province, top of beach, 9 Feb. 1960, *St. John* 26,342 (BISH).

This seems to be distinctive in its unusually long prickles; those on the leaf base up to 11 mm. long; in the large cephalium, 27 cm. long, 19 cm. thick, with 106 phalanges; and in the stout phalanges of 5–9, usually 6–7 carpels, about 6 cm. long and 4 cm. thick.

Pandanus odoratissimus L.f. forma *karikayo* (St. John) B. C. Stone, comb. et stat. nov.

P. Karikayo St. John, *Pac. Sci.* 15: 335. f. 16. 1961.

P. adduensis St. John, *ibid.* 15: 328. f. 12. 1961.

P. Hartmannii St. John, *ibid.* 15: 333. f. 15. 1961.

Holotype: Maldive Islands: Fadiffolu Atoll, Kuredu Islet, Shore, 25 Sept. 1957, *W. D. Hartmann* 1 (A).

This form may be tenable because of the larger number of carpels per phalange, usually from 9 to 14.

Pandanus odoratissimus L.f. forma *rubricoloratus* (St. John) B. C. Stone, comb. et stat. nov.

P. rubricoloratus St. John, *Pac. Sci.* 17: 32, f. 163. 1963.

Holotype: Malaya: Pahang; Pulau Tioman, Telok Paya, sealevel, 19 May 1927, *M. R. Henderson* 18,444 (SING).

Rather distinctive because of its small globose cephalium only 9×8.5 cm., with 34 phalanges, each about 3.6×2.5 cm., the stigmas somewhat elevated.

Pandanus odoratissimus L.f. forma *hueensis* (St. John) B. C. Stone, comb. et stat. nov.

Pandanus hueensis St. John, *Pac. Sci.* 16: 88. f. 60. 1961.

Holotype: Vietnam: Thai Duong Ha, Hue, thicket at edge of brackish marsh by inner beach, sandy soil, 2 m. alt., 3 April, 1960, *H. St. John* 26,343 (BISH).

This seems to have certain characters permitting it to be ranked, at least for the time being, as a forma, although its relationship to *P. odoratissimus* is certainly very close. The important features are these: the short prickles, which even at the leaf base are only 2–4 mm. long (but white!); the large cephalium, 28×20 cm., with 143 phalanges; the large, rather narrow phalanges, about 7.4–8 cm. long and 2.8–4.6 cm. thick, with 4–9 carpels; and the high position of the endocarp, in the upper third of the phalange.

Summary and post-script.

Pandanus odoratissimus L.f. (Sect. *Pandanus*), the type species of the genus, was described from a male flowering specimen from Ceylon. A neotype collection has been made by Prof. H. St. John (Pac. Sci., in sched.) to establish the identity of the female plant, particularly the fruit: cf. Fig. 6. This is a coastal species, and the phalanges are distributed by ocean-currents. It is to be expected then that it should have a fairly wide distribution, in the manner of most coastal plants with oceanic dispersal, e.g. *Ipomoea pes-caprae*, *Canavalia rosea*, *Hernandia sonora*, *Heritiera litoralis*, etc. Nonetheless a very large number of species have been described, especially in the last few years, on the basis of specimens which are agreed to be close relatives (at least) of *P. odoratissimus*. By means of an analysis of the taxonomic criteria involved, and a tabular comparison of the alleged distinguishing features, it is believed to be evident that only one species can be distinguished, but it is clearly rather polymorphic, and hence several formae may be recognized. Although there are still no doubt further synonyms among the relevant binomials in existence, it is already possible to confirm that the broad concept of Warburg (1900) who considered that only one species ranged from the Indian Ocean to the limits of Polynesia, is erroneous; and that instead, there are undoubtedly a few distinct species in the Pacific Islands, though certainly fewer than the available binomials in existence would indicate. One of the Pacific species has borne the name *Pandanus tectorius*, which however is considered now to date validly only from its publication by Warburg in 1900, and not from Parkinson, 1773. Consequently another name must be found for the species (singular or plural) of Tahiti; several are available, including *Pandanus douglasii* Gaudich. (1841) which has already been used for the Hawaiian plants (manifestly of only one species) which certainly also occurs in Tahiti and no doubt elsewhere in Polynesia. How many species of this general 'Pacific' alliance can finally be discriminated, it is too early to tell; but it is certain that none penetrates into the Indian Ocean, at least not to the Maldives or beyond, and apparently throughout that area and in Malaysia (Malesia) the vicariant representative species is *P. odoratissimus*. Nonetheless, a member of this 'tectorius' group does overlap into the area of *P. odoratissimus*, evidently in the general region of

Wallacea, i.e. in parts of the Malayan-Indonesian Archipelago, particularly in the vicinity of Celebes-Amboina-Halmaheira, as also perhaps on the eastern coast of the Philippines.

Pandanus odoratissimus owes a number of its synonyms and in general much of the confusion surrounding the species is also due to the ephemeral nature of one of the major characteristics of the species, namely the abrupt fleshy dark red shoulders of the mature phalanges. Immature fruits, even when seen in the field, lack these; dried fruits, even when collected fully mature, also lack them (due to shrinkage); and many field-collected fruits lack them from depredations of ants or other insects. Consequently, this character, so effective in defining *P. odoratissimus*, has either been missed or ignored by most previous authorities. The other major character is the nature of the large, white spines of the leaves. By itself, this feature of armature must have seemed of secondary importance to earlier botanists; yet in conjunction with the fleshy shoulders, it is the hallmark of the species. *Neither character is found in the Pacific Islands beyond Malaysia.* Instead, these plants — whether of one, or as I rather believe, a few closely related species — have no shoulders on the phalanges, or if present, these are orange or vermilion, merely slightly bulging and never abrupt or dark red, and persisting after drying, i.e. not merely consisting of pulpy exocarp; and further, the leaves bear shorter, green spines, rarely as much as 4 mm. long, in contrast to those of *P. odoratissimus*, which may reach a length of 8 or 10 mm. Other distinguishing features will no doubt be found to correlate with these two obvious ones.

The western limit of *P. odoratissimus* appears to be the Maldive Islands of the Indian Ocean, although I suspect that *P. balfourii* Martelli of the Seychelle Islands is merely a form; but nothing like the species has ever been recorded from Mauritius, Madagascar, or the South African coast. Rendle's *P. rabaiensis* needs reviewing in the light of the above discussion also; this was from Mombasa — Dar-es-Salaam.

The eastern limit of *P. odoratissimus* seems to be along Wallace's Line, approximately. Field investigations in this region are critically needed. The status of *P. coronatus* Martelli (Philippines) must be reviewed. The distribution clearly extends northward into the Ryukyu Islands (cf. *P. tectorius* var. *liukiensis* Warb., and var. *ferreus* Y. Kimura). No doubt also Warburg's *P. tectorius* var. *sinensis* pertains to *P. odoratissimus*. *Exploration on these borders is a major desideratum*, for only until these borders are fully known can the questions relating to distribution be approached.

REFERENCES

- RIDLEY, H. N. 1925. The Flora of the Malay Peninsula. Vol. V. Monocotyledones (concluded), Gymnospermae, General Indices. *Pandanus*, pp. 72-81. L. Reeve & Co., London.
- ST. JOHN, H. 1959-67. Revision of the Genus *Pandanus*. *Pacific Science*, 14-21, (continuing).
- STONE, B. C. 1967. On the use of Carpel Number as a Taxonomic Criterion in distinguishing species of *Pandanus*. *Amer. Journ. Bot.* 54 (in press).

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange / No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. albibracteatus</i> St. John	1, 23 × 17.5 cm. subglobose ped. 27 cm.	4 — 7 /67 ph.	55 — 62 × 25 — 40 mm. <i>green—pink</i> orange-red	usu. none rarely 1 — 2	yes	yes /35	Penang sea beach	1.7 — 2 m. 5 — 5.5 cm. spine tips reddish- brown
<i>P. ambiglaucus</i> St. John ..	1, 21 × 16 cm. ellipsoid ped. 40 cm.	7 — 8 /85 ph.	60 — 66 × 28 — 40 mm.	none	no (but immature)	no /44 — 46	Singapore, Kranji, fresh water swamp	2 — 2.5 m. 5.8 — 6.3 cm. spines white
<i>P. Boryi</i> Gaud. ..	1, (16 × 14 cm.) Small cylindric (ellipsoid) red when ripe (ped. 22 cm.)	6 (—10) / ?	63 × 28 — 34 mm. (55 — 60 × 20 — 34) <i>green—brown</i> yellowish	none	yes	no /39 — 45	Singapore edge of "dry", mangrove swamp	1.7 m. × 3.5 cm. prickles "pale", or on midrib "reddish"

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS — continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange/ No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. carnosus</i> St. John ..	1, 18 × 15 cm. subglobose	6 — 10 / ?	67 — 73 × 24 — 35 mm. partly green red-orange	none	yes	no / 45	Singapore, Kranji village Pahang-Kuantan	1.8—2.4 m. × 4.4—5.2 cm. spines pale but reddish-tipped
<i>P. globosus</i> St. John ..	1, 8.8 × 8.8 cm. globose ped. 9 cm.	5 — 6 / 26	36 — 39 × 22 — 28 mm.	none	no, but very immature	no / 38	Pulau Langkawi on limestone coast Celebes Borneo-Pulau Is.	81—90 cm. × 3.5 cm. prickles "Brown tipped"
<i>P. inclinatus</i> St. John ..	1, 16 — 23 cm. × 13—20 cm. subglobose ped. 30 cm.	(6) (7—9) (12) rarely doubled—18 / 44 — 61	60 — 68 × 23 — 43 mm. greenish orange-red	none	yes	no / 38 — 40	Singapore, Kranji, brackish swamp	1.5—1.7 m. × 4.4—4.7 cm. spines all white with brown tips

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange / No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. incrassatus</i> St. John ..	1, 15 × 14.5 cm. ped. 23 cm.	5—8 /54	46—52 × 23—36 mm. <i>green</i> red-orange	none	yes	no /34 — 35	Singapore, Kranji	1.4 — 1.7 × 4.2 cm. spines white, brown-tipped
<i>P. obtusus</i> St. John ..	1, c. 12 × 12 cm. ped. 23+ cm.	8—10 /38	50—55 × 27—38 mm. (dried) brown	none	no, but <i>immature</i>	no /21 — 39	Pahang- <i>Kuantan</i> Singapore	0.8 — 1.3 m. × 3.4 cm. prickles pale but reddish
<i>P. rubricoloratus</i> St. John	1, 9 × 8.5 cm. ped. 15+ cm.	6—9 /34	36 × 20 — 27 mm. <i>red</i> <i>red</i>	none	yes	no /27	Pulau Tioman	66 — 73 × 2.8 — 3 cm. prickles pale + brown- tipped

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange / No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. remotus</i> St. John ..	1, 23 × 18 — 20 cm. ellipsoid ped. 20 cm.	(7) (8—9) 10 /50+	42 × 46 — 16 — 30 mm. yellow orange	a few or other partial ones but shallow	yes	yes / ?	Hongkong	0.95—1.6 m. × 4.5 cm. prickles yellowish
<i>P. hueensis</i> St. John ..	1, 28 × 20 cm. elliptic-ovoid ped. 30 cm.	(5—) 6—7 (—9) /143	74 — 80 × 28 — 46 mm. orange yellow	none	no (apparently)	no / ?	Vietnam	1.4—1.6 m. × 4.7 — 5.5 cm. small spines white often browntipped
<i>P. integratipicis</i> St. John	1, 17 × 10 — 11 cm.	7 — 9 /74	27 — 31 × 18 — 30 mm. green orange	none	yes	no /?	Vietnam	78 — 87 × 4.2 — 4.5 cm. large pale prickles; tip almost devoid of prickles!

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange/ No. of phalange/ per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. Phamhoangii</i> St. John	1, 11—12.5 × 9—10.5 cm. ped. 15 cm.	5—8 /34	34—38 × 22—40 mm. green	none	no, but immature	no /?	Vietnam St. J. also reports spms. from Riouw Isls.	0.6—1.3 m. × 3.4—3.6 cm. prickles white often brown-tipped
<i>P. projectens</i> St. John	1, 18.5 × 14.5 cm. ped. 10 + cm.	6—9 /82	42—46 × 22—40 mm. ? yellow	none	no, but immature	no /?	Vietnam	1.26 m. × 5 cm. prickles yellowish but brown-tipped
<i>P. reversispiralis</i> St. John	1, 12—16 × 11—14 cm. ped. 20—25 cm.	5—7 /52—94	43—46 × 23—38 mm. orange	none or few very shallow ones	yes	yes /?	Vietnam	0.7—1.3 m. × 4.8—6 cm. prickles white, brown-tipped

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange/No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. semiobacularis</i> St. John	1, 17 × 14.5 cm. ped.	(5) (7—8) (10) /86	45—50 × 24—43 mm. green— orange	same as above	no, but immature	yes /?	Vietnam	0.8—1 cm. × 4.5—5 cm.
<i>P. Smitinandii</i> St. John ..	1, 14 × 11.5 cm.	6—12 (8—9) /72	40—43 × 21—33 mm. green yellowish	none or few	no, but immature	no /?	Vietnam dunes	1—1.15 m. × 4.3—4.8 cm. prickles "straw- color"
<i>P. subcarnosus</i> St. John ..	1, 16 × 14 cm. orange ped. 20 cm.	6—10 (7—8) /84	45—49 × 22—42 mm. orange	none	yes	no /?	Vietnam	1—1.13 m. × 3.7—4 cm. prickles white
<i>P. subulatus</i> St. John ..	1, 10—12 × 10 cm. ped. 15—20 cm.	5 (—6) /47—73	35—41 × 18—33 mm. orange	none	no, but slightly immature	no /?	Vietnam	70—74 × 4 cm. prickles white

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange/ No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. vietnamensis</i> St. John	27 × 19 cm. scarlet—red ped. 30 cm.	5—9 (6—7) /106	58—60 × 25—42 mm. scarlet + orange-red yellowish	none	yes	no /?	Vietnam	1—1.5 m. × 5—6 cm. prickles white lower spines to 11 mm.
<i>P. Hendersonii</i> St. John ..	1, 19 × 11 cm. ped. 20+ cm.	7—11 (8—10) /70	(39—45) — 50) × 24—40 mm.	none	yes	no /38—42	Indonesia Anamba Isl.	1—1.5 m. × 4—5 cm. prickles pale, browntipped
<i>P. adduensis</i> St. John ..	?	9—13	4.5—4.9 × 3.4—4.1 cm.	none	?	no	Maldive Islands	1.5 m. × 6.3 cm. prickles browntipped

TABLE I — COMPARISON OF THE DIAGNOSTIC FEATURES OF 25 PROPOSED SPECIES OF PANDANUS—continued

Species	Syncarp size + shape (all syncarps pendent at last); ped = peduncle	No. of carpels per phalange/ No. of phalanges per cephalium	Size + Shape of phalanges + color	Lateral sutures present or not	With fleshy shoulders or not	Male known / # of veins per lf. half	Locality, ecol.	Leaves: length × width; Spine details
<i>P. Hartmannii</i> St. John ..	20 × 14 cm. ellipsoid	12 (— 14)	4 — 4.3 × 2.8 — 4 cm.	none (or very few shallow)	?	no	Maldive Islands	1.2 m. × 5.7 cm. "dark tips" on prickles
<i>P. Karikayo</i> St. John ..	18 × 13 cm. "Bright red"	10 — 14	3.8 — 4.4 × 2 — 3.4 cm.	none	?	no	Maldive Islands	1 — 1.25 (— 3?) m. × 5.2 cm. "pale"
<i>P. Maldivicus</i> ..	14 × 11 cm. broad ellipsoid	5 — 9, usu. 6 /60	4.8 — 5.2 × 2.2 — 3.4 cm.	none	?	no	Maldive Islands	1.17 m. × 4 — 5 cm. "dark-tipped" prickles



Figure 1

Pandanus odoratissimus L.f. A fruiting female tree about 8 m. tall, on the sandy beach at Tanjong Bungah, north coast of Penang (Stone 6171), near the type locality of *P. albibracteatus*.



Figure 2

Pandanus odoratissimus L.f. A young plant in the Singapore Botanic Gardens.

Above, view of the whole plant. Note the numerous small leafy branches near the base at left.

Below, midportions of several leaves showing the ventral surfaces. Note the slender, elongated, white marginal prickles.

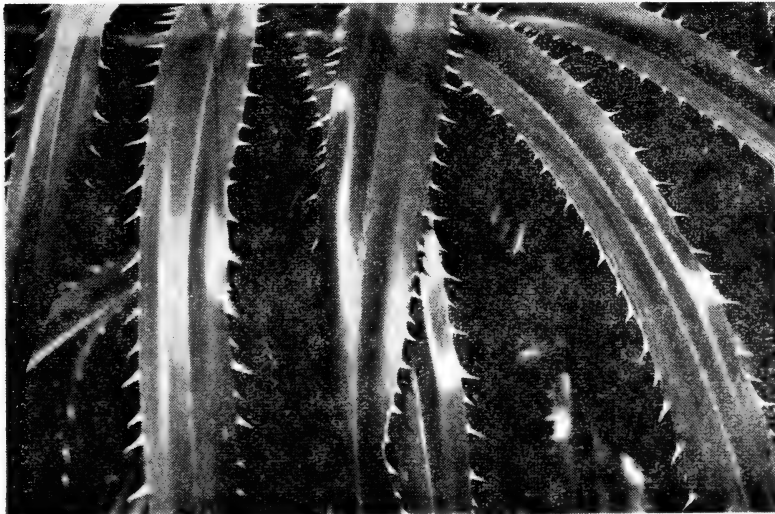




Figure 3

Mature cephalium of *Pandanus odoratissimus* L.f. (Stone 6171 from Penang). The color is red-orange or vermillion; a few carpel tips are still green.

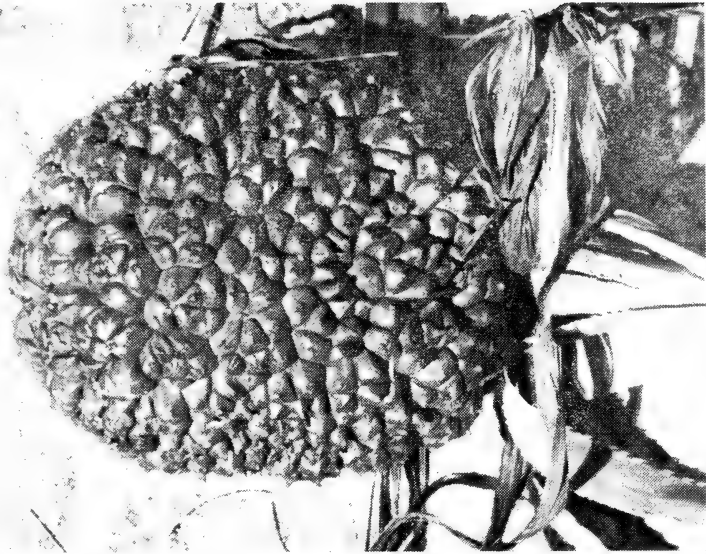


Figure 4

Cephalia of *Pandanus odoratissimus* L.f. (Stone 6171 from Penang).

Above, an unripe young cephalium.

Below, a ripe cephalium cut in half.



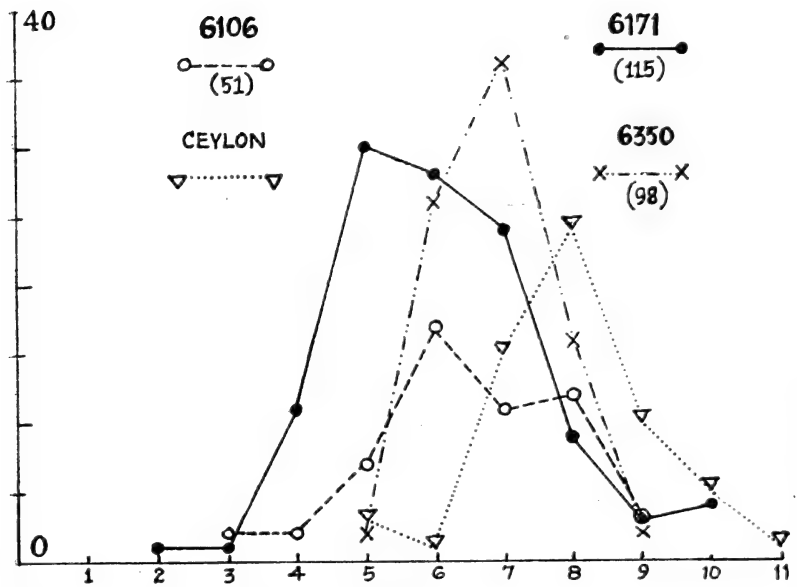


Figure 5

Carpel numbers in *Pandanus odoratissimus* L.f.

The vertical axis shows number of phalanges; the horizontal axis shows number of carpels per phalange. Whole-cephalium samples only are used. The numbers above the sample line refer to collections. The number in parentheses below the sample line indicate the total number of phalanges borne by the cephalium. No. 6106 is from Johore; no. 6171 is from Penang; and no. 6350 is from Penang. Major carpel numbers are: for 6106 6; for 6171, 5; and for 6350, 7. The total range is 2–10. Individual ranges are: for 6106, 3–9; for 6171, 2–10; for 6350, 5–9. It should be added that two additional cephalia, not shown graphically here, from the same individual as 6106, gave the following data: (a) total phalanges 40; range 5–9; major carpel number 7. (b) total phalanges 47; range 4–8; major carpel number 7. The Ceylon sample (*St. John 24212*) shows a major carpel number 8; the range is 5–11; total phalanges 59.

Note.—Strictly, these graphs should be histograms, but in order to conserve space, lines have been used so that several samples may be superimposed. The variation between each carpel number is of course not continuous.

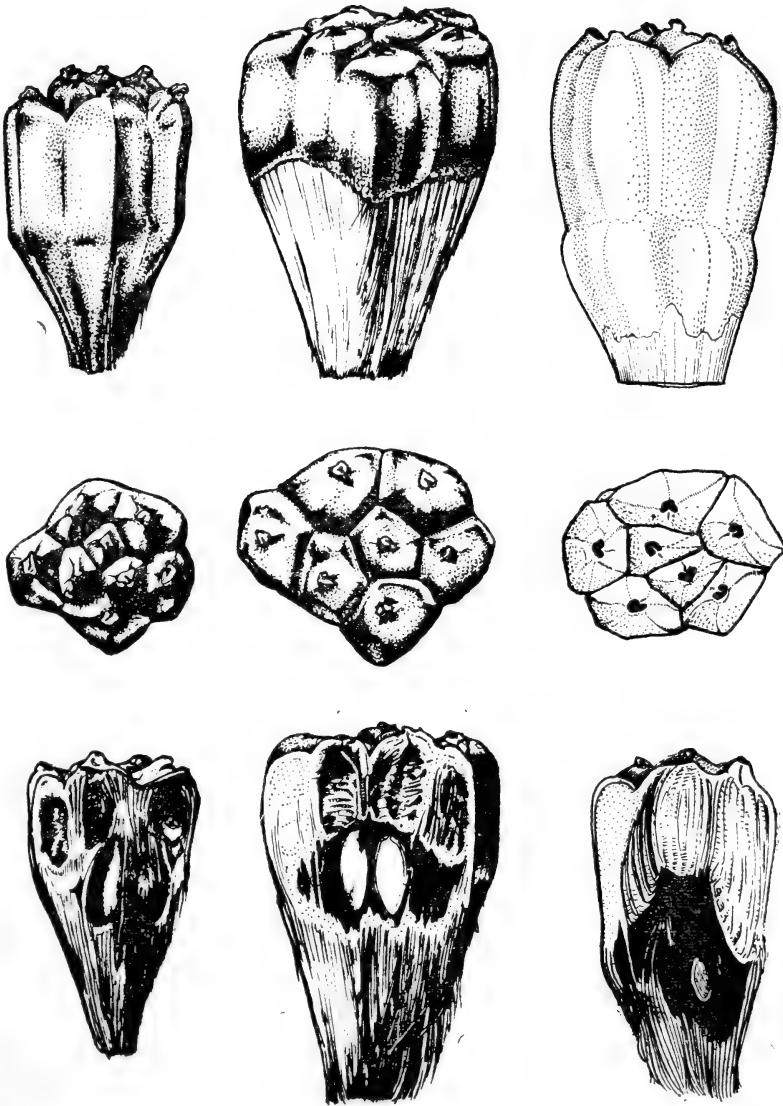


Figure 6

Phalanges of *Pandanus odoratissimus* L.f.

Left: profile, top view, and sectional view of *St. John 24212* from Ceylon.

Centre: profile, top view, and sectional view of *St. John 24218* from Ceylon.

Right: profile, top view, and sectional view of *Stone 6350* from Penang (Natural size).



Taxonomic Notes on Bornean Dipterocarpaceae, III

by

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This paper succeeds two others (this journal, XIX (1962) 253–319; id., XX (1963) 229–284) in which new species of *Dipterocarpaceae* from Brunei and Malaysian Borneo were described, others reduced to synonymy and reassessments were made of the infrageneric classification of some genera. The first two papers were published as precursors to my Manual of the Dipterocarp trees of Brunei State (O.U.P., 1964); the present similarly precedes a forthcoming supplement to the Brunei Manual to include additional information on the same species, and all further species, that occur in Sarawak. Furthermore, since the Brunei manual was sent for publication, more complete material has been obtained of several taxa there referred to separate and undescribed taxa.

This paper is the last in the present series to be devoted solely to problems in Bornean Dipterocarpaceae. Subsequent papers in this series will directly relate to an eventual revision of the family for Flora Malesiana.

This work has been greatly assisted both by the inspiring leadership and continued encouragement of B. E. Smythies, Conservator of Forests in Sarawak during the initial stages of this work, and by Dr. J. A. R. Anderson, who has given invaluable guidance throughout.

The plates are the work of Mr. Ahmad Akip, a promising young artist at present attached to the Sarawak Forest Department.

SUMMARY

Anisoptera Korth., sect. *Anisopterae*: *A. reticulata* Ashton is described.

Dipterocarpus Gaertn.f.: *D. cuspidatus* Ashton is described.

Dryobalanops Gaertn. f.: *D. abnormis* Sloot. is reduced to synonymy with *D. oblongifolius* Dyer.

Vatica L.: *Retinodendropis aspera* Heim is reduced to *V. sarawakensis* Heim.

The Bornean species previously referred to *V. odorata* Griff. is now identified as *V. mindanensis* Foxw., which is considered to be a subspecies of *V. odorata*. *V. aerea* Sloot. is reduced to the same subspecies.

5 subspecies are recognised in *V. oblongifolia* Hook. f.

7 new species are described: *V. badiifolia*, *V. brunigi*, *V. compressa*, *V. congesta*, *V. globosa*, *V. rotata*, and *V. rynchocarpa*.

Hopea Roxb.: *H. laxa* Sym. is reduced to *H. pachycarpa* (Heim) Sym.

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12 species are described: *H. andersoni* with subspecies, *H. depressinerva*, and *H. megacarpa* in sect. *Hopeae*, subject. *Hopeae*; *H. aequalis*, *H. bullatifolia*, *H. centipeda*, *H. enicosanthoides*, *H. pterygota* and *H. tenuinervula* in subsect. *Pierreae* (Heim) Ashton; *H. altocollina*, *H. kerangasensis* and *H. longirostrata* in sect. *Dryobalanoides* (Miq.), subsect. *Dryobalanoides*; and *H. mesuoides* in subject. *Sphaerocarphae* (Heim) Ashton.

Shorea Roxb. ex Gaertn. f.: Two new subsections are described: *Polyandrae* in sect. *Richetioides* Heim, and *Sagittatae* in sect. *Muticae* Brandis.

S. meadiana Synr. is reduced to *scrobiculata* Burck.

2 subspecies are recognised in *S. agami* Ashton.

S. grandiflora Brandis is recognised as a subspecies of *S. hemsleyana* King.

S. leptoclados Sym. is reduced to *S. johorensis* Foxw.

S. rugosa Heim var *uliginosa* (Foxw.) Sym. is reinstated as a species.

17 new species are described: *S. brunnescens* and *S. lunduensis* in sect. *Shoreae*, subsect. *Shoreae*: *S. cordata* in sect. *Anthoshoreae*; Pierre; *S. alutacea*, *S. bakoensis*, *S. cuspidata*, *S. iliasii*, *S. macrobalanos*, and *S. mujongensis* in sect. *Richetioides* Heim subsect. *Richetioides*; *S. polyandra* in subsect. *Polyandrae*; *S. praestans* and *S. rotundifolia* in sect. *Pachycarpae* Heim; *S. pubistyla* and *S. carapae* in sect. *Brachypterae* Heim Brandis subsect. *Brachypterae*; *S. foraminigera* and *S. pallidifolia* in sect. *Muticae* subsect. *Muticae*; and *S. sagittatae* in subsect. *Sagittatae*.

ANISOPTERA

Anisoptera reticulata Ashton sp. nov

Plate 1.

Species floribus ut in sectione sed foliis ramulisque glabris intercostis subreticulatis.

Foliae ramulique glabri. Ramuli apices versus c. 2 mm. diam. teretes ruguli fuscii; internodis 1.5 cm. longis; cicatricibus stipularibus brevibus horizontalibus. Gemmae 2 × 2 mm. ovoideae subacutae. Stipulae ignotae. Lamina 4.5–13 × 2.2–5.5 cm. elliptico-obovata coriacea basim versus late cuneata, apice in acumen 5 mm. longum breve abrupte terminata; costis lateralibus utrinsecus 9–14 curvatis subtus prominentibus angulo 60–65° exorientibus; intercostis subreticulatis; costa media supra applanata vel subdepressa subtus prominente. Petiolus 15–35 mm. longus, c. 2 mm. diam. teres prominente geniculatus apicem versus tumescens, in sicco niger. Racemi 6 cm. longi, terminales vel axillares breves teretes plus minus persistente aureo-pubescentes stipitis basi in fructu 3 mm. diam. semel ramosi. Alabastrum 8 × 3 mm. fusiforme. Lobi calycis anguste deltoidei inaequales valvati. Petala lorata crema partibus in alabastris expositis pubescentibus. Stamina c. 35 subaequalia, filamentis brevibus compressis antheris oblongis attenuatis aristis filiformibus. Stylopodium oblongum obtusum pubescente. Pedicellus in fructu 4 mm. longus 3 mm. diam. crassus prominens. Calyx in fructu sparsim caduce aureopubescentis, tubo 2 cm. diam. subgloboso; lobis longioribus 2, 13 × 3 cm. lorato-spatulatis obtusis basim versus 9 mm. latis attenuatis; lobis brevioribus 3, 20 × 3 mm. lineare-lanceolatis acutis. Nux apicem versus conferte persistente alutaceo-pubescentis stylopodio 4 mm. longo 3 mm. diam. oblongo obtuso pubescenti coronata.

Collections.—Sabah: SAN. 12864 (Wood) SAN. 15172 (Wood) (Holotypus in Herb. Kew) Ulu Sipitang; Brunei: Hotta 12988, Bt. Teraja; Sarawak: S. 1503 (Drahman) Lawas.

This distinctive species resembles *A. marginata* Korth. of the swamps but differs however in the c. 35, not c. 25, stamens, larger fruits, fewer nerves, subreticulate intercostals, and lustrous entirely glabrous thickly coriaceous lamina. It appears to be rare and found in Mixed Dipterocarp forest on leached yellow sandy soils.

DIPTEROCARPUS

Dipterocarpus cuspidatus Ashton sp. nov.

Plate 2.

D. eurhynchi Miq. affinis sed petiole longiore lamina cuspidata alis tubi nucis latioribus differt.

Gemma conferte persistente longe alutaceo-tomentosa; stipulae externe (intus glabrae) ramuli petioli costa media supra nervi laminarum subtus sparsim longe subpersistente fusco-tomentosi. Ramuli apices versus c. 1 mm. diam. graciles teretes multo ramosi griseo-brunnei; internodis -2 cm. longis, cicatricibus stipularibus gracilibus obscuris. Gemmae -7×3 mm. oblongae. Stipulae -18×5 mm. lineares caducae. Lamina 6-11×2-4 cm. anguste elliptico-ovata applanata in statu expanso vix plicata; basi acuta vel rare cuneata; apice in acumen -2 cm. longum gracile prominente cuspidatum attenuata; costis lateralibus utrinsecus 8-9 gracilibus sed subtus prominentibus angulo 35-45° exorientibus; intercostis conferte scalariformibus; costa media gracili subtus prominenti. Petiolus 12-18 mm. longus c. 1 mm. diam. gracilis geniculatus apicem versus tumescens. Flores ignoti. Racemi -5 cm. longi stipitis basi in fructu c. 2 mm. diam. terminales vel axilares teretes graciles sparsim persistente longi fusco-tomentosi semel ramosi. Pedicellus in fructu -5 mm. longus c. 2 mm. diam. prominens. Calyx in fructu glaber; lobis longioribus 2, -8×1.8 cm. spatulatis obtusis vel subacutis basim versus 4-6 mm. latis attenuatis; lobis brevioribus 3, -9×4 mm. oblongis obtusis subrevolutis; tubo -2 cm. longo -1.8 cm. diam. alis prominentibus 5 chartaceis subundulatis basim versus attenuatis sed apicibus -9 mm. latis subauriculatis. Nux -3×1.6 cm. ovoidea supra tubum maxime extrusa.

Collections.—Sarawak: S. 15138 (Ilias Paie), S. 22061, 22064 (Ashton) Segan F. R.; S. 22058 (Ashton) Ulu Segan; S. 15821 (Ilias Paie) Labang F. R., Bintulu (Holotypus in Herb. Kew).

The leaves of this species resemble in shape the sapling leaves of *D. eurhynchus* Miq., thus differing from the leaves of the type specimen of that species only in their smaller average size. The relatively longer petiole and cuspidate acumen serve to distinguish this species at once from mature *D. eurhynchus*, with which it certainly appears to be closely allied, as well as the fruit with its broader, distally subauriculate, aliform processes on the tube. The species appears to be a local endemic of central northern Sarawak, where it is found on low hills in Mixed Dipterocarp forest on arenaceous soils.

DRYOBALANOPS

The identity of *Dryobalanops abnormis* Sloot.

Dryobalanops oblongifolia Dyer (J. Bot. 12 (1874) 100) was originally based on two collections, Beccari 2533 from G. Matang, Sarawak, and Beccari 3734 from Bintulu; the latter was later cited as type of *D. kayanensis* Becc., a synonym of *D. lanceolata*, so that Beccari 2533 becomes lectotype. Brandis (J. Linn. Soc. Bot. 31 (1895) 51) first described the fruits, from Beccari 2993, also from Matang.

In his revision of the genus *Dryobalanops* Van Slooten (Bull. Jard. Bot. Btzig. 12 (1932) 22) correctly reduced *Baillonodendron malayanum* Heim (Bull. Soc. Linn. Paris, 2 (1891) 867) and *Dryobalanops beccariana* Ridl. (Fl. Mal. Pen. I (1922) 211) to *D. oblongifolius* Dyer. Nevertheless his description of *D. oblongifolius* fruit is clearly based on Malayan and Sumatran material, and his illustration shows Malayan fruit, and leaves that in their shape and their revolute bases appear characteristic of *D. lanceolata* Burck and not of this species.

Van Slooten founded *D. abnormis* (Bull. Jard. Bot. Btzig. 16 (1940) 449) on 9 numbers from West and South Indonesian Borneo, two of which, bb. 29641 and 30213, from near Tjatit, Melawi, Kapuas, bear fruit; I choose the latter (at BO) as lectotype. He states that *D. abnormis* differs from *D. oblongifolius* 'among other characters ... by its larger rigid leaves, its lenticellate and differently shaped calyx tubes, and its nuts, which are lenticellose and smooth'; elsewhere he states that the calyx tube is constricted medially and longer in *D. abnormis* than in *D. oblongifolius*: furthermore the sepals in *D. abnormis* are deltoid and prominent, whereas in *D. oblongifolius* they are reduced almost to an undulating ring. Though these comparisons are, with the exception of the length and construction of the calyx tube which depends on the ripeness of the fruit, valid between *D. abnormis* and Malayan material of *D. oblongifolius*, the Beccari type and his fruiting collection collected nearby match *D. abnormis*, so that *D. abnormis* must be considered a synonym.

The lamina dimensions quoted by Van Slooten under the two names overlap and those quoted for Bornean *D. abnormis* are well within the range of Malayan and Sumatran *D. oblongifolius* specimens now at my disposal. I do not on present evidence consider that the Malayan and Sumatran specimens represents a separate taxon.

VATICA

The identity of *Retinodendropsis* Heim.

This genus was described (Compt. Rend. Ass. Franc. Pau 1892 (1893) 470) from a single number, Lowe s.n., consisting of two shoots bearing somewhat fragmentary leafy twigs, inflorescences, and part of a fruit, in the Kew herbarium; the single species, *R. aspera* Heim, was published in the same paper.

Heim described the anatomy of the parts available to him in considerable detail. He concluded that the material represented a dipterocarp, whose fruit recalled those of the genus *Retinodendron* Korth. (synonymous with the type section of *Vatica*, see Ashton, Gard. Bull. Sing. 20 (1963) 264), though with a thinner pericarp than usual and with ascending, not reflexed, sepals. He noted that in other characters it resembled his own *Vatica sarawakensis*, founded on Beccari 3018 from Sarawak, which is a flowering collection. Heim, whose generic concepts were extremely narrow (see Ashton, loc. cit.) considered that as the material was inadequate to confirm its position in *Retinodendron* a new genus should be created for it!

The specimen is without doubt one of *V. sarawakensis* Heim bearing immature fruit. In this species the fruit calyx lobes are at first ascending, as in the specimen, and become reflexed as the fruit ripens.

The identity of *Vatica mindanensis* Foxw. and *Vatica aerea* Sloot.

Vatica mindanensis was founded on Elmer 13680 with young fruit, and 13398 and 13359 with flowers from Mr. Urdaneta, Cabadbaran, Agusan Province, Mindanao.

Vatica sorsogonensis was later described from Elmer 16840, from Mt. Bulusan, Irosin, Sorsogon, Luzon and clearly represents a fruiting specimen of the same taxon. The complete material of *V. mindanensis* is found to be identical with *V. odorata* (Griff) Sym. as it occurs in Borneo. Furthermore *V. odorata* in Borneo occurs typically between 350–1,300 m. altitude, as also does *V. mindanensis* in the Philippines.

V. mindanensis differs from the type and other mainland material of *V. odorata* in having a somewhat longer, more or less geniculate, petiole, and lamina drying greyish, not yellow-brown. The ranges in petiole length overlap, and I consider that *V. mindanensis* should be considered as a subspecies of *V. odorata*.

Bornean material has been separately described by Van Slooten under the name *Vatica aerea* (Bull. Jard. Bot. Btzg. 3, 17 (1942) 133) based on bb. 26438 (Budding), a fruiting collection from Tjatit B. Tengkojoeng, Melawi; this decision is based on my examination of the isotype in the Leiden herbarium; the Holotype is at Bogor.

***V. odorata* (Griff.) Sym. ss. *odorata*.**

Petiole 6–18 mm. long, not geniculate; lamina drying yellow-brown.

Type: Griffith s.n., Mergui (K).

Distribution.—Indo-China, Thailand, Peninsular Burma, Malaya, West Borneo.

ssp. *mindanensis* (Foxw.) Ashton., stat. nov.

Lectotype: Elmer 13398, Mt. Urdaneta, Mindanao (K).

V. mindanensis Foxw., Leaf. Philip. Bot. 6 (1913) 1957.

1957.

V. sorsogonensis Foxw., Philip. J. Sc. Bot. 13 (1918) 196.
196.

V. aerea Sloot., Bull. Jard. Bot. Btzig. 3, 17 (1942) 241.

Petiolus 15–20 mm. longus, plus minus geniculatus, lamina delapsa sicco grisea.

Distribution.—Borneo, Philippines.

Intraspecific variation in *V. oblongifolia* Hook. f. Plate 3–7.

Lowe s.n. (K), the fruiting specimen upon which this species is based, is clearly distinguishable from other species in the type section of *Vatica* both by its stout compressed twigs, narrowly oblong-obovate thickly coriaceous leaves (blue-green when fresh), and vinous tomentum. Nevertheless 4 distinct taxa, sharing these characters but each differing in lesser criteria, including the number and appearance of the nerves, length of the petiole, size of lamina and twigs, and size and shape of the fruit sepals, exist. Each of these 4 taxa have a well defined geographical and ecological distribution and I have not seen two sharing a common habitat. In view of their close similarity, however, I prefer on present evidence to regard them as subspecies, though intermediate forms have not as yet been found.

Subspecies *oblongifolia*.—Ramuli c. 4×2 mm. diam. crassi. Lamina $10-31 \times 4.5-10$ cm. obovata vel oblonga basi obtusa acumine brevi lato; costis lateralibus utrinsecus 10–18 subtus prominentibus. Petiolus 2.5–5 cm. longus. Lobi calycis in fructu -3×2 mm. deltoidei acuti.

Collections.—Lowe, s.n. Borneo (Holotypus in herb Kew). Sarawak: S. 21550, 21560 (Ashton) Batu Empar, Santubong; S. 15907 (Brain) Nyabau F.R., S. 9618 (Ariffin) Lundu; S. 9605 (Ariffin) G. Pueh F.R.; S. 8644 (Brunig) Similajau F.R., S. 7980 (Bojeng) G. Gading; S. 12783 (Hj. Bujang) G. Santubong; S. 13145, 13251 (Smythies) S. Bena, Kapit; S. 22293 (Suib) Bt. Raya, Kapit; S. 12816 (Asah) Semengoh F.R.; Kep. 358 (Omar) Bt. Siol; S. 13305 (Ilias) G. Periggi; S. 21371 (Othman) Bt. Lambir. Brunei: Brun. 5683 (Ashton) K. Belalong; Brun. 2625 (Ashton) Andalau F.R.; Kep. 48222 (Wyatt-Smith) Badas-Labi road; Kep. 80112 (Wyatt-Smith) Peradayan F.R. Sabah: SAN. 16424 (Wood and Charrington) Timbang Batu, Kudat; SAN. 16660 (Wood) Ulu Moyah Sipitang; SAN. 23857 (Jad Binting) Pulau Sepanggor, Jesselton; SAN. 32014 (Mikil) Halogilat, Beaufort; SAN. 20702 (Meijer) Bt. Ataidon, Ranau.

Distribution.—Throughout Sarawak to western Sabah. Found on shallow leached loams derived from both granite, sandstone, and shale.

Subspecies *selakoensis* Ashton, ssp. nov. Ramuli c. 2×1 mm. graciles. Lamina $6.5-22 \times 2.5-6.5$ cm. anguste elliptica basi cuneata apice in acumem -1.5 cm. longum angustum attenuata, costis lateralibus utrinsecus 11–18 gracilibus subtus vix elevatis. Petiolus 1.5–2.5 cm. longus. Lobi calycis in fructu -4×3 mm. oblongi obtusi.

Collections.—Sarawak: S. 18466 (Chai), S. 13340 (Ilias) (Holotypus in herb Kew), S. 12619 (Smythies), S. 9639 (Ariffin), Sinclair and Kadim 10387, G. Gading F.R.; S. 13171, 13174 (Smythies) G. Berumput.

Distribution.—Found on shallow leached raw-humus bearing soil above 600 m. alt. on the upper slopes and summits of the granodiorite mountains of W. Sarawak. *Ssp. oblongifolia* and *ssp. multinervosa* occur on the same mountains but at lower altitudes.

Subspecies crassilobata Ashton, *ssp. nov.* Ramuli c. 4×2 mm. crassi. Lamina $11.5-21 \times 4.5-10.5$ cm. late oblonga basi obtusa vel cordata apice in acumen breve latum attenuata; costis lateralibus utrinsecus 16-23 crassi subtus prominentibus. Petiolus 1.8-2.8 cm. longus. Lobi calycis in fructu -15×12 mm. obovati obtusi vel emarginati subrotati.

Collections.—Brunei: Brun. 614 (Holotypus in Herb. Kew), 615 (Ashton), S. 2246, 5601 (Anderson), Andulau F.R.; Brun. 5157 (Ashton) Berakas F.R.; Hotta 13002, Bt. Puan. Sarawak: Fuchs 21371, Bt. Pesu, Ulu Semut, Tubau; s.n. (Anderson) Bt. Gaharu.

Distribution.—Local, in Sarawak and Brunei, on strongly leached very deep pale yellow sandy soils derived from poorly consolidated soft sandstones and clays.

Subspecies multinervosa Ashton *ssp. nov.* Ramuli c. 4×2 mm. crassi. Lamina $14-31 \times 4-8.5$ cm. anguste obovata basi anguste obtusa vel cuneata apice in acumen -1.5 cm. longum gracile attenuata; costis lateralibus utrinsecus 18-27 subtus prominentissime elevatis intercostis prominentibus. Petiolus 1.5-2.5 cm. longus. Lobi calycis in fructu -13×8 mm. oblongi obtusi reflexi.

Collections.—Sarawak: S. 22239, 22240, 22295 (Suib) Bt. Raya, Kapit; S. 17739 (Ashton) Ulu Belaga; S. 12623 (Smythies) G. Gading. Brunei: S. 5786 (Wood, Smythies, Ashton) Bt. Biang. Sabah: SAN. 26077 (Muin Chai) Takun, Lahad Datu; SAN. 18475 (Martyn) Ulu Kelumpang, Tawau; SAN. 26029 (Meijer and Muin Chai) Mt. Silam, Lahad Datu; SAN. 30052 (Aban) Beradaya F.R., Tawau; SAN. 29835 (Muin Chai) Kelumpang, Tawau; SAN. 19713 (Meijer) (Holotypus in herb. Kew), SAN. 22509 (Singh) Sepilok F.R.; SAN. 34083 (Aban) Ayer Panas, Tawau.

Distribution.—Throughout Sarawak, Brunei and Sabah, on relatively fertile clay rich latosolic soils.

Subspecies elliptifolia Ashton *ssp. nov.* Ramuli c. 3×2 mm. Lamina $12-20-3.5-7$ cm. elliptico vel obovata basi late cuneata apice in acumen -1 cm. longum breve attenuata; costis lateralibus utrinsecus 14-16 gracilibus subtus prominentibus. Petiolus 10-14 mm. longus brevis. Lobi calycis in fructu -8×4 mm. oblongi obtusi revoluti.

Collections.—Brunei: Brun. 925 (Ashton) Andulau hills at Bt. Kukub (Holotypus in Herb. Kew). Sarawak: S. 23225 (Sibat) Bt. Iju, Arip, Balingian.

Distribution.—Known only from these two collections from Mixed Dipterocarp forest, the one from leached yellow sands overlying the Seria formation, the other from similar soils on the Arip rhyolite.

***Vatica badiifolia* Ashton.**

Plate 8.

V. bantamensis Sensu Ashton, Man. Dipt. Brun. (1964), 67, non Burck.

V. bantamensis (Hassk.) Burck affinis, sed lamina delapsa in sicco badia costis lateralibus utrinsecus 6–10 costa media supra prominente elevata tomento roseo-brunneo differt.

Ramuli apices versus racemi gemmae stipulae petiolique plus minus conferte caduce pulverulente fulvo-tomentosi. Ramuli apices versus –3 mm. diam. teretes vel costati dein levescentes pallide roseo-brunnescentes; internodis 1.5–2 cm. longis. Gemma –1.5 × 1 mm. ovoidea subacuta. Stipula –5 × 1.5 mm. hastata acuta. Lamina 7.5–15 × 3–6.5 cm. coriacea plus minus elliptica; basi plus minus cuneata, apice in acumen –5 mm. longum deltoideum attenuata; costis lateralibus utrinsecus 9–12 curvatis subtus prominentibus teretibus supra paullum elevatis. Petiolus 2–3.5 cm. longus –3 mm. apicem versus incrassatus geniculatus sicco fulvescens vel nigrescens. Lamina delapsa sicco badius. Racemi –8 cm. longi stipitis basi in fructu –2 mm. diam., terminales vel axillares semel vel bis ramosi. Alabastrum –1.3 cm. longum; calyx conferte breviter cremio-pubescentis; flores aliter ut in *Vaticis* aliis. Pedicellus in fructu –5 mm. longus –1 mm. diam. gracilis. Lobi calycis in fructu caduce badio-tomentosi ad basim liberi; longioribus 2, –8 × 2.5 cm. chartaceis oblongo-spatulatis basi –8 mm. latis constrictis; brevioribus 3, –30 × 8 mm. hastatis acutis basi –4 mm. latis constrictis. Nux –8 × 8 mm. globosa breviter plane badio-pubescentis stylo –2 mm. longo lineari, coronata.

Collections.—Sarawak: S. 15857 (Ilias and Johnson) Similajau, Labang F.R. (Holotypus in herb. Kew); S. 22080 (Ashton) Nyabau reservoir. Brunei: S. 2115, 2120 (Smythies) Bt. Teraja; Kep. 47025 (Smith) 'Brunei'; Kep. 48135 (Flemmich) Balai Rotan; Kep. 39650 (Durant) Labi F.R.

This species, found on yellow sandy loams in Mixed Dipterocarp forest from the Belait valley to the lower Rejang in northern coastal Borneo, bears a close superficial resemblance to *V. bantamensis* (Hassk.) Burck of West Java; the two can be differentiated as follows:

<i>V. badiifolia</i>	<i>V. bantamensis</i>
Lamina drying chestnut-brown.	Lamina drying grey-green.
Nerves 6–10 pairs, stout.	Nerves 8–11 pairs, slender.
Midrib prominently raised above.	Midrib more or less applanate above.
Petiole 2.2–3.5 cm. long.	Petiole 1–2 cm. long.
Tomentum pink-brown.	Tomentum buff.

Vatica brunigi Ashton sp. nov.**Plate 9.**

V. maingayi Dyer affinis sed lamina petiolo ramulisque conferte breviter ochraceo-tomentosa costis lateralibus subtus haud prominentibus differt.

Ramuli apices versus gemmae stipuli lamina subtus petiolique breviter alutaceo-scabrido-tomentosi, lamina supra fugace floccosa tomentosa. Ramuli apices versus c. 2 mm. diam. graciles teretes; internodiis -1.5 cm. longis brevibus. Gemmae -3 × 2 mm. ovoideo-conicae obtusae. Stipulae -5 × 2 mm. loratae obtusae. Lamina 6-12 × 2.5-6.5 cm. ovato-elliptica vel obovata basi cuneata vel obtusa apice in acumen -1 cm. longum attenuata; costis lateralibus utrinsecus 9-12 gracilibus subtus paullum elevatis angulo 65°-80° exorientibus; costa media supra vix elevata subtus prominenti; intercostis scalariformibus supra obscuris subtus paullum elevatis. Petiolus 8-15 mm. longus c. 1.5 mm. diam. Racemi -12 cm. longi, stipitis basi in fructu -2 mm. diam.; teretes vel angulati conferte breviter persistente ochraceo-scabrido-tomentosi terminales vel apices ramulorum versus axillares semel (axillares) vel bis (terminales) ramosi; ramulis -6 cm. longis; flores distichos gerentibus; bracteolis -3 × 1 mm. ellipticis sparsim pubescentibus. Alabastrum -8 × 2 mm. ellipsoideum. Calyx conferte breviter ochraceo-griseo-pubescentis; petala cremia anguste oblonga obtusa externe sparsim pubescentia intus glabra; aristae breves erectae; stylum columellare quam ovarium longiore; flores aliter ut in *Vaticis* aliis. Pedicellus calyxque in fructu sparsim alutaceo-pubescentis, nux scabrido-alutaceo-pubescentis. Pedicellus -3 mm. longus -1 mm. diam., gracilis. Lobi calycis longiores 2, -6.5 × 1.5 cm. lorati vel spathulati obtusi; breviores 3, -15 × 6 mm. ovati acuti paullum recurvati. Nux -9 × 7 mm. ovoidea subacuta.

Collections.—Brunei: S. 1011, 12352 (Brunig) Ulu Ingei. Sarawak: S. 17045 (Ilias Paie) (Holotypus in Herb. Kew) Sabal F.R.; S. 6758, 17451 (Brunig), S. 17885, 17871 (Ilias Paie), S. 17300 (Ilias Paie and Paul Chai) Bako National Park; S. 18389 (Ashton) Tubau; S. 6437, 7132 (Brunig) G. Pueh F.R.; S. 5969 (Brunig) Sempadi F.R.; S. 8256 (Yakup), S. 1484 (Dan) Marudi F.R.; S. 6524 (Yakup) Kampong Mienki, Ulu Sebuyau, Simanggang; S. 8937 (Yakup) Setapok F.R.

At once distinguished by the densely shortly evenly yellowish buff lamina undersurface, this further addition to Section *Sunaptea* (Griff.) Burck is found throughout Sarawak north-eastward to the Belait basin of Brunei. It is named in honour of Dr. E. F. W. O. Brunig, who is contributing so much to our knowledge of the floristics and ecology of Heath forest in Borneo.

This species was not known to me from Brunei when I compiled the Manual of Dipterocarp trees for that State.

Vatica compressa Ashton sp. nov.**Plate 10.**

V. maritimae Sloot. affinis sed ramulo compresso, lamina intercostis remotioribus, petiolo 15-23 mm. longo glabrescenti differt.

Novelli breviter plane pallide roseo-pubescentes stipulae intus exceptae, gemmae stipulaeque externe persistente pubescentes

partes aliter glabri. Ramuli apices versus c. 3×1 mm. compressi pallide fusci leves; internodis -3 cm. longis; cicatricibus stipularibus primo c. 2 mm. longis pallidis horizontalibus vel descensibus prominentibus. Gemmae c. 3×3 mm. ovoideae acutae compressae. Stipulae $-4-1.2$ cm. oblongae obtusae subcaducae. Lamina $11-19 \times 5-8.5$ cm. ovato-elliptica coriacea basi obtusa apice in acumen -1 cm. longum attenuata; costis lateralibus utrinsecus $10-15$ gracilibus subtus paullum elevatis haud prominentibus supra vix elevatis curvatis angulo c. 50° exorientibus, secundariis brevibus obscuris; intercostis scalariformibus; costa media subtus prominenti supra applanata vel elevata. Petiolus $15-23$ mm. longus c. 2 mm. diam. sicco nigrescens. Racemi -7 cm. longi, basim versus $-$ mm. diam. paullum compressi sparsim pallide roseo-brunneo-pubescentes, irregulariter semel vel bis ramosi. Alabastrum -9×4 mm. lanceolatum. Calyx conferte pallide fulvo-pubescentis; corolla cremia partibus in alabastro expositis conferte pubescentibus; flores aliter ut in *Vaticis* aliis. Pedicellus in fructu -8 mm. longus, -1 mm. diam. gracilis pubescens. Calyx in fructu puberulens vel glabrescens; lobis longioribus 2, -6.5×1 cm. loratis plus minus obtusis basim versus c. 3 mm. latis gradatim attenuatis; lobis brevioribus 3, -20×6 mm. deltoideis acutis revolutis. Nux -5 mm. diam. breviter ovoidea conferte breviter alutaceo-pubescentis, stylo -3 mm. longo glabro coronata.

Collections.—Sarawak: SFN. 35618 (Daud and Tachun) Hutan Setapok (Holotypus in herb. Kepong); S. 309 (Mead), SA. 604 (Igon) Mile 6 F.R., Kuching; S. 6101, 5984 (Brunig) Sempadi F.R.; S. 6604 (Brunig) Bako N.P.; S. 13275 (Anderson) S. Klauh, Simangang.

A species which is locally frequent on poorly drained sandy podsols in Heath forest in Sarawak west of the Batang Lupar.

***Vatica congesta* Ashton sp. nov.**

Plate 11.

V. coriaceae Ashton affinis sed petiolo $1.2-2.5$ cm. longo, racemis brevibus fasciculatis conferte congestis differt.

Ramuli apices versus gemmae stipulae petiolique conferte breviter pallide ochraceo-fusco-scabrido-tomentosi, lamina subtus costa media basim versus supra sparsim eadem. Ramuli apices versus c. 3 mm. diam. crassi primo angulati rugosi dein fusciscentes chartaceo-exfoliantes striati; internodis $1-3$ cm. longis. Gemmae -4×3 mm. late ovoideo-conicae acutae. Stipulae -8×3 mm. anguste deltoideae acutae. Lamina $8-22 \times 3.5-8$ cm. oblongo-elliptica vel obovata coriacea, basi obtusa, margine revoluta, apice subacuminato vel obtuso vel retuso; costis lateralibus utrinsecus $7-12$ supra paullum elevatis subtus crassis prominentibus, angulo $40^\circ-55^\circ$ exorientibus; intercostis subtus prominentibus, supra paullum elevatis reticulatis; costa media supra vix elevatis subtus crassa striata prominenti. Petiolus $1.2-2.5$ cm. longus $2-3$ mm. diam. crassus sicco rugescens. Inflorescentiae paniculatae -3 cm. longae, stipitis basi in fructu -2 mm. diam., breves axillares vel breviter ochraceo-scabrido-tomentosae semel ramosae; ramulis -1.8 cm. longis flores distichos gerentibus. Alabastrum -8×3 mm.

Calyx conferte breviter ocharceo-tomentosis, lobis deltoideis acutis in alabastro expansis; petala lorata conferte pubescentia; aristae breves bifurcatae; stylum breve sericeum; flores aliter ut in *Vaticis* aliis. Pedicellus in fructu -4 mm. longus gracilis. Calyx glaber; lobis longioribus 2, -12×2.2 cm. loratis obtusis prominente 3-costatis; lobis brevioribus 3, -4.5×1.5 cm. anguste ovatis attenuatis acutis recurvatis. Nux -12×8 mm. ellipsoidea glaber apice in stylo -6 mm. longo gracili attenuata.

Collections.—Sarawak: S. 9347A (Holotypus in herb. Kew), 9347 (Yakup), S. 15606, 15713 (Galau), S. 15021, 15045, 14936 (Rosli), Sinclair and Kadim 10219, Semengoh F.R.; S. 15148 (Ilias Paie) Segan F.R., Bintulu.

S. 15148 differs from the Semengoh collections in having 7–8, instead of 10–13, pairs of nerves in the lamina, but shares the large fruit calyx and the short ramiflorous inflorescences, by which this species is so clearly distinguished from *V. coriacea* Ashton and *V. teysmanniana* Burck (as well as in other leaf character). I therefore have no hesitation in considering it to represent the same species.

V. congesta has been collected in Mixed Dipterocarp forest on leached yellow soils rich in clay, on low hills.

***Vatica globosa* Ashton sp. nov.**

Plate 12.

Species fructu ut in *V. oblongifolia* Hook. f. sed tomento rufo haud vinoso lamina chartacea subcaudata petiolo brevi ramulo tereti differt.

Ramuli gemmae petiolique persistente rufo-sericei. Ramuli apices versus c. 2 mm. diam. teretes levescentes pallide brunnescentes; internodis -3 cm. longis; cicatricibus stipularibus brevibus horizontalibus obscuris. Gemmae 2×2 mm. ovoideae acutae. Stipulae ignotae. Lamina $7-18 \times 3-6.5$ cm. obovata subchartacea, basi anguste cuneata, apice in acumen -2 cm. longum cuspidatum attenuata; costis lateralibus utrinsecus 13–16 gracilibus subtus prominentibus supra elevatis angulo $35^\circ-60^\circ$ exorientibus, secundaris multis brevibus; intercostis gracilibus reticulatis; costa media supra subtusque prominenti. Petiolus $7-15$ mm. longus c. 2 mm. diam. supra sulcatus. Racemi -3 cm. longi, stipitis basi in fructu -1 mm. diam. terminales vel -3 axillares congesti costati vel teretes persistente rufo-sericei plus minus semel ramosi; bracteolis fugacis. Alabastrum -5×2 mm. lanceolatum; calyx externe conferte rufo-pubescentis intus glaber; corolla cremia partibus in alabastro expositis rufo-pubescentibus; aristae conicae quam antheras $\frac{1}{2}$ -plo longioribus; flores aliter ut in *Vaticis* aliis. Fructus omnibus partibus persistente rufo-sericei. Pedicellus in fructu -2 mm. longus c. 2 mm. diam. Lobi calycis -4×3 mm. aequales oblongi obtusi reflexi. Nux -20 mm. diam. globosi obtusi suturis 3.

Collections.—Sarawak: S. 18091 (Ashton) Ulu Stirau, Labang (Holotypus in herb. Kew); S. 14485 (Brain) Nyabau F.R.; Haviland and Hose 3159, Niah; Haviland and Hose 3148, near Kuching; S. 23751 (Jugah) Bt. Iju, Arip.

This species differs from *V. oblongifolia* Hook. f. both in the rufous, not vinous tomentum, the terete twigs, and the texturally thinner lamina with subcaudate acumen and short petiole. Apart from the single record Haviland and Hose 3148 it is known only from central Sarawak between the Kemena and Niah drainages, where it is locally frequent in Mixed Dipterocarp forest.

***Vatica rotata* Ashton sp. nov.**

Plate 13.

V. dulitensis Sym. affinis sed lamina late elliptica costis lateralibus utrinsecus 9–11 vix elevatis intercostis conferte reticulatis petiolo 8–12 mm. longo differt.

Ramuli gemmae petioli costa media subtus persistente conferte vinoso-sericei. Ramuli apices versus c. 1 mm. diam. graciles multum ramosi teretes griseo-fuscescentes leves. Gemmae c. 2 × 1 mm. ovoideae subacutae. Stipulae ignotae fugaces. Lamina 5.5–10 × 3–5 cm. late elliptica vel ovata coriacea, basi obtusa, apice in acumen –8 mm. longum attenuata; costis lateralibus utrinsecus 9–11 curvatis vix elevatis angulo 65°–80° exorientibus; intercostis gracilibus conferte reticulatis; costa media supra obscura depressa basi excepta subtus prominentibus. Petiolus 8–12 mm. longus c. 1 mm. diam. gracilis. Flores ignoti. Fructus racemique omnibus partibus persistente plane vinoso-sericei. Racemi –1.5 cm. longi, stipitis basi in fructu c. 1 mm. diam., terminales vel axillares graciles teretes semel ramosi. Pedicellus in fructu –9 mm. longus c. 1 mm. diam. longus gracilis. Lobi calycis in fructu –7 × 4 mm. aequales suborbiculares revoluti rotati. Nux c. 4 mm. diam. subglobosa obtusa suturis 3 obscuris.

Collection.—Sarawak: S. 19594 (Ashton) Ulu Kenyana, Mukah (Holotypus in herb. Kew).

A member of the type section. Though only known from this single collection this species, whose fruit is very similar to that of *V. vinosa* Ashton and *V. dulitensis* Sym., but whose leaf recalls that of *V. borneensis* Burck in sect. *Sunapteae*, is quite distinct from other described species. It was collected in Heath forest.

***Vatica rynchocarpa* Ashton sp. nov**

Plate 14.

Lamina ut in *V. venulosam* Bl. sed costis lateralibus utrinsecus 10–14 vix elevatis lobi calycis in fructu inaequales longiores 2 ascendentes spatulati.

Ramuli apices versus racemi gemmae stipulae petiolique breviter sparsim griseo-puberulentes, dein glabrescentes. Ramuli apices versus –1 mm. diam. graciles teretes dein levescentes pallide griseo-brunnescentes; internodis –8 mm. longis brevibus. Gemma –1.5 × 1 mm. conica subacuta. Stipula –2.5 mm. longa anguste hastata acuta fugax. Lamina 5–8.5 × 1.3–2.5 cm. anguste elliptica vel lanceolata chartacea; basi obtusa apice in acumen –1 cm. longum angustum attenuata; costis lateralibus utrinsecus 10–14 gracilibus marginem versus curvatis subtus vix elevatis angulo 75°–85° exorientibus remotis, nervis secundariis brevibus; costa media gracili subtus elevata supra paullum depressa. Petiolus –4 mm. longus –1 mm. diam. brevis gracilis sicco nigrescens. Flores

ignoti. Racemi -3 cm. longi stipitis basi in fructu -1 mm. diam. terminales vel axillares semel ramosi pallide brunneo-pubescentes. Pedicellus in fructu -7 mm. longus -1 mm. diam. gracilis. Calyx in fructu glaber, lobis basi liberis, longioribus 2, -6.2×1.4 cm. chartaceis spathulatis angustis obtusis basim versus -2.5 mm. latis gradatim attenuatis; brevioribus 3, -15×2.5 mm. hastatis acutis. Nux -18×8 mm. ovoidea glaber stylo -4 mm. longo lineare

Collections.—Sarawak: SA. 514 (Egon) N. Temulan, Rejang (Holotypus in herb. Kepong); S. 16568 (Ashton) Ulu Sinrok, Simalajau F.R.; S. 22047 (Ashton) N. Sepulau, Segan; S. 12107 (Ashton) N. Amau, Mujong. Brunei: Brun. 3354, Ulu Senuko.

This well-defined species is now fairly well known, and is locally common along river banks in Sarawak North-East of the Rejang.

HOPEA

The identity of *Hopea laxa* Sym.

This species, based on Richards 2361, with flowers, from G. Dulit (Holotype at Kew) was described by Symington (Gard. Bull. S. S. 8 (1934) 33) at a time when only the type of *Hopea pachycarpa* (Heim) Sym., Haviland 2730 with fruit, and one other, at that time unidentified, specimen (S. 512, Merit, Sarawak) has been collected. The type of the latter has, on the evidence of material at present available, smaller leaves with fewer nerves than the average for the species, while in Richards 2361 the reverse is true. There is no doubt, however, that the two are conspecific, Heim's name being the older.

Hopea aequalis Ashton sp. nov.

Plate 15.

H. nervosae King affinis, sed lamina basi obtusa costis lateralibus utrinsecus 16-20, lobi calycis in fructu breves subaequales differt.

Costa media supra puberulens, partes aliter glabrae. Ramuli apices versus c. 2 mm. diam. teretes leves pallide fuscii internodiis -4 cm. longis; cicatricibus stipularibus brevibus horizontalibus obscuris. Gemma c. 2×1 mm. ellipsoidea obtusa. Stipulae ignotae. Lamina 13-25×5.5-8 cm. lanceolata chartacea basim versus obtusa apice in acumen -1 cm. longum attenuata; costis lateralibus utrinsecus 16-20 gracilibus subtus prominentibus angulo 65°-70° exorientibus; intercostis conferte scalariformibus gracillimis a nervis diagonale exorientibus; costa media supra subdepressa subtus prominenti gracili. Petiolus 15-18 mm. longus c. 2 mm. diam. sicco niger. Flores ignoti. Racemi -9 cm. longi, stipitis basi in fructu c. 1 mm. diam., axillares teretes glabri non vel semel ramosi. fructu c. 1 mm. diam., axillares teretes glabri haud vel semel ramosi. ovati subacuti saccati incrassati. Nux -23×15 mm. ovoidea acuta saepe resinifera.

Collection.—Sarawak: S. 15881 (Ilias Paie) Nyabau F.R. (Holotypus in Herb. Kew). Sabah: SAN. 38797 (Meijer) Mile 80½, Labuk Road trace, Sandakan.

Though founded on but two collections the fruit and leaf characters of this species are sufficiently striking to distinguish it at once from its nearest allies, which appear to be *H. nervosa* King and *H. sublancoolata* Sym.

***Hopea altocollina* Ashton sp. nov.**

Plate 16.

H. mengerawan Miq. affinis, sed lamina breviori lanceolata prominente revoluta acumine caudato differt.

Omnes partes glabrae. Ramuli apices versus c. 2 mm. diam. teretes fusci lenticellis parvis pallidis punctati; internodis –2 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma –1×1 mm. subglobosa parva. Stipulae ignotae. Lamina 7–10×3–4.5 cm. lanceolata prominente revoluta basim versus obtusa apice in acumen –1 cm. longum caudatum attenuata; costis 'dryoblanoidis', costis lateralibus utrinsecus c. 16 obscuris; costis secundariis brevibus; costa media gracili supra subtusque vix elevata. Petiolus 10–13 mm. longus c. 1 mm. diam. subgeniculatus apicem versus subtumescens gracilis sicco niger. Flores ignoti. Racemi –4 cm. longi, stipitis basi in fructu c. 1 mm. diam. terminales vel –2 axillares teretes glabri semel ramosi. Fructus glaber. Pedicellus in fructu –2 mm. longus –1 mm. diam. Lobi calycis in fructu longiores 2, –4.5×0.8 cm. spatulati obtusi basim versus –3 mm. lati attenuati, partibus basalibus –6×3 mm. anguste ovatis incrassatis saccatis; breviores 3, –4×4 mm. suborbiculares obtusi. Nux –7×5 mm. ovoidea apice in stylo –2 mm. longo gracili attenuata.

Collections.—Sarawak; Brun. 1030 (Ashton) Bt. Antu, Ulu Sembayang, Limbang (Holotypus in Herb. Kew); S. 22461 (Sibat) Bt. Mersing, Anap; S. 19618 (Ashton) Carapa Pila, Ulu Mujong; S. 21267 (Ashton) base of Batu Kapal, Mujong; S. 22705, 22706, 22714 (Murthy and Ashton) G. Dulit.

The attenuate apex of the enut suggests that these floral ovary lacks a stylopodium. This species most resembles *H. mengerawan* Miq. of E. Borneo, Sumatra, and Malaya; it differs however in the powdery flaky not ruggedly fissured bark surface, and in the revolute margin of the relatively shorter lamina with its caudate acumen.

H. altocollina is confined to clay rich soils at these altitudinal limits of the Mixed Dipterocarp forests, and has been observed at between 900–1,400 m. It is sometimes an enormous tree, –60 m. tall, –4 m. girth and with tall convex thin spreading plank buttresses.

***Hopea andersoni* Ashton sp. nov.**

Plate 17.

H. sangal Korth. affinis sed staminibus 15 lamina lanceolato-falcata inaequalis glabra, costis lateralibus remotioribus subtus minus prominentibus differt.

Foliae ramulique glabri. Ramuli apices versus c. 1 mm. diam. teretes leves fusci; internodis –3 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma –1×1 mm. subglobosa. Stipulae ignotae. Lamina 5–14×2–6 cm. lanceolato-falcata vel elliptica coriacea.

basim versus adaxiale obtusa abaxiale cuneata inaequalis, apice in acumen -2 cm. longum gracile saepe falcatum attenuata; costis lateralibus utrinsecus 9-12 gracilibus subtus vix elevatis curvatis angulo 65° - 75° exorientibus saepe domatiis prominentibus pustularibus axillaribus; intercostis scalariformibus; costa media supra vix elevata subtus prominenti. Petiolus 5-10 mm. longus c. 2 mm. diam. sicco niger. Racemi -12 cm. longi, stipitis basi in fructu-1 mm. diam., terminales vel axillares teretes saepe fasciculati conferte plane plus minus persistente pallide griseo-puberulentes; semel ramosi flores -9 secundis gerentibus; bracteolis -2 mm. longis linearibus puberulentibus fugacis. Alabastrum -3×2 mm. ellipsoideum. Calyx lobis ovatis acutis subaequalibus externe conferte pubescentibus intus sparsius eisdem. Petala lanceolata partibus in alabastro expositis conferte pubescentibus. Stamina 15 verticillis 3 inaequalibus; filamentis basim versus compressis attenuatis apicem versus filiformibus; antheris late ellipsoideis; aristis gracilibus quam antheras 2-2½-plo longioribus. Ovarium stylopodiumque cylindricum conferte papillosum puberulente, parte media subconstricta, stylopodium quam ovarium paullum angustiore; stylo brevi columellari. Pedicellus in fructu -3 mm. longus c. 1 mm. diam. gracilis. Calyx in fructu basim versus puberulens aliter glabrescens; lobis longioribus 2, -6×2 cm. oblongis obtusis basim versus 3 mm. latis attenuatis; partibus basalibus -4×3 mm. ellipticis subincrassatis saccatis; lobis brevioribus 3, -4×3 mm. ovatis obtusis saccatis. Nux -8×5 mm. ovoidea glabra stylopodio parvo truncato styloque c. 1 mm. longo mucronata coronata.

Holotypus: S. 11096 (Anderson) Kuching road, Bau (in Herb. Kew).

Two subspecies are recognised:—

Subsp. andersoni subsp. nov.

Lamina delapsa in sicco rufescens. Cortex nigrescens altis fissis.

Collections.—Sarawak: S. 12238 (Anderson), S. 10038 (Zen), Seburan, Bau; S. 11096, 4639 (Anderson) G. Benarat, Baram; S. 10334, 10352, 10353 (Brunig) Bt. Serapah, Serian road; S. 22865, 22876 (Chai and Lee) Bt. Tabai, Bau; S. 16182 (Chai and Lee) Bt. Kolong, Bau.

Subsp. basalticola subsp. nov.

Lamina delapsa in sicco rava. Cortex fulvescens tenue exfolians.

Collections.—Sabah: SAN. 28649 (Meijer and Baker) Ulu Balong, Tawau; SAN. 23278 (Meijer and Lampangi) Bt. Tingka, Kinabatangan. Sarawak: S. 25005 (Holotypus in Herb. Kew), S. 25040 (Sibat) Bt. Mersing, Anap; S. 23481 (Othman and Suib) Long Kelaby, Ulu Dapoi, Tinjar; S. 22736 (Murthy and Ashton) G. Dulit.

This species is named after Dr. J. A. R. Anderson, in honour of his work on the peat swamp and limestone vegetation of Borneo.

The two subspecies, though only recognisable with experience in the herbarium, are very distinctive in the field owing to their characteristic bark configurations. The type subspecies is an obligatory calcicole, whereas ssp. *basalticola* appears to be confined to basic intrusive rocks and calcareous shales.

Hopea bullatifolia Ashton sp. nov.

Plate 18.

Hic species sect. *typici* subsect. *Pierreae* sedis; lamina bullata subtus badio-pubescenti facile distinguitur.

Gemma stipulae externe (intus glaber) petiolus costa media subtusque conferte persistente plane badio-pubescentis; lamina costaeque laterales subtus costa media supra sparsim eidem. Ramuli apices versus c. 2 mm. diam. teretes dein leves pallide fusci; internodis 3 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma -1×1 mm. parva subglobosa. Stipulae 4 mm. lineares caducae. Lamina $16-34 \times 4.5-9$ cm. oblonga inter costas prominente bullata, basim versus cordata subaequalis, apice in acumen 1 cm. longum gracile gradatim attenuata; costis lateralibus utrinsecus 17-26 crassis subtus prominentibus supra depressis angulo $35^\circ-45^\circ$ exorientibus basi excepta prope marginem saepe conjunctis; intercostis scalariformibus subtus prominentibus supra depressis; costa media subtus supraque prominente. Petiolus 3-6 cm. longus 2-5 mm. diam. brevis crassus. Flores racemique ignoti. Fructus glaber. Lobi longiores calycis in fructu 8×1.5 cm. spatulati obtusi basim versus 4 mm. lati attenuati, partibus basalibus 8×3 mm. ovatis incrassatis saccatis; lobi breviores 3, 15 mm. longi lanceolati graciles basim versus ut in lobilongiores, nucem obscurantes. Nux c. 10×7 mm. ovoidea apiculata.

Collections.—Sarawak: S. 522 (Mashor) S. Danaw, Rejang (Holotypus in herb. Kew); S. 17730 (Ashton) Ulu Belaga.

A small smooth-barked tree, endemic to Central Sarawak where it is found in scattered groups in the understory of Mixed Dipterocarp forest. It most resembles *H. enicosanthoides* (also described in this paper) but differs in the somewhat smaller leaf with pubescent undersurface and petiole, bullate between the intercostals, drying dark chocolate-brown not pale rust-brown.

Hopea centipeda Ashton sp. nov.

Plate 19.

—*H. acuminata* (non Merr.) Ashton, Man. Dipt. Brun. (1964) 94.

—*H. acuminatae* Merr. similis, sed ovario stylopodioque pyriformi, costis lateralibus lamina domatiis pubescentibus ornatis differt.

Ramuli apices versus gemmae stipulae petiolus et costis lateralibus subtus plus minus conferte breviter brunneo-tomentosi. Ramuli apices versus 1 mm. diam. horizontale ramosi dein griseo-brunnescentes levescentis glabrescentis lenticellis cremiis parvis orbicularibus punctati; internodis 1-1.5 cm. longi. Gemma 1.5 mm. longa subglobosa. Stipula 3 mm. longa linearis. Lamina $5.5-9 \times 1.5-3.5$ cm. lanceolata basi inaequali cuneata apice in

acumen -1.5 cm. longum caudatum attenuata; costis lateralibus utrinsecus 7-9 subtus prominentibus paullum curvatis angulo 30° - 40° exorientibus domatiis axillaribus pilosis prominentibus; intercostis gracilibus subscalariformibus; costa media subtus prominenti tereta supra angusta depressa. Petiolus 4-7 mm. longus -1 mm. diam. gracilis. Racemi -4 cm. longi, stipitis basi in fructu -0.5 mm. diam. axillares semel ramosi puberulentes. Alabastrum -6 \times 2 mm. lanceolatum. Calyx sparisim pubescens, lobis ovatis acutis externis 2 quam interni 3 paullum longioribus. Petala cremia basim versus roseo-suffusa. Stamina 15, verticillis 3 inaequalibus; aristis quam antheras subglobosis c. 3-plo longioribus. Ovarium stylopodiumque pyriforme glabro; stylo stylopodium aequanti. Pedicellus in fructu -1 mm. longus. Calyx in fructu glabrescens, lobis longioribus 2, -2.8 \times 0.6 cm. spatulatis obtusis basim versus -1.5 mm. latis attenuatis partibus basalibus -2.5 \times 2 mm.; brevioribus 3, -4 mm. longis, basim versus ut in lobis longioribus. Nux -4 \times 3 mm. ovoidea glabra apice acuta.

Collections.—Brunei: S. 5750 (Wood, Smythies, Ashton) K. Belalong; Brun 726 (Ashton) K. Sekurop, Temburong. Sarawak: S. 18440 (Ashton) Ulu Tubau, Bintulu; S. 12111 (Ashton) N. Amau, Mujong; S. 19645 (Ashton) N. Sebatang, Mujong; S. 23012, 23011, 23010 (Othman), S. 22682, 22653, 22654, 22655, 23342 (Holotypus in herb. Kew) (Murthy and Ashton) Ulu Dapoi, Tinjar.

I had previously compared this species, owing to its obvious leaf similarities, with *H. acuminata* Merr. of the Philippines. The latter, however, is hard wooded, with flaky bark, only 10 stamens, and a truncate stylopodium.

Hopea depressinerva Ashton sp. nov.

Plate 20.

H. sangal Korth. affinis sed lamina coriaceori costis lateralibus utrinsecus 5-8 sine domatiis differt.

Novelli glabrescentes. Ramuli apices versus 1-2 mm. diam. teretes leves rufo-brunnei; internodis -3 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma -1 \times 1 mm. minuta. Stipula ignota. Lamina 5-13 \times 2-5 cm. lanceolata vel anguste elliptica coriacea basi cuneata apice in acumen -1.5 cm. longum gracile attenuata; costis lateralibus utrinsecus 6-8 subtus gracilibus elevatis supra paullum depressa, angulo 40° - 50° exorientibus; intercostis gracilibus scalariformibus. Petiolus 11-13 mm. longus c. 1 mm. diam. teres sicco nigrescens. Racemi -7 cm. longi stipitis basi -1 mm. diam. teretes terminales vel axillares conferte persistente alutaceo-pubescentes; semel ramosi ramulis -1.5 cm. longis flores -5 secundos gerentibus; bracteolis fugacis ignotis. Alabastrum -3 \times 2 mm. ellipsoideum. Calyx conferte alutaceo-sericea lobis ovatis acutis, externis 2 quam internis 3 paullum longioribus angustioribus. Petala externe rosea, intus flavo-rubra elliptica obtusa partibus in alabastro expositis conferte pubescentibus. Stamina 10 aequalia; aristis quam antheras c. 2-plo longioribus

filiformibus gracilibus. Ovarium stylopodiumque glabrum cylindricum truncatum stylo brevi coronatum. Fructus maturus ignotus; lobis calycis inaequalibus ut in flores.

Collections.—Sarawak: S. 15439 (Holotypus in herb. Kew), 15516 (Anderson), Bt. Gebong, Lundu; S. 395 (Ariffin) G. Pueh F.R.

This taxon is undoubtedly closely allied to *H. sangal* Korth., but the appearance of the leaf is quite distinct, in many ways recalling that of immature *Shorea maxwelliana* King.

Hopea enicosanthoides Ashton sp. nov.

Plate 21.

H. polyalthioides Sym. affinis, sed lamina maiori costis lateralibus utrinsecus 16–30 intercostis conferte scalariformibus differt.

Ramuli gemmae stipulae costa media supra basim versus petiolusque caduce pallide badio-pubescentes vel glabri. Ramuli c. 3 mm. diam. teretes vel subcompressi leves dein fusci sub cicatricibus petiolorum prominente costati; internodis –5 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma –2×1 mm. conica acuta. Stipula –8 mm. longa linearis subpersistens. Lamina (16) 27–46 × (5) 8–15 cm. maxima oblonga coriacea facie superiore inter costis lateralibus prominente convexa, basim versus inaequalis cordata, apice in acumen –2.5 cm. longum angustum attenuata; costis lateralibus utrinsecus 16–30 gracilibus subtus prominentibus supra depressis angulo 45°–50° exorientibus; costa media gracili supra elevata subtus crassa prominenti; intercostis conferte scalariformibus gracilimis. Petiolus 5–8 mm. longus c. 3 mm. diam. glaber. Racemi –12 cm. longi stipitis basi in fructu c. 1 mm. diam. brevis crassus sicco niger. Flores ignoti. Racemus fructusque –2 axillares saepe ramiflori teretes laxi semel ramosi; ramulis –3 cm. longi ascendentibus –5 flores gerentibus; bracteolis c. 2 mm. longis linearibus subpersistentibus. Peticellus in fructu c. 1 mm. longus, brevis. Lobi calycis in fructu longiores 2, –13 × 3 cm. plus minus late spatulati obtusi basim versus –6 mm. latus attenuati, partibus basalibus –12 × 10 mm. ovatis saccatis; lobi breviores 2, –2 mm. longi lanceolati acuti, partibus basalibus saccatis vix incrassatis, nucem obscurantibus. Nux –10 × 6 mm. ovoidea stylopodio –2 mm. longo filiformi attenuata.

Collections.—Sarawak: S. 18116 (Ashton) Ulu Labang, Bintulu (Holotypus in herb. Kew); S. 18304 (Ashton) Ulu Sinrok, Similajau F.R.; S. 13200 (Symthies) S. Bena, Baleh; S. 1467, 1470 (Esmit) Miri; s.n. (Anderson) S. Sebakai, Bintulu.

This species, which appears to be widespread though local on alluvium along slow moving non-tidal waterways, is at once distinguished by its huge pendant lustrous leaves, evocative of some of the larger-leaved *Enicosantha* (Anonaceae); they are conspicuously magenta on first opening. *H. enicosanthoides* suffered conspicuously as a result of the unprecedented floods of 1962–63; in the Bintulu drainage in particular a very high proportion of the population died.

Hopea kerangasensis Ashton sp. nov.**Plate 22.**

Hic species laminis parvis late ovatis costis lateralibus domatiis axillaribus prominenti pubescentibus lobi calycis in fructu ovatis parvis subaequalibus facile distinguitur.

Ramuli apices versus petioli costa media supra domatiae gemmaeque breviter plane plus minus persistente pallide flavido-brunneo-tomentosi. Ramuli apices versus c. 1 mm. diam. multo ramosi teretes dein levescentes brunnescentes internodis 3–8 mm. longis brevibus. Gemma -1×1 mm. minuta globosa. Stipula fugax ignota. Lamina $1.5-4.5 \times 1-3$ cm. parva ovata chartacea basi cuneata apice in acumen -1 cm. longum caudatum attenuata; costis lateralibus utrinsecus c. 6 dryobalanoidiis obscuris; costa media supra paullum depressa subtus gracili prominenti, domatiis utrinsecus -6 magnis pallide fulvo-pubescentibus. Petiolus 3–5 mm. longus c. 1 mm. diam. gracilis. Racemi -12 cm. longi stipitis basi in fructu -0.5 mm. diam. axillares parvi teretes sparsim alutaceo-puberulentes; semel ramosi ramulis -4 mm. longis flores -3 distichos gerentibus; bracteolis minutis linearibus fugacibus. Alabastrum c. 1.5×1 mm. ovoideum. Sepala ovata acuminata glabra; interna 3 quam externa 2 breviora apicem versus angustiora media parte latiora. Petala lanceolata partibus in alabastro expositis puberulentibus. Stamina 15 verticillis 3 inaequalibus, antheris subglobosis, aristis quam antheras 2–3-plo longioribus gracilibus. Ovarium ovoideum glabrum; stylo ovarium aequanti columellari attenuata. Fructus ex integro glabra. Peticellus in fructu -1 mm. longus brevis. Lobi calycis in fructu -6×5 mm. subaequales ovati acuti saccati incrassati externis 3 quam internis 2 brevioribus angustioribus incrassatioribus. Nux -8×5 mm. ovoidea subacuta.

Collections.—Sarawak: S. 15530 (Anderson et al.) S. Serayan, Lundu; S. 15608 (Galau), S. 8944 (Holotypus in herb. Kew), 8912, 8912a (Yakup), S. 21299 (Ashton), S. 14926 (Rosli), Whitmore 446, Semengoh F.R.; S. 9454, 9306 (Bojeng), S. 8932 (Yakup), S. 2274 (Abg. Muas) Setapok F.R.; S. 9669 (Browne) Munggu Unjam F.R.;

Haviland $\frac{1030}{857}$ Sadong, coal mine hill.

Haviland 857 was identified by Brandis as *H. vesquei* Heim but the present species, which is locally common in Mixed Dipterocarp forest West of the Batang Lupar, is at once recognised from other members of subsection *Dryobalanoides* by its very small leaves with prominent domatia, as well as by its short subequal calyx lobes.

Hopea longirostrata Ashton sp. nov.**Plate 23.**

H. beccariana Burck, *H. dryobalanoides* Miq. affinis sed omnibus partibus glabris pedicello c. 5 mm. longissimo differt.

Omnes partes glabri. Ramuli apices versus c. 2 mm. diam. multo ramosi teretes fuscii leves; internodis -1.5 cm. longis, cicatricibus stipularibus brevibus obscuris. Gemma -2×2 mm. subglobosa obtusa. Stipula ignota caduca. Lamina $7-9 \times 3-5$ cm. ovato-elliptica coriacea basi obtusa apice in acumen -1.5 cm. longum subcaudatum

attenuata; costis 'dryobalanoidiis'; costis lateralibus utrinsecus c. 12 obscuris haud elevatis; secundariis longis subaequalibus; costa media gracili supra prominenti subtus acuta. Petiolus 7–10 mm. longus c. 1 mm. diam. geniculatus sicco nigrescens. Flores ignoti. Racemus fructusque glaber. Racemi -4 cm. longi stipitis basi in fructu c. 1 mm. diam. terminales vel -3 axillares semel ramosi; ramulis -5 flores gerentibus. Pedicellus c. 5 mm. longus c. 1 mm. diam. Lobi calycis in fructu longiores 2, -24 × 6 mm. spatulati basim versus -3 mm. lati attenuati, partibus basalibus in media parte tuberculatis incrassatis; lobi breviores -15 mm. longi lineares vel spatulati obtusi vel acuti basim versus ut in lobi longiores. Nux -6 × 4 mm. ovoidea stylo -2 mm. longo attenuata.

Collections.—Sarawak: S. 18191 (Ashton) Ulu Tubau, Bintulu; S. 17742 (Ashton) Ulu Belaga, Rejang (Holotypus in herb Kew).

This is a further species in the difficult subsection *Dryobalanoides*. The leaves closely resemble those of several others, including *H. dryobalanoides*, *H. beccariana*, and particularly *H. latifolia* Sym. with which it also shares an overall smooth bark surface. The completely glabrous parts however distinguish it from *H. beccariana* and *H. latifolia*, while the inordinately long fruit pedicel and centrally tuberculate basal portion to the calyx lobes are characteristic and unique in the genus.

H. longirostrata is only known by two collections, though in the area where I collected it the species was fairly common. It may well be more widespread as it is easy to overlook when sterile.

Hopea megacarpa Ashton sp. nov.

Plate 24.

H. semicuneatae Sym. affinis sed costis domatiis obscuris lobis calycis in fructu -10 cm. longis basim versus subauriculatis differt.

Ramuli apices versus, costi laminae subtus petiolique sparsim caduce puberulentes, gemmae persistente eadem. Ramuli apices versus c. 1 mm. diam. graciles teretes leves dein rufo-brunnescens; internodis -3 cm. longi; cicatricibus stipularibus parvis obscuris. Gemma -1 × 1 mm. minuta. Stipula -2 mm. longa lineare-falcata caduca. Lamina 6–12 × 1.5–5 cm. plus minus anguste elliptica chartacea undulata basi cuneata apice in acumen -2 cm. longum prominenti attenuata; costis lateralibus utrinsecus 6–7 gracilibus subtus elevatis angulo 25°–40° exorientibus; intercostis gracilibus conferte scalariformibus; costa media subtus prominenti tereti, supra applanata vel paullum elevata. Petiolus c. 6 mm. longus c. 1 mm. diam. brevis supra striatus sicco nigrescens. Racemi -3 cm. longi stipitis basi in fructu -1 mm. diam. axillares teretes glabri laxi semel ramosi, ramulis flores -3 gerentibus; bracteis bracteolisque -2 mm. longis linearibus subsistentibus. Alabastrum -4 × 3 mm. subglobosum. Lobi calycis fimbriati, externi 2 ovati, interni 3 suborbiculares submucronati. Petala pallide rosea elliptico-oblonga obtusa partibus in alabastro expositis sparsim puberulentibus. Stamina 15, antheris oblongis; aristis quam antheras c. 3-plo longioribus gracilibus filiformibus. Ovarium stylopodiumque cylindricale subtruncatum glabrum stylo brevi. Fructus ex integro glaber. Pedicellus in fructu -3 mm. longus

diamque. Lobi calycis in fructu longiores 2, -10×1.3 cm. anguste spatulati subacuti basim versus c. 5 mm. lati attenuati partibus basalibus -9×15 mm. subauriculatis saccatis; breviores 3, -20×9 mm. ovati basim versus ut in lobi longiores. Nux -12×10 mm. ovoidea apice minute truncata mucronata calyce obscura.

Collections.—Sarawak: SFN. 35625 (Daud and Tachun) (Holotypus in Herb. Kew), SA. 639 (Egon) N. Pelagus; S. 14743 (Anderson) Bt. Raya, Pelagus.

This species, only known at present from a very limited area on the middle Rejang, is at once distinguished by its fruit, though the leaves in many ways resemble the widespread *H. semicuneata* Sym.

Hopea mesuoides Ashton sp. nov.

Plate 25.

H. subalata (non Sym.) Man. Dipt. Brun. (1964) 110.

H. subalatae Sym. affinis, sed lamina maiore coriaceore attenuata margine revoluta, lobis calycis in fructu suborbicularibus aequalibus differt.

Gemma stipulaeque breviter persistente pallide alutaceo-tomentosa, aliter glaber. Ramuli apices versus -1.5 mm. diam. graciles leves teretes badii; internodis $1.5-3.5$ cm. longis. Gemma -1 mm. longa subglobosa. Stipula -2.5×1 mm. hastata acuta fugax. Lamina $8-14 \times 2.5-5$ cm. ovata chartacea basi obtusa apice in acumen -1.5 mm. caudatum gradatim attenuata margine paullum revoluta; costis lateralibus utrinsecus c. 11 subdryobalanoidiis subtus paullum elevatis curvatis angulo $55^\circ-75^\circ$ exorientibus; costis intermediis brevibus; intercostis reticulatis obscuris; costa media subtus prominenti supra anguste depressa. Petiolus $7-10$ mm. longus -1 mm. diam. gracilis sicco nigrescens. Racemi -4 cm. longi, stipitis basi in fructu -0.7 mm. diam. axillares breves glabris semel ramosi, bracteolis -1 mm. longis deltoideis glabris subpersistentibus. Alabastrum parvum late ovoideum. Calyx externe sparsim pubescens, intus glaber, lobis externis 2 suborbicularibus obtusis vel acutis internis 3 suborbicularibus plus minus breviter mucronatis. Corolla purpurea; petalis oblongis obtusis partibus in alabastro expositis pubescentibus. Stamina 15, aristis quam antheras 2-3-plo longioribus gracillimis. Ovarium stylopodiumque glabrum apice papillosa excepta cylindricum truncatum ovarium quam stylopodium paullum latiore; stylo brevi glabro. Pedicellus in fructu c. 1 mm. longum brevis in calyce impressus. Lobi calycis in fructu -14×12 mm. subaequales ovati chartacei imbricati saccati ad nucem appressi apices subacutas versus plus minus erosi. Nux -14×14 mm. subglobosa glaber stylopodio truncato persistenti coronata calyce obscurata.

Collections.—Sarawak: S. 15551 (Ilias) Segan F.R. (Holotypus in herb. Kew); S. 11247, s.n., Marudi F.R.; S. 25028 (Sibat) Bt. Mersing, Anap; s.n. (Yakup) Marudi F.R. Brunei: Brun. 91 (Ashton) Mile 3, K. Abang Road; Brun. 879 (Ashton) Bt. Bedawan; Brun. 5674 (Asah) K. Belalong; Kep. 35532, 35536 (Symington)

Pangkalan Ran; Kep. 34451 (Flemmich) Bt. Rampayoh, Labi Hills; Kep. 39639, 48203 (Flemmich) Labi Hills F.R.; Kep. 28657 (Smith) Bt. Kerita, Ladan Hills.

At the time of writing my Brunei Manual only immature fruit were known from Borneo; these appeared to resemble those of the Malayan species exactly though there were differences in the leaf. Mature fruit (in S. 15551) however have confirmed that this taxon should be considered as a separate species.

Hopea pterygota Ashton sp. nov.

Plate 26.

H. tenuinervulae Ashton affinis sed lobi calycis in fructu late auriculati lamina intercostis remotioribus.

Novelli primo conferte alutaceo-pubescentes dein glabrescentes gemmis stipulis exceptis. Ramuli apices versus c. 2 mm. diam. fuscii dein levescentes glabrescentes; internodis -3 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma -2 × 1 mm. ovoidea acuta. Stipula -4 mm. longa linearis caduca. Lamina 12-28 × 5-9 cm. oblongo-lanceolata vel oblanceolata, basi obtusa vel subcordata inaequalis, apice in acumen -2 cm. longum subcaudatum attenuata, margine subrevoluto, costis lateralibus utrinsecus 12-21 gracilibus subtus prominentibus supra depressis angulo 50°-60° exorientibus curvatis; intercostis gracilibus scalariformibus; costa media supra prominenti subtus prominentiore. Petiolus 3-8 mm. longus c. 2 mm. diam. brevis crassus. Racemi -8 cm. longi stipitis basi in fructu -1 mm. diam. teretes glabri graciles saepe fasciculati axillares saepe ramiflori semel ramosi; ramulis flores -8 secundos gerentibus. Alabastrum -3 × 2 mm. ellipsoideum. Calyx glaber, sepalis externis 2, lanceolatis acuminatis; internis 3, suborbicularibus quam externis 2 paulum brevioribus breviter mucronatis. Petala linearia partibus in alabastro expositis pubescentibus. Stamina 15 verticillis 3 inaequalibus, filamentis basim versus compressis apicibus filiformibus attenuatis; antheris subglobosis; aristis gracilibus quam antheris 3-4 longioribus. Ovarium anguste ovoideum glabrum stylopodio fusiformi quam ovarium paulum breviori. Fructus glaber. Pedicellus in fructu -1 mm. longus -1 mm. diam. brevis. Lobi calycis in fructu longiores 2, -10 × 1.5 cm. spatulati chartacei basim versus -7 mm. lati attenuati, partibus basalibus -20 mm. latis auriculatis in media parte incrassatis; breviores 2, -3 cm. longi subacuti attenuati basim versus ut in lobis longioribus. Nux -7 × 5 mm. ovoidea acuta calyce obscura.

Collections.—Sarawak: s.n. (Anderson) G. Lesong, Simanggang; S. 15206 (Smythies) Bt. Gaharu (Holotypus in Herb. Kew); s.n. (Tready) Marudi; S. 4355 (Dan) Lambir Hills; S. 25022 (Sibat) Anap P.F.; S. 22314 (Suib) Bt. Alet. N. Bah, Rejang; S. 23245, 23612 (Sibat) Bt. Iju, Arip.

This species is most obviously distinguished from its allies *H. tenuinervula* Ashton and *H. philippinensis* Dyer by the broadly auriculate bases to the fruit calyx lobes. In the field it is distinguished by its smooth, not flaky, bark surface and soft white wood.

H. pterygota is found in Heath forest and sandy ridges in Mixed Dipterocarp forest; though local it is often a very common medium-sized tree where it occurs, as in Marudi F.R. where many trees border the Limbang road.

***Hopea tenuivervula* Ashton sp. nov.**

Plate 27.

—*H. philippinensis* (non Dyer) Ashton, Man. Dipt. Brun. (1964) 107.

H. philippinensis Dyer similis, sed lamina maiore costis lateralibus subtus utrinsecus 12–16 differt.

Novelli conferte pallide flavido-brunneo-tomentosi, ramuli apices versus gemmae stipulae petiolique persistente tomentosi, costae laminae subtus subpersistente eadem; aliter tomento caduco. Ramuli apices versus –2 mm. diam. dein levescentes glabrescentes rufo-brunnescentes; internodis 1.5–2.5 cm. longis. Gemma –3 × 1.5 mm. lanceolata. Stipula –5 mm. longa linearis subpersistens. Lamina 10–18 × 3–5.5 cm. anguste ovata vel lanceolata basi obtusa inaequalis apice in acumen –1 cm. longum attenuata; margine paullum revoluta; costis lateralibus utrinsecus 12–16 gracilibus subtus prominentibus angulo 50°–60° exorientibus curvatis; intercostis gracilibus conferte scalariformibus; costa media tereta ex integro elevata. Petiolus 3–7 mm. longus –2.5 mm. diam. brevis crassus. Racemi –8 cm. longi stipitis basi in fructu –1 mm. diam. –2-axillares rare terminales teretes laxi glabri; semel ramosi ramulis –3 cm. longis flores secundos –4 gerentibus; bracteolis –1 mm. longis deltoidiis glabris subpersistentibus. Alabastrum –4 mm. longum ellipsoideum subsessile. Calyx fimbriatus aliter glaber, lobis externis 2 anguste ovatis prominente acuminatis, lobis internis 3, suborbicularibus vel late ovatis mucronatis. Petala oblongo-lanceolata acuta partibus in alabastro expositis conferte tomentosius aliter glabra. Stamina 15; antheris oblongo-ellipsoideis, aristis quam antheras c. 2-plo longioribus gracilibus. Ovarium ovoideum glabrum; stylopodio ovarium aequali fusiformi glabro stigma obscura. Fructus ex integro glaber. Pedicellus in fructu –1 mm. longus brevis. Lobi calycis in fructu longiores 2, –8.5 × 1.7 cm. spatulati anguste obtusi basim versus –2 mm. lati attenuati partibus basalibus –6 × 4 mm. anguste ovatis prominente saccatis incrassatis; lobi breviores 3, –1.3 cm. longi subaequales acuti partibus basalibus –7 mm. longis paullum auriculatis. Nux –12 × 8 mm. ovoidea stylopodio brevi attenuata.

Collections.—Sabah: SAN. 38708 (Mikil) Gaya Island. Brunei: Brun. 619, 3290, 2624 (Ashton) Andulau F.R.; S. 1187 (Brunig) Bt. Teraja; Sarawak: S. 14812 (Rosli), S. 11091, 213 (Abg. Muas), near tree 1154 (Rosli and Asah) Semengoh F.R.; S. 9869 (Anderson) Rantau Panjang, Sibul; S. 12614 (Symthies) Mt. Meroyong, Sempadi F.R.; S. 9616 (Ariffin) Lundu (Holotypus in herb. Kew); Haviland 3167 (Haviland and Hose) near Kuching.

This species, found on leached yellow sandy soils in Mixed Dipterocarp forest, and on deep white sand podsols in Heath forest closely resembles *H. philippinensis* Dyer, but differs, among other characters, in the larger lamina with more abundant nerves.

SHOREA

The identity of *Shorea meadiana* Sym.

Symington (Gard. Bull. S.S. 10 (1939) 366) based this species on Kep. 49845 (Symington) Bt. Goh F.R. Kuantan, Pahang, a flowering collection. The species is well known in Malaya, and the many collections now extant show no constant differences from the also well collected *S. scrobiculata* Burck of Borneo, whose synonymy I have discussed before (Gard. Bull. Sing. 20 (1963) 272). Symington rightly describes *S. meadiana* as having 28–32 stamens, while Burck describes his species as having 20–30. I have, however found up to 32 in Bornean collections, though none lower than 24. I consequently reduce *S. meadiana* to *S. scrobiculata*.

Collections examined.—Sabah: s.n. (Wyatt-Smith) 5 miles from Dalas, 16.8.54; s.n. (Wyatt-Smith) 5 miles from Dalas, 18.8.54; SAN. 15012 (Wood) Mt. Silam; SAN. 29590 (Aban) Balong, Tawau; SAN. 26895 (Bakar) Bt. Serudong, Tawau; SAN. 25848, 26895 (Meijer) Tawau river F.R.; SAN. 44226 (Pereira) J. Pahudia, Tanjong F.R., Tawau; SAN. 47230 (Meijer) J. Ayer Panas, Tawau; SAN. 25426 (Meijer) Bt. Mesasan, Beluran; SAN. 23135, 26589 (Meijer) Lubuk Buaya, Kinabatangan; Brunei: S. 5572 (Anderson), Brun. 3271, 623, 52 (Ashton), SAN. 17530 (Smythies et al.) Andulau F.R.; Brun. 2606 (Ladi) K. Temburong Machang; S. 2117 (Smythies) Bt. Teraja; S. 5723, 5760 (Smythies et al.) K. Bealong; Brun. 740 (Ashton) K. Sekurop, Ulu Temburong; Brun. 632 (Ashton) Bt. Puan; S. 1952 (?) Bt. Telugong, Sarawak; Kep. 80491 (Wyatt-Smith) S. Dalam F.R.; s.n. (Anderson) Bt. Gondol, Bako N.P.; SFN. 10254 (Sinclair and Kadim) G. Gaharu, Serian; SA. 462 (Majid) Bayor, Lundu, S. 1817 (Hj. Sulong) Bt. Tegarai, Limbang; S. 9441 (Ariffin) Lundu; S. 9923 (Brunig) Bako N.P. (fr. of *Vatica* sp.); Jacobs. 5544, Becc. P.B. 2538, Matang; Becc. P.B. 2889, Sarawak; S. 263, 269 (Sipudin) Nyabau F.R.; S. 1252 (Ariffin) Batang Ayer Betumbok F.R.; S. 2792 (Brunig) Selang F.R.; Malaya: Kep. 50604 (Ismail) S. Nal, Kep. 65760 (Nik Yusoff) Ulu Lebir, Kep. 50507, 50508 (Browne) S. Chalil, Kep. 37976, 37844 (Symington) Tualang Gelam, Kep. 37974 (Symington), Kep. 32820 (Walton) Lata Mak Mik Nol, Kep. 33425 (S.F.O., Kelantan) Bt. P. Lelah, Kep. 33290 (Walton) Pulau Chondong, Kep. 52904, 52902 (Browne), Kep. 38371 (Mohd. Alias) Chebang Tongkat F.R., Kelantan; Kep. 53417 (Ahmad) Kelantan road, mile 37, Besut, Trengganu; Kep. 80850 (Kochummen) 3½ miles from Jerangan police station, Dungun, Kep. 17224 (Debab), Kep. 94918 (Kochummen and Yong), Kep. 49840, 43128 (Symington), Kep. 48042, 47138 (D.F.O., Kuantan), Baloh F.R., Kep. 31751, 31752, 31753, 31761, 31762 (Awan) Jeram, Kep. 49845 (Symington) Dt. Goh F.R.) Kuantan, Pahang; Kep. 34704 (S.F.O., (Kedah) Relau F.R., Kedah; Kep. 51554 (Walton), Kep. 45753, 45754, 45755 (Abd. Taib) Kep. 12973 (Durant) Chikus F.R.; Kep. 29904, 29916, 29942, 29877 (Symington) Bubu F.R.; Kep. 40608 (Symington) Manong, Kep. 33771, 32162, 28969, 33702 (Arnot); Kep. 33685 (Pendak), Kep. 28975 (Tachun and Arnot), Kep. 25442,

21405, 21406, 25885, 25415, 24632, 24519, 24478 (Symington), Kep. 11964 (?) Keledang Saiong F.R., Kep. 24632, 24467, 24470 Tg. Tualang F.R., Perak; Kep. 68950 (Aziz Budin) Forest Research Institute, Kepong, Selangor.

***Shorea brunnescens* Ashton sp. nov.**

Plate 28.

S. ciliatae King affinis, sed staminis 40–62 lamina coriacione intercostis subtus prominentus elevatis.

Gemma conferte breviter persistente alutaceo-pubescentis, novellis caduceis eisdem, lamina glaber. Ramuli apices versus c. 1 mm. diam. teretes leves nigrescentes; internodiis 1–3.5 cm. longis; cicatricibus stipularibus brevibus horizontalibus obscuris. Gemma -2.5×2 mm. parva ovoidea acuta. Stipulae ignotae. Lamina 6–12 \times 2.5–6 cm. late ovata vel lanceolata coriacea basi cuneata, apice in acumen -1 cm. longum angustum attenuata; costis lateralibus utrinsecus 9–11, gracillimis subtus vix elevatis curvatis angulo 45° – 60° exorientibus; intercostis confertis subreticulatis evidentibus vix elevatis; costa media supra obscura depressa subtus prominentibus sulcatis. Petiolus 1–1.5 cm. longus 1–2 mm. diam. sicco nigrescens. Racemi -9 cm. longi stipitis basi in fructu c. 1 mm. diam. terminales vel axillares angulati sparsim breviter pallide alutaceo-pubescentis semel ramosi; ramulis -1.5 cm. longis floribus secundis bracteolis ignotis. Alabastrum -4×2 mm. anguste ellipsoideum. Calyx externe conferte pubescens intus glaber, lobis ovatis acutis internis 2 quam externis 3 paullum brevioribus latioribus. Corolla albida petalis lanceolatis partibus in alabastro expositis breviter pubescentibus. Stamina 40–62, filamentis glabris basim versus compressis apicibus filiformibus attenuatis; antheris elliptico-oblongis glabris loculis internis 2 quam externis 2 paullum minoribus; aristis quam antheros brevioribus setis longis apicalibus 2 alter glabris. Ovarium stylopodiumque pyriformi conferte pubescenti stylo brevi columellari glabro coronatum. Fructus maturus ignotus. Calyx in fructu dein griseo-sericeus; lobis aliformibus exterioribus 3 quam aliis 2 longioribus. Nux ovoidea conferte breviter pubescens.

Collections.—Sarawak: S. 13179 (Smythies) G. Berumput; S. 15220, 15218 (Holotypus in Herb. Kew) (Smythies) Bt. Gaharu; Jacobs 5544, G. Matang; S. 19373 (Ashton) Bt. Naoung, Muput Kanan, Anap; S. 18194 (Ashton) Ulu Tubau; S. 7995, 10179 (Bojeng) G. Gading; S. 14910, 15019, 14904, 14988, 14928 (Rosli), tree no. 87, 111 (Asah), S. 362 (Omar), S. 45 (Ahmad Kabir), Sinclair and Kadim 10192, S. 15714 (Galau), S. 15773 (Jugah), S. 14931 (Anderson), S. 11057 (Ghazalli), S. 8943, 8945 (Yakup), S. 15172, 15763 (Rosli and Jugah) Semengoh F.R.

This species differs from *S. ciliata* King of Malaya principally in the larger number of stamens, though small but consistent differences in lamina characters are also noticeable. These two species are therefore allied in the same way as *S. sumatrana* (V. Sl. ex Foxw.) Sym. of Sumatra and Malaya is to *S. seminis* (De. Vr.) Sloat of Borneo and the Philippines, *S. lumutensis* Sym. of Malaya is to *S. inappendiculata* Burck of Borneo, and *S. astylosa* Foxw. of the Philippines is to *S. domatiosa* Ashton of Borneo. I have chosen

to consider these as pairs of species rather than as geographical subspecies of single species partially as the range in the number of stamens in each taxon of a pair does not overlap, partially as there are also other, though less clearly defined, differences and partially also in order to avoid upsetting presently accepted nomenclature in the absence of experimental or other conclusive evidence. It appears that a change in the mean number of stamens in separated parts of a population of species in section *Shoreae* is commonly one of the earliest evolutionary divergences to occur. In *S. foxworthyi* Sym. for example the number varies between 33–41 in Malaya and between 32–34 in Borneo; I do not feel this difference is sufficient to merit being given taxonomic status. The 'instability' of this character is not altogether surprising in view of their centrifugal origin.

Though *S. brunnescens* is common in Semengoh F.R. at low altitudes, elsewhere it is confined to hills, being found typically along ridges between 600–1,000 m., in this resembling its Malayan counterpart. The present species is known to me up to the present only from Sarawak, where it is widespread west of the Baram drainage.

***Shorea lunduensis* Ashton sp. nov.**

Plate 29.

S. collinae Ridl. affinis sed lamina minus coriaceori lobis calycis in fructu inaequalibus longioribus differt.

Ramuli gemmaeque breviter plane fugace pallide alutaceo-pubescentes, laminae glabrae. Ramuli apices versus c. 3×2 mm. diam. primo compressi dein nigrescentes nitentes; internodis 1–3.5 cm. longis; cicatricibus stipularibus c. 3 mm. longis pallidis prominentibus ascensis. Gemma -5×3 mm. ovoidea acuta niger. Stipulae ignotae. Lamina 14–24 \times 6–15 cm. magna ovata vel elliptica basi late cuneata vel subcordata, apice in acumen -1 cm. longo attenuata; costis lateralibus utrinsecus 11–15 supra obscuris subtus prominentibus angulo 40° – 55° exorientibus basi excepta intercostis sinuatis conferte scalariformibus; costa media supra vix elevata subtus prominenti. Petiolus 2–3.5 cm. longus c. 2 mm. diam. crassus siccus nigrescens. Racemi -12 cm. longis stipitis basi in fructu -2 mm. diam. terminales vel axillares subteretes conferte breviter fasciculate alutaceo-pubescentes semel vel bis ramosi; ramulis -3 cm. longis; bracteolis -4×2 mm. ovatis conferte breviter pubescentibus fugacibus. Flores secundi. Alabastrum -10×3 mm. anguste ovoideum calyce expansa. Calyx partibus in alabastro expositis sericeis, lobis anguste ovatis subacutis internis 2 quam exterioribus 3 minoribus latioribus. Corolla cremia, petalis linearibus partibus in alabastro expositis conferte pubescentibus. Stamina 47–52 filamentis compressis attenuatis glabris; antheris oblongis glabris apicem versus attenuatis; aristis quam antheras longioribus conferte setosis. Ovarium stylopodiumque pyriforme conferte pubescente stylo columellari coronatum. Fructus maturus ignotus, novello sparsim breviter pubescens; lobis calycis externis 3, inaequalibus quam internis 2 longioribus spatulatis subacutis. Nux apiculo -1 mm. longo attenuata.

Collections.—Sarawak: S. 15396 (Anderson et alia) G. Lundu (Holotypus in Herb. Kew); S.A. 587 (Baharol) S. 10172, 7984, 7968 (Bojeng), s.n. (Anderson), S. 59 (Browne), Gunong Gading F.R.; S. 15502 (Anderson et al.) Bt. Gebong; S. 15482 (Anderson) Bt. Seburan, Bau.

Belonging to the type section and subsection and differing from *S. collina* Ridl. of eastern Malaya principally in the aliform fruit calyx, this species appears to be confined to Mixed Dipterocarp forest in West Sarawak.

***Shorea agami* Ashton; infraspecific variation.**

Two distinct forms of this species (Ashton, Gard. Bull. Sing. 19 (1962) 270), based solely on the size of the lamina, are discernable, and appear to merit subspecific status.

subsp. *agami*.

(Ashton, id. 271, Pl. 9)

Lamina 10–15 × 6–10 cm. late ovata.

Collections (others than those cited in the original description). Sarawak: S. 10077 (Yong) Baram; S. 1454 (Gusni) Miri; S. 1936, 1462 (Dan) Riam road, Miri; S. 1430 (Keram) Bakam, Miri; S. 1489 (Suib) Limbang road, Marudi; S. 1757 (Drahman) Bt. Meringgit, Lawas.

subsp. *diminuta* Ashton subsp. nov.

Plate 30.

Lamina 4.5–10 × 2.5–4 cm. anguste ovata.

Collections.—Sarawak: S. 25027 (Sibat) Bt. Mersing, Anap (Holotypus in herb. Kew); S. 22335 (Suib) Bt. Leran, Niah; S. 17771 (Ashton), S. 23961 (Wright), S. 23860 (Jugah) Bt. Raya, Kapit; S. 15227 (Jugah) S. Sabal Tapang, Serian.

This latter subspecies is also widespread in western Kalimantan; the ranges of the two subspecies appear not to overlap.

***Shorea cordata* Ashton sp. nov.**

Plate 31.

S. hypochrae Hance affinis sed lamina maiore haud lepidota basim versus cordata.

Ramuli apices versus petioli conferte, lamina costis lateralibus subtus sparsim caduce pubescentes, gemmae stipulaeque persistente pubescentes. Ramuli apices versus c. 3 × 2 mm. diam., paullum compressi fuscescentes terescentes levescentes vel ruguli; internodis –5 cm. longis; cicatricibus stipularibus horizontalibus latis pallidis prominentibus. Gemma –7 × 4 mm. ellipsoidea compressa acuta. Stipula –12 × 6 mm. elliptica obtusa. Lamina 8–15 × 5.5–10.5 cm. oblonga vel obovata, basi cordata vel rare acuta, apice obtusa vel retusa vel in acumen –8 mm. longum abrupte attenuata; costis lateralibus utrinsecus 15–18 subtus prominentibus apicem versus angulo 30°–40° basim versus angulo –100° exorientibus; intercostis gracilibus conferte scalariformibus; costa media supra depressa subtus prominenti. Petiolus 13–25 mm. longus c. 2 mm. diam. teres saepe rugulosus sicco nigrescens.

Racemi -12 cm. longi stipitis basi in fructu -2 mm. diam. terminales vel axillares laxi compressi vel costati persistente alutaceo-puberulentes semel ramosi; ramulis -5 cm. longis -5 flores plus minus secundis gerentibus; bracteis -10×3 mm. lanceolatis acutis puberulentibus fugacibus; bracteolis -10×5 mm. ellipticis obtusis puberulentibus subpersistentibus. Alabastrum -10×5 mm. fusiforme. Calyx externe sericeus, intus glaber; lobis anguste deltoideo-lanceolatis obtusis exterioribus 3 quam interioribus 2 paullum maioribus. Petala oblongo-lanceolata externe sericea intus glabra. Stamina 15 verticillis 3 inaequalibus vel externis 10 vestigialibus; filamentis angustis compressis attenuatis; antheris elliptico-oblongis; aristis quam antheras -6-plo longioribus filiformibus tenuatis. Ovarium ovoideum glabrum, stylo columellari quam ovarium 2-plo longiore attenuato basim versus sericeo apicem versus obscure trifurcato. Fructus glaber. Pedicellus in fructu obscurus in calycem decurrens. Lobi calycis longiores 3, -13×2.5 cm. lorati obtusi basim versus -8 mm. lati attenuati, partibus basalibus -12×12 mm. orbicularibus incrassatis saccatis; lobi breviores 2, -6.5×0.8 cm. angusti lanceolati acuti, basim versus ut in lobi longiores. Nux -14×10 mm. globosa calyce obscurata.

Collections.—Sarawak: S. 13183 (Smythies) G. Berumput; SA. 678 (Egon) outside Semengoh F.R. (Holotypus in Herb. Kew); S. 7988, 7986, 10177 (Bojeng) G. Gading; S. 19306 (Ashton) Ulu Mayeng, Kakus.

Apparently allied to *S. hypochra* Hance of Malaya, Thailand, Cambodia and Cochin China, *S. cordata* differs mainly in the larger cordate glabrescent lamina lacking the characteristic pale yellowish lepidote undersurface of the former species; in this it resembles immature specimens of *S. hypochra*. *S. cordata* is a rare tree, found to date in Central and West Sarawak; it can be of immense size.

***Shorea polyandra* Ashton sp. nov.**

Plate 32.

Ramuli petioli lamina subtusque persistente rufo-lepidoti, gemmae stipulaeque persistente breviter rufo-puberulentes. Ramuli apices versus c. 1 mm. diam. graciles teretes griseo-fuscescentes leves vel minute striati; internodis -2 cm. longis; cicatricibus stipularibus brevibus horizontalibus obscuris. Gemma -2×1 mm. parva ellipsoidea subacuta. Stipula -5×2 mm. lanceolata subacuta fugax. Lamina 8-13×3-5 cm. lanceolata chartacea undulata basi cuneata apice in acumen -2 cm. longum gracile gradatim attenuata; costis lateralibus utrinsecus 11-14 gracilibus subtus elevatus angulo 40°-60° exorientibus; intercostis scalariformibus gracilibus; costa media gracili supra applanata subtus prominenti. Petiolus 14-20 mm. longus c. 1 mm. diam. gracilis. Racemi -6 cm. longi, stipitis basi in fructu -2 mm. diam., terminales vel axillares teretes conferte rufo-pubescentes semel ramosi; ramulis -1 cm. longis flores -3 plus minus distichos gerentibus; bracteolis -4×3 mm. ellipticis subacutis rufo-pubescentibus caducis. Alabastrum -5×4 mm. late ovoideum. Calyx partibus in alabastro expositis sericeus, lobis suborbicularibus subaequalibus. Petalae oblongae obtusae partibus

in alabastro expositis conferte pubescentibus. Stamina 102–107 plurima subaequalia; filamentis basim versus compressis apicem versus attenuatis; antheris quam filamentos –2-plo longioribus anguste oblongis loculis 2; aristis filiformibus attenuatis quam antheris paullum brevioribus conferte setosis. Ovarium ovoideum conferte pubescente stylo brevi late columellari trifurcato pubescenti apice excepto attenuatum. Pedicellus in fructu –1 mm. longus –2 mm. diam. brevis. Calyx in fructu basim versus sparsim rufo-pubescentis glabrescens; lobis longioribus 3, -8×1.4 cm. spatulatis obtusis vel subacutis basim versus –8 mm. latis attenuatis partibus basalibus -10×8 mm. tuberculatis saccatis incassatis; brevioribus 2, -5×0.5 cm. linearibus acutis basim versus ut in lobis longioribus. Nux -30×13 mm. anguste ovoidea acuta conferte rufo-pubescentis.

Collections.—Sarawak: S. 10171 (Holotypus in herb. Kew) 10174, 10189, 7977, 7979 (Bojeng) G. Gading F.R. Sabah: SAN. A3959, A3465, 15265 (Wood) Kalabakan, Tawau; SAN. 16478 (Wood) Quoin Hill, Tawau; SAN. 16342 (Wood and Kapis) Pangi, Tenom. Kalimantan: Kostermans 13302, Mt. Medadam, N. of Sengkulirang; b.b. 21976 (Zwaan), 21974, 21975 (Henar) Djalepat, P. Laut; b.b. 31167, 27186 (Chatihoe) Seblimbingan, P. Laut; b.b. 31559 (Kadiri), 12345 (Zwaan), 12901 (Hildebrand) Sei Paring, P. Laut; b.b. 25158 (Soeli), b.b. 26404, 26405, 26406 (Lammers) Tg. Miri, P. Laut; b.b. 12239 (Ramli) Sei Taip, P. Laut; b.b. 23888 (Henar) Seratah, P. Laut; b.b. 20165 (Mahboel) Batoeng, Kandangan; b.b. 20455 (Nandika) Petarikan, Kota Waringin; b.b. 23349, 23350, 23351 (Dachlan) Sakadoea, Martapoera; b.b. 23353 (Dachlan) Taha Doea, Martapoera; b.b. 14629 (Pohan) Katak, E. Kutei; b.b. 17557 (Atjil) Sotek, Balikpapan; b.b. 15758, 15777, 15779 (Hamid) Sebulu, W. Kutei; b.b. 26050 (Soepomo) Mendan, W. Kutei; b.b. 23080, 23081 (Dijen) G. Karap, W. Kutei; b.b. 23072 (Dijen) Lebak Njur, W. Kutei; b.b. 22937 (Nandika) Benua Baru, W. Kutei; b.b. 2049 (de Jong) Pait, W. Borneo; b.b. 22882, 22610 (Walinjan) Bt. Rompin, Sintang; b.b. 25100, 25101, 25099 (Budding) Tjatit B. Tengkojoeng, Malawi.

This striking species is in fruit very similar to *S. gibbosa* Brandis and *S. faguetiana* Heim, but the flowers are so different from other numbers of Section *Richetioides* that it justifies the creation of a new infrageneric group to contain it. The anthers, though shaped as in Section *Anthoshoreae* are yet 2-locular, a character unique to Section *Richetioides*. In wood anatomy too Gottwald considers it to be typical of the latter section (in litt.), though Murthy tells me that there are small differences, as follows.

Character	Typical sect. <i>Richetioides</i>	<i>S. polyandra</i>
Silica	Absent	Absent, but presence of crystals in rays very much like silica distribution.
Calcium oxalate crystals	Present but not abundant	Abundant
Rays canals	Fairly common	Rare, though present.
Chambered crystals in paranchyma	Frequent, always present	Rare.

I therefore consider that it merits the creation of a new subsection within Section *Richetioides* rather than a separate section altogether. The description of Section *Richetioides* thus needs further amplification.

Section *Richetioides* Heim.

Type: *S. faguetiana* Heim.

Anthers with 2 pollen sacs; appendage to connective erect, filiform, more or less scabrous or setose. Style shorter than ovary. Stipules and bracts minute, fugaceous; lamina nervation usually more or less reticulate, pellucid, midrib raised or sunken above, evident.

Subsection 1. *Richetioides*.

Flowers usually small, bud fusiform; stamens 15 (rarely 10), in 3 verticils; filaments broad at base, frequently gibbous, tapering more or less abruptly medially, filiform below anther; anthers broadly oblong to subglobose; appendage to connective longer than anther, more or less scabrous towards apex; ovary with stylopodium, shortly tomentose, with a slender columnar style.

Subsection 2. *Polyandrae* Ashton, subsect. nov.

Type: *S. polyandra* Ashton

Alabastrum -5×4 mm. magnum late ovoideum. Staminal 8, sine verticillis; filamentis basim versus compressis apicem versus gradatim attenuatis; antheris anguste oblongis; aristis quam antheras paullum brevioribus conferte setosis. Ovarium ovoideum sine stylo conferte longe pubescente stylo brevi lato prominenti trifurcato.

Shorea alutacea Ashton sp. nov.

Plate 33.

S. gibbosae Brandis, *S. faguetianae* Heim affinis sed lamina maiore costis lateralibus utrinsecus 14–19 petiolo 6–10 mm. longo breviori costa media subtus petiolo ramulique conferte persistente plane pallide ochraceo-pubescentibus.

Ramuli stipulae gemmae petioli costae mediaeque breviter conferte persistente alutaceo-pubescentes, lamina subtus sparsim eadem. Ramuli apices versus c. 2 mm. diam. teretes; internodis 1–4.5 cm. longis; cicatricibus stipularibus c. 1.5 mm. longis horizontalibus. Gemma c. 2×1.5 mm. ovoidea acuta parva. Stipula -8×3 mm. anguste deltoidea acuta magna. Lamina 15–22 \times 6–8 cm. ovata vel lanceolata undulata chartacea basi cordata apice in acumen -1 cm. longum attenuata; costis lateralibus utrinsecus 14–19 curvatis gracilibus supra anguste depressis subtus prominentibus basim versus angulo -100° apicem versus angulo 60° – 70° exorientibus; intercostis subscalariformis gracilibus obscuris; costa media supra depressa subtus prominenti tereti. Petiolus 6–10 mm. longus c. 2 mm. diam. sicco rugosus. Racemi -15 cm. longi, stipitis basi in fructu -2 mm. diam. terminales vel axillares teretes recti conferte breviter pallide alutaceo-pubescentes semel vel bis ramosi; ramulis -2.5 cm. longis; bracteolis -4×3 mm.

ovatis acutis conferte breviter alutaceo-pubescentibus fugacibus. Flores secundi. Alabastrum -6×3 mm. ellipsoideum magnum. Calyx partibus in alabastro expositis conferte pubescentibus, lobis late ovatis subaequalibus internis 2 breviter acuminatis quam externis 3 marginem versus characeoribus basim versus angustioribus. Petala lanceolata badia partibus in alabastro expositis pubescentibus, statu aperto basim versus imbricatis apicem versus contortis. Stamina 15, verticillis 3 inaequabilibus; filamentis basim versus latis compressis attenuatis apicem versus filiformibus; antheris late oblongis loculis 2; aristis quam antheros 3–4-plo longioribus gracilibus glabris. Ovarium stylopodiumque pyriforme conferte pubescente stylo columellari glabro attenuatum; stylo stylopodium aequanti. Pedicellus calyxque in fructu sparsim breviter caduce pubescens. Pedicellus c. 1 mm. longus brevis. Lobi calycis longiores 3, -8×1.8 cm. spatulati basim versus -4 mm. lati attenuati, partibus basalibus -7×7 mm. ovatis saccatis incrassatis; lobis brevioribus 2, -6×1.2 cm. alter ut in lobis longioribus. Nux -2.2×1 cm. anguste ovoidea conferte breviter plane alutaceo-tomentosa apiculo brevi attenuata.

Collections.—Sarawak: S. 7976, 7975, 10170 (Holotypus in Herb. Kew) (Bojeng) Gunong Gading F.R.

A member of section *Richetioides* Heim and allied to *S. faguetiana* Heim and *S. gibbosa* Brandis among others, the lamina differences quoted in the preceding diagnosis serve at once to distinguish it.

S. alutacea is known at present only on the granodiorite Gading mountains of West Sarawak, where it is scattered below 400 m. alt.

Shorea bakoensis Ashton sp. nov.

Plate 34.

S. laxa Sloot. affinis, sed lamina oblongo-lanceolata basi obtusa, petiolo 10–12 mm. longo c. 2 mm. diam., lamina petiolo ramuloque glabro differt.

Laminae petioli ramulique glaber. Ramuli apices versus c. 2 mm. diam. primo leves pallide fusci lenticellis nigris punctati dein fuscentes exfoliati; internodis c. 1.5 cm. longis; cicatricibus stipularibus brevibus horizontalibus. Stipula gemmaque ignota. Lamina 13–18 \times 5–6 cm. anguste oblonga vel lanceolata coriacea basi obtusa apice in acumen -1 cm. longum angustum attenuata; costis lateralibus utrinsecus 9–10 curvatis subtus prominentibus angulo 55° – 65° exorientibus; intercostis gracilibus subtus vix elevatis subscalariformibus; costa supra applanata subtus prominenti. Petiolus 10–12 mm. longus c. 2 mm. diam. brevis crassus sicco niger. Flores racemique ignoti. Peticellus in fructu brevis obscurus. Lobi calycis -4×3 mm. subaequales oblongi obtusi incrassati saccati patentes externe sparsim persistente alutaceosericei. Nux -25×14 mm. ellipsoideo-cylindrica conferte plane persistente alutaceo-pubescentibus apice in stylum -1 mm. longum attenuata.

Collections.—Sarawak: S. 17502 (Brunig) Bako National Park (Holotypus in Herb. Kew).

This rare species is only known from a few localities in W. Sarawak. It somewhat resembles *S. laxa* Sloot. and *S. obovoidea* V. Sl., but differs in the glabrous leaf with obtuse base and relatively shorter petiole, as well as in the ellipsoid — cylindric, not obovoid, nut.

***Shorea Cuspidata* sp. nov.**

Plate 35.

S. gibbosa Brandis, *S. faguetana* Heim. affinis, sed lamina 5–9 × 2–6 cm. minori glabra costis lateralibus utrinsecus 5–7.

Gemma stipulæque breviter persistente pubescens, ramulus caduce pubescens, lamina glaber. Ramuli apices versus c. 1 mm. diam. graciles teretes fuscii minute striati; internodis 1–2.5 cm. longis. Gemmae c. 1 mm. longae parvae ovoideae. Stipulae parvae fugaces. Lamina 5–9 × 2–6 cm. late ovata subcoriacea basi cuneata apice in acumen –1.5 cm. longum subcaudatum attenuata; costis lateralibus utrinsecus 5–7 gracilibus subtus vix elevatis curvatis angulo 40°–50° exorientibus; intercostis reticulatis obscuris; costa media gracili supra applanata vel paulum elevata subtus prominenti. Petiolus 7–11 mm. longus c. 1 mm. diam. gracilis sicco niger. Racemi –9 cm. longi, stpitis basi in fructu –1.5 mm. diam., terminales vel axillares teretes graciles conferte plane breviter alutaceo-pubescentes semel ramosi; ramulis –1.5 cm. longis flores secundos gerentibus. Alabastra –3 × 2 mm. parva ellipsoidea. Calyx partibus in alabastro expositis pubescentibus sepalis late ovatis parvis subaequalibus acutis, internis 2 quam externis 3 latioribus marginem versus chartaceoribus. Petala pallide lutea lanceolata prominente contorta partibus in alabastro expositis conferte pubescentibus basibus connatis. Stamina 15, verticillis 3 inaequalibus; filamentis basim versus compressis apicem versus filiformibus attenuatis; antheris loculis 2 ellipsoideis; aristis quam antheras c. 1½-plo longioribus gracilibus dimidiis apicalibus pubescentibus. Ovarium stylopodiumque pyriforme sericeum stylo brevi columellari glabro coronatum. Pedicellus calyxque in fructu breviter sparsim pubescens. Pedicellus c. 1 mm. longus brevis. Lobi calycis longiores 3, –5 × 1.5 cm. late spatulati obtusi basim versus –3 mm. lati attenuati; partibus basalibus –5 mm. latis saccatis incrassatis; lobis brevioribus 2, –4 × 1 cm. aliter ut in lobis longioribus. Nux –2.5 × 1.5 cm. obovoidea conferte breviter plane alutaceo-pubescentis in apice mucronata attenuata.

Collections.—Sarawak: S. 15258 (Holotypus in Herb. Kew), 15715 (Galau), S. 9345, 9345A (Yacup), S. 11056 (Ghazalli), S. 15179 (Rosli and Jugah), S. 14999, 15718 (Rosli), Tree No. 603 (Asah), S. 10033 (Zen) Semengoh F.R.; S. 15211 (Smythies) Bt. Gaharu; S. 9607, 9609, 9615 (Ariffin) G. Tamin, Lundu; S. 6513 (Yakup) Gunong Tabut, Ulu Sebuyau; S. 9483, 9487, 9487A (Saidi) Santubong; S. 364 (Ariffin) Bt. Sebandar, Lundu; S. 10289, 10289A (Ardzi) Bako N.P.

This species is allied to *S. faguetiana* Heim and *S. gibbosa* Brandis in section *Richetioides* Heim, but differs in the fewer nerves, glabrous leaf and smaller size of all parts. Furthermore

the bark surface configuration appears to be unique in the section: at first smooth, chocolate-brown with grey lichen-mottling; becoming regularly surface-fissured, fissures 8 mm. broad, 4 mm. deep, V-section, anastomosing, separated by short sharp zig-zag ridges; ridges flaking evenly in small oblong pieces leaving an overall smooth tawny prominently scroll-marked surface beneath; in old trees further flaking irregularly. This surface-fissure configuration evokes that of *Shorea biawak* Ashton of section *Shorea* subsection *Barbatae* Sym. ex Ashton (see my Manual of the Dipterocarp Trees of Brunei State, p. 129, pl. 37), but in that species the flaking is chunky and bears no relation to the surface fissuring.

S. cuspidata formerly bore the code-letter names *Shorea* H₁, *Shorea* K₄, and *Shorea* Z₃. It is found on yellow sandy soils in Mixed Dipterocarp forest. It is widespread in Sarawak west of the Lupar, and is frequently the most abundant representative of the section.

***Shorea iliasii* Ashton sp. nov.**

Plate 36.

Species lamina ut in *S. faguetiana* Heim, sed 19–25 × 9–12 cm. maiore costis lateralibus utrinsecus 12–14 petiolo 22–30 mm. longo c. 3 mm. diam. differt.

Novelli caduce griseo-sericei. Ramuli apices versus c. 2 mm. diam. teretes griseo-fusci saepe chartaceo-exfoliati; internodis 4 cm. longis; cicatricibus stipularibus brevibus horizontalibus. Gemma stipulaeque ignota. Lamina 19–25 × 9–12 cm. oblongo-ovata, basi obtusa sed breviter decurrenti subaequali, apice in acumen 8 mm. longum breve attenuata; costis lateralibus utrinsecus 12–14 curvatis subtus prominentibus angulo 50°–75° exorientibus; intercostis remote scalariformibus; costa media supra applanata vel paullum elevata subtus prominenti. Petiolus 22–30 mm. longus c. 3 mm. diam. crassus teres sicco nigrescens. Racemi 10 cm. longi, stipitis basi in fructu c. 3 mm. diam., teretes caduce griseo-sericei. Alabastrum 4 × 2 mm. parvum fusiforme. Calyx partibus in alabastro expositis conferte puberulentibus, lobis externis 3 ovatis acutis internis 2 quam externis minoribus breviter fimbriatis basim versus angustioribus. Petala crema lineara obtusa partibus in alabastro expositis conferte pubescentibus. Stamina 15 verticillis 2 inaequalibus, internis 5 quam aliis paullum longioribus, filamentis basim versus latis sub antheris subglobosis filiformibus attenuatis; aristis quam antheras c. 1½-plo longioribus apices versus sericeis. Ovarium anguste ovoideum pubescente stylo brevi glabro attenuatum. Calyx basim versus sparsim griseo-sericeus, aliter glaber; lobis longioribus 3, 8 × 2.2 cm. spatulatis obtusis vel subacutis basim versus 4 mm. latis attenuatis; partibus basalibus 6 × 5 mm. saccatis incrassatis prominenti tuberculatis; lobis brevioribus 2, 5.5 × 1.2 cm. aliter ut in lobis longioribus. Nux 10 × 8 mm. ovoidea acuta conferte persistente griseo-sericea.

Collections.—Sarawak: S. 15102 (Ilias) Ulu Segan, Bintulu (Holotypus in herb. Kew); SA. 310 (Spurway) Long Sangga, Baram; S. 1455 (Brunig) Ulu Skroh, Kapit; S. 15842 (Ilias and

Johnson) Similajau F.R., Labang; S. 22063, 22041 (Ashton) N. Sepulau, Segan; S. 22258, 22259 (Suib) Bt. Raya; S. 22304 (Suib) Bt. Wong, Pelagus.

Differing from *S. faguetiana* Heim in the larger size of all parts and the greater number of lamina nerves, this species is known so far from the Lower Rejang to the Kemena drainage in Central Sarawak.

***Shorea macrobalanos* Ashton sp. nov.**

Plate 37.

S. longiflorae (Brandis) Sym. affinis, sed lamina 19–37 × 8–15 cm. latiore nervis angulis 45°–65° exorientibus basi excepta petiolo 1.8–3.7 cm. longo differt.

Gemma stipulaque persistente alutaceo-pubescentis aliter glaber. Ramuli apices versus c. 4 mm. diam. primo teretes dein verrucosi pallide alutacei; internodis –7 cm. longis; cicatricibus stipularibus c. 3 mm. longis obscuris ascendentibus. Gemma –2 × 2 mm. ovoidea acuta. Stipula ignota. Lamina 19–37 × 8–15 cm. oblonga coriacea, margine revoluto, basi cordata, apice in acumen brevi abrupte attenuata vel obtusa; nervis utrinsecus 12–16 subtus prominentibus angulo 45°–65° exorientibus basi excepta; intercostis gracilibus remote subreticulatis; costa media supra applanata subtus prominenti. Petiolus 1.8–3.8 cm. longus c. 4 mm. diam. sicco nigrescens. Flores ignoti. Racemi –32 cm. longi, basi stipitis in fructu –5 mm. diam., longi terminales vel axillares paullum compressi glabri pallide fuscis rugescentes semel vel bis ramosi. Fructus sessilis glaber; lobis calycis –8 × 8 mm. subaequalibus ovatis saepe marginem versus undulatis expansis. Receptaculum –1 cm. diam. –8 mm. longum magnum. Nux –5 × 2.5 cm. magna oblonga breviter apiculata.

Collections.—Sarawak: S. 13192 (Smythies) G. Berumput (Holotypus in Herb. Kew); S. 10324 (Brunig), S. 11726 (Hj. Bujang) Semengoh F.R.; S. 13712 (Ilias Paie) G. Pueh.

Undoubtedly closely allied to *Shorea longiflora* (Brandis) Sym. of Section *Richetioides* Heim, this West Sarawak species differs in the relatively longer petiole, relatively broader lamina and larger parts generally, and in the much larger size the tree attains.

***Shorea mujongensis* sp. nov.**

Plate 38.

S. gibbosae Brandis affinis sed lamina maiore subtus glabra margine prominente revoluto petiolo glabrescenti differt.

Ramuli apices versus gemmae petiolique breviter alutaceo-pubescentes dein glabrescentes. Ramuli apices versus c. 2 mm. diam. teretes ruguli lenticellis pallidis minutis punctati; internodis –3 cm. longis; cicatricibus stipularibus brevibus obscuris. Gemma –2 × 1 mm. conica. Stipula ignota. Lamina 7–14 × 2.8–5.5 cm. ovata margine revoluto basi obtusa vel late cuneata, apice in acumen –8 mm. longum attenuata; costis lateralibus utrinsecus 9–13 gracilibus subtus prominentibus curvatis angulo c. 50° exorientibus; intercostis scalariformibus obscuris haud elevatis; costa media supra applanata subtus prominente tereta. Petiolus 10–16 mm.

longus c. 2 mm. diam. teres sicco nigrescens. Flores ignoti. Racemi –6 cm. longi, stipitis basi –2 mm. diam. semel ramosi teretes ruguli breviter plane alutaceo-pubescentes. Pedicellus in fructu –2 mm. longus –1 mm. diam. puberulens. Calyx in fructu sparsim puberulens dein glabrescens; lobis longioribus 3, -7×1.5 cm. spatulatis obtusis basim versus c. 4 mm. latis attenuatis partibus basalibus -6×5 mm. tuberculatis incrassatis; lobis brevioribus 2, -4.5×0.7 cm. aliter ut in lobis longioribus. Nux -2.2×0.7 cm. anguste ovoidea conferte breviter pallide alutaceo-pubescentes.

Collections.—Sarawak: S. 19038 (Ashton) Base of Bt. Temedu, Hose Mountains (Holotypus in Herb. Kew); S. 19993, 19603 (Ashton) Carapa Pila.

At present this magnificent tree is known only from the inaccessible woods on the middle slopes of the Hose mountains. The lustrous leaves make its pale crown easily identifiable in aerial photographs.

***Shorea hemsleyana* King ex Foxw., Mal. For. Rec. 10 (1932) 167:
Notes on infraspecific variation.**

Symington (Gard. Bull. S.S. 7 (1933) 129) revised the nomenclature and synonymy of this Malayan species. He reduced *Shorea grandiflora* Brandis (J. Linn. Soc. Bot. 31 (1895) 93) to it, based on Haviland 2121, with flowers and fruits, from the Kuching area of Sarawak. Until recently this remained the only Bornean collection; but now that more material has been collected from Borneo it has become apparent that the type specimen of *S. grandiflora* bears leaves and twigs larger than they are on mature trees of this species in Borneo, inferring that it was collected from an immature specimen. These parts are considerably smaller than is normal for the species in Malaya, and justify the Bornean form's resurrection as a separate subspecies:

ssp. hemsleyana

Lamina 14–35 \times 6–15 cm. Petiolus 1.4–2 cm. longus. Racemus –25 cm. longus.

Collections examined.—Malaya: Kunstler 6670, 7562, Larut Perak, Scortechini 1653, Perak (Syntypes); Curtis 2512, 3739, Province Wellesley; Kep. 16814, Lumut F.R.; Dindings; Kep. 75983, 80220, Kepong plantations; Kep. 16826, Bruas F.R., Dindings; Kep. 12018, Parit F.R., Tronoh, Perak.

ssp. grandiflora (Brandis) Ashton, stat. nov.

—*S. grandiflora* Brandis, J. Linn. Soc. Bot. 31 (1859) 93.

Omnes partes ut in *ssp. hemsleyana* sed lamina 10–23 \times 4–11 cm., petiolo 6–12 mm. longo, racemis –4 cm. longis differt.

Collections.—Sarawak: Haviland 2121, near Kuching (Holotypus in herb. Kew); S. 18860 (Ashton), S. 12612 (Smythies) Bt. Mero-yong, Sempadi F.R., Lundu; S. 6503 (Yakup) G. Menuku, Sebuyau (fruit excepted); S. 21585 (Ashton) G. Matang; S. 22333 (Suib) Bt. Leran, Niah; S. 6236 (Brunig) G. Pueh F.R.

The identity of *Shorea johorensis* Foxw.

This species was described (Mal. For. Rec. 10 (1932) 236) from a single specimen, Kep. 5992 (Bain) Gunong Panti, Johore, now in the Kew herbarium. It bears somewhat immature fruits. Symington (Mal. For. Rec. 16 (1943) 72) regarded it as a dubious species, tentatively synonymous with *S. singkawang* Miq., notwithstanding that species has vestigial fruit calyx lobes, whereas the fruit of Kep. 5992 is prominently winged.

The material of *S. singkawang* now available shows that the fruit of Kep. 5992 is definitely not of this species; though it is detached, Foxworthy's photograph of the fresh material with attached fruits is clear enough to be unequivocal. Kep. 5992 is however identical with Kep. 35758 and 35759, from the same locality, cited by Symington in his original description of *S. leptocladus* (Gard. Bull. S.S. 10 (1939) 376). The Holotype of *S. leptocladus*, Kep. 30533 (Smith) Batu Apoi, Brunei in the Kepong herbarium, differs, as does most, but not in fact all, Bornean material, from Malayan material in possessing 3–6 pairs of pale scale-like domatia in the axils of the first 3–6 pairs of basal nerves. This, the only difference, is not only small but inconstant, and I feel compelled, therefore to reduce *S. leptocladus* to Foxworthy's species.

Shorea uliginosa Foxw. reinstated.

This species was described (Mal. For. Rec. 10 (1932) 210) from Kep. 7938 (Foxworthy) Bukit Cheraka F.R., Selangor, a flowering collection, represented both at Kepong and Kew. Symington (Gard. Bull. S.S. 10 (1939) 372) reduced it to a variety of *S. rugosa* Heim, stating that '*S. uliginosa* has slightly larger leaves with relatively longer petioles, and smaller, less hairy fruits'. He concludes 'I think a reasonable and satisfactory way of treating the problem is to consider *S. uliginosa* Foxw. as a variety of *S. rugosa* Heim'.

Symington noted that the two varieties might occur in different habitats; they do, Foxworthy's species being confined to peat swamps and Heim's to leached sandy soils. Though the flowers, inflorescences, tomentum and bark appear similar in the two taxa there are other differences besides those mentioned by Symington. The lamina of *uliginosa* is chartaceous and prominently concave, whereas that of *rugosa* is applanate and thickly coriaceous. The habit of *uliginosa* with its oblong diffuse crown with large flopping semi-pendant leaves is quite different from the dense hemispherical crown of *rugosa*. I consequently consider that these two taxa are specifically distinct, and reinstate *S. uliginosa* Foxw.

Shorea carapae Ashton sp. nov.

Plate 39.

S. coriaceae Burck affinis sed lamina 13–18 × 7–10 cm. costis lateralibus utrinsecus 11–13 subtus crassis prominentibus petiolo breviter conferte plane persistente alutaceo-sericeo differt.

Ramuli gemmae stipuli petiolique persistente conferte plane alutaceo-sericei, costis subtus costa media supra sparsim eisdem. Ramuli apices versus c. 3 × 2 mm. primo compressi rugosi dein

terescentes levescentes pallide griseo-fusci; internodis 6 cm. longis; cicatricibus stipularibus prominentibus prope amplexicaulibus descensis. Gemmae c. 7×2 mm. lanceolatae caudatae. Lamina $13-18 \times 7-10$ cm. late ovato-elliptica coriacea basi obtusa vel cordata apice in acumen breve latum attenuata; costis lateralibus utrinsecus 11-13 crassis prominentibus angulo $50^\circ-70^\circ$ exorientibus; internodis gracilibus conferte scalariformibus haud elevatis; costa media supra applanata vel paullum depressa subtus prominenti. Petiolus 23-35 mm. longus c. 2 mm. diam. teres.

Collections.—Sarawak: SK. 168 (Brunig) Batu Skalap, Merurong Plateau; S. 3864 (Pickles) S. Julan, Usun Apau; S. 13991 (Ashton) Ulu Teniai, Hose mountains. Sabah: SAN. 39323 (Meijer) Tavai plateau, Ulu Karamuak. Indonesian Kalimantan: Kostermans 13095, Mr. Palimasan, near Tabang, Ulu Belajan, W. Kutei (Holotypus in herb. Kew).

Differing from *S. coriacea* Burck, to which it appears to be most closely allied, in its larger leaf with pubescent petiole and stouter more prominent nerves. This species is characteristic of 'carapa' — pole forest under poor drainage conditions — on high level plateaux, usually between 700-1,300 m. alt., and has been observed on sandstone, dacite and also ultrabasic rocks; SAN. 39323, which is the record from the latter, is however atypical in having an unusually short petiole.

The bark morphology suggests that this species belongs to sec. *Brachyterae* Heim.

Shorea foraminifera Ashton sp. nov.

Plate 40.

S. teysmanniana Dyer ex Brandis affinis sed lamina late ovata, costis lateralibus utrinsecus 8-9 subtus prominentibus domatiis magnis axillaribus costa media subtus tereti differt.

Novelli lamina stipulaeque excepta fugace puberulentes. Ramuli apices versus 1-2 mm. diam. primo paullum compressi dein teretes fusci leves; internodis 3.5 cm. longis; cicatricibus stipularibus brevibus subhorizontalibus. Gemma 8×5 mm. ovoidea compressa subacuta. Stipula 10×5 mm. oblongo-elliptica obtusa caduca. Lamina $6-9 \times 4-7$ cm. late ovata coriacea, basi cordata vel obtusa, apice in acumen 5 mm. longum paullum falcatum abrupte attenuata; costis lateralibus utrinsecus 8-9 crassis subtus prominentibus curvatis domatiis axillaribus prominentibus foraminiferis angulo $55^\circ-70^\circ$ exorientibus basi excepta; intercostis obscuris conferte scalariformibus; costa media supra applanata subtus crassa tereti prominenti. Petiolus 10-15 mm. longus c. 2 mm. diam. Flores racemique ignoti. Pedicellus in fructu c. 1 mm. longus c. 1 mm. diam. brevis. Calyx in fructu basim versus alutaceo-puberulens apicem versus sparsim idem; lobis longioribus 3, 7×1.2 cm. spatulatis subacutis basim versus 4 mm. latis attenuatis partibus basalibus 11×5 mm. ovatis incrassatis saccatis; lobis brevioribus 2, 4.5×0.4 cm. loratis acutis basim versus ut in lobis longioribus. Nux 15×10 mm. ovoidea persistente alutaceo-pubescenti breviter apiculata.

Collections.—Kep. 35719, Andulau F.R.; S. 1916 (Smythies) (Holotypus in herb. Kew), SAN. 17531 (Wood, Smythies, and Ashton) Brun. 5541 (Ashton), Andulau F.R.; Brun. 243 (Ashton) Ulu Belait Boundary rentis; s.n., Hasan, enumeration survey, Baram-Rawa, Ulu Belait, 9/2/53.

This species I had previously regarded as a variety of *S. teysmanniana* Dyer ex Brandis (Manual of the Dipterocarp Trees of Brunei State (1964) 225, where the two trees are compared). It is so far only known from Brunei, where it is sometimes very common, and is found in fresh water swamp forest unlike *S. teysmanniana* which is confined to peat.

***Shorea pallidifolia* Ashton sp. nov.**

Plate 41.

Species lamina ut in *S. elliptica* Burck sed 13–22×7–13 cm. maiori tomento ochraceo scabrido basi subcordata costis lateralibus utrinsecus 12–19.

Ramuli gemmae stipulae costae laminarum subtus petiolique persistente pallide flavo-brunneo-scabrido-tomentosi, lamina subtus brevissime conferte persistente ochraceo-scabrido-pubescentibus. Ramuli apices versus c. 6×3 mm. diam. crassi primo compressi costati dein terescentes; internodis 1–4 cm. longis; cicatricibus stipularibus –2 mm. longis subhorizontalibus prominentibus. Gemma –10×8 mm. late ovoideo-conica compressa. Stipula –15×7 mm. oblonga obtusa caduca. Lamina 13–22×7–13 cm. late oblonga vel ovata vel obovata coriacea, basi obtusa vel subcordata, apice in acumen breve latum abrupte attenuata; costis lateralibus utrinsecus 12–19 curvatis supra obscuris subtus prominentibus basim versus angulo –110° exorientibus apicem versus angulo 45°–70° exorientibus; intercosti gracilibus conferte scalariformibus subtus vix elevatis; costa media supra obscura depressa subtus prominenti. Petiolus 2–3.5 cm. longus c. 4 mm. diam. crassus siccus rugosus. Racemi –15 cm. longi, stipitis basi in fructu –4 mm. diam., paullum compressi angulati axillares vel rare terminales semel vel bis ramosi; ramulis –3 cm. longis –6 flores distichos gerentibus; bracteolis –4×3 mm. ellipticis obtusis caducis externe breviter plane pubescentibus intus glabris. Alabastrum –6×3 mm. ellipsoideum. Lobi calycis partibus in alabastro expositis pubescentibus, extiores 3 deltoidei acuti interni 2 ovati quam externi 3 minores marginem versus tenuiores. Petala elliptica partibus in alabastro expositis pubescentibus. Stamina ignota. Ovarium ovoideum glabrum, stylo filiformi glabro quam ovarium paullum longiore. Pedicellus calyxque in fructu breviter sparsim plane pubescens. Pedicellus c. 1 mm. longus c. 1 mm. diam. parvus. Lobi calycis longiores 3, –7×1.5 cm. late spatulati obtusi basim versus –7 mm. lati attenuati, partibus basalibus –10×8 mm. late ovatis paullum incrassatis; lobi breviores 2, –4×0.3 mm. lineares basim versus ut in lobi longiores. Nux –12×9 mm. ovoidea breviter apiculata conferte breviter pallide alutaceo-pubescentibus.

Collections.—Sarawak: S. 16054 (Rashid) Bako National Park (Holotypus in Herb. Kew); Kep. 79314 (Wyatt-Smith) Munggu Unjam F.R.; S. 7452 (Brunig) Selang F.R.; S. 9315 (Bujang)

Setapok F.R.; S. 5957, 6161 (Brunig) Sempadi F.R.; S 13357 (Abang Muas) Balai Ringin P.F.

As the stamens are unknown this species cannot be placed in a section with conviction, though it appears to be most closely allied to *S. elliptica* Burck in Section Rubella Ashton; it differs in the larger lamina with more abundant nerves and ocherous scabrid not cream tomentose undersurface like *S. elliptica*. It is confined to the region of West Sarawak, where it is found in Heath forest.

Shorea praestans Ashton sp. nov.

Plate 42.

S. stenoptera Burck, *S. macrophylla* (De Vr.) Ashton affinis sed lamina 24–35 × 11–20 cm. maiore basi cordata stipulis 4–6.5 cm. longis glabris maioribus differt.

Partes ex integro glabri. Ramuli apices versus c. 5 × 3 mm. crassi compressi leves; internodis 3–4.5 cm. longis; cicatricibus stipularibus gracilibus evidentibus amplexicaulis. Gemma –25 × 7 mm. falcato lanceolata compressa acuta. Stipulae –11 × 5 cm. grandissimae ellipticae subacutae subpersistentes. Lamina 24–35 × 11–18 cm. grandis plus minus late oblonga coriacea basi cordata apice obtusa vel breviter late acuminata; costis lateralibus utrinsecus 11–13 supra obscuris subtus prominentibus angulo 45°–70° exorientibus basi excepta; intercostis remote scalariformibus gracilibus subtus evidentibus; costa media supra applanata subtus prominenti. Petiolus 4–6.5 cm. longus c. 5 mm. diam. crassus sicco nigrescens rugescens. Flores racemique ignoti. Fructus ex integro glaber. Pedicellus in fructu c. 5 mm. longus c. 5 mm. diam. crassus. Calyx lobis longioribus 3, –15 × 3 cm. spatulatis obtusis basim versus c. 1.5 cm. latis attenuatis partibus basalibus –1.5 × 1.8 cm. late ellipticis saccatis; lobis brevioribus 2, –10 × 1.5 cm. loratis subacutis basim versus ut in lobis longioribus. Nux –2 × 2 cm. ovoidea glabra stylopodio –4 mm. longo filiformi attenuata.

Collections.—Sarawak: s.n., 18.6.58 (Anderson), s.n. (Brunig) (Holotypus in herb. Kew), S. 22074, 22075 (Ashton) Bintulu reservoir, Nyabau F.R.; S. 19598 (Ashton) Ulu Kenyana, Mukah.

This is a local species, known so far in Central Sarawak; though this small tree of Heath forest is closely allied to *S. stenoptera* Burck the lamina is considerably larger, the base cordate and the petiole relatively longer. Though only immature fruit have been collected they appear to be more similar to those of *S. beccariana* Burck than *S. stenoptera*, with relatively small nut and 3 long aliform calyx lobes.

Shorea pubistyla Ashton sp. nov.

Plate 43.

S. scaberrimae Burck *S. fallaci* Meijer affinis sed lamina latiore basi cordata petiolo racemoque longiore lobis calycis in fructu longioribus aliformibus differt.

Ramuli gemmae costa media subtus petiolique conferte persistente scabrido-fulvo-tomentosi; costae laminae costa media supra stipulae externe brevior scabrido-tomentosi stipulae intus caduce plane pubescentes. Ramuli apices versus c. 7 mm. diam. crassi primo prominente costati dein terescentes; internodiis 1–3 cm. longis; cicatricibus stipularibus c. 2 mm. longis horizontalibus obscuris. Gemmae –1.3 mm. longae –1.3 mm. diam. ovoideo-compressae. Stipulae –2.5×0.7 cm. lanceolatae subcaudatae caducae. Lamina 11–19×7–12 cm. late oblonga vel obovata coriacea, basi obtusa vel cordata, apice subretusa vel breviter acuminata; costis lateralibus utrinsecus 14–16 supra obscure depressis subtus prominentibus basim versus angulo –110° exorientibus apicem versus angulo –45° exorientibus; intercostis remote scalariformibus subtus prominentibus. Petiolus 2.5–4 cm. longus c. 3 mm. diam. crassus. Racemi –20 cm. longi, stipitis basi in fructu –3 mm. diam., costati conferte breviter fulvo-scabrido-tomentosi laxi axillares semel ramosi; ramulis –6 cm. longis –12 flores secundis gerentibus; bracteolis –8×5 mm. oblongo-ovatis subacutis breviter plane pubescentibus caducis. Alabastrum –7×3 mm. lanceolatum. Lobi calycis conferte tomentosi exterioribus 3 ovatis acutis interioribus 2 ovatis marginem versus fimbriatis quam exterioribus tenuioribus basim versus angustioribus. Petala externe rosea intus coccinea elliptico-lanceolata partibus in alabastro expositis pubescentibus. Stamina 15 internis 5 quam externis 10 paulum longioribus; filamentis basim versus latis compressis apicem versus filiformibus abrupte attenuatis; antheris late ellipsoideis; aristis gracilibus glabris quam antheris 2–3-plo longioribus. Ovarium ovoideum conferte pubescente stylopodio quam ovarium paulum longiore crasso columellari conferte pubescenti stylo brevi glabro. Pedicellus in fructu –3 mm. longus, –3 mm. diam. crassus. Calyx in fructu basim versus sparsim caduce pubescens; lobis longioribus 3, –14×2.5 cm. spatulatis obtusis basim versus –8 mm. latis attenuatis; partibus basalibus –1.3×1.4 cm. late ovatis saccatis incrassatis; lobis brevioribus 2, –12×1.2 cm. loratis obtusis aliter ut in lobis longioribus. Nux –3×1.8 cm. anguste ovoideis conferte breviter plane pallide cremio-pubescentibus apice in apiculo –4 cm. longo attenuata.

Collections.—S. 14930 (Anderson) (Holotypus in herb. Kew) S. 15000, 14938 (Rosli), S. 15182 Galau), tree no. 614, 51 (Asah), FA. 1301 (Carroll) Semengoh F.R.; S. 6227 (Brunig) Sempadi F.R.; Sinclair and Kadim 10258, Gunong Gaharu, Serian; S. 16473 (Ashton) Ulu Kelawit, Tatau; S. 19575 (Ashton) Bt. Iju, Arip. Balingian; Hotta 15720, 219, Minah camp, Kakus; S. 2118 (Smythies) Bt. Teraja.

This species is identical in floral characters to *S. scaberrima* Burck, but differs in the longer inflorescence and fruit sepals, smaller nut, and larger coriaceous leaves with cordate bases and longer petioles.

It is found in Mixed Dipterocarp forest on leached clay rich soils, both overlying shales and rhyolite, in many localities west of the Belait drainage in Brunei and throughout Sarawak.

Shorea rotundifolia Ashton sp. nov.

Plate 44.

S. amplexicaulis Ashton affinis sed laminis alternatis remotis orbicularibus; stipulis -6×2 cm. grandibus subpersistentibus; petiolis 3–4 cm. longis.

Ramuli apices versus petioli stipulaeque pruinosi aliter glabri. Ramuli apices versus c. 3×2 mm. diam. teretes vel paullum compressi atro-brunnei leves dein pallide brunnescentes; internodis -6 cm. longis; cicatricibus stipularibus amplexicaulibus prominentibus. Gemma -20×8 mm. grandis lanceolata compressa. Stipula -6×2 cm. lanceolato-falcata obtusa subpersistens. Lamina $9-21 \times 8-14$ cm. alternata late ovata vel suborbicularis coriacea plus minus lustra basi obtusa vel cordata apice in acumen -1 cm. longum cuspidatum attenuata; costis lateralibus utrinsecus $9-11$ curvatis subtus prominentibus basim versus angulo -115° apicem versus angulo c. 45° exorientibus; intercostis remote scalariformibus; costa media supra applanata subtus prominenti tereti. Petiolus 3–4 cm. longus, c. 3 mm. diam. longissimus sicco nigrescens. Flores inflorescentiaeque ignoti. Fructus ex integro glaber. Pedicellus in fructu c. 6 mm. longus c. 3 mm. diam. Lobi longiores calycis in fructu 3, c. 13×2.5 cm. spatulati obtusi basim versus c. 6 mm. lati attenuati partibus basalibus c. 15×18 mm. saccatis; lobis breviores 2, -8×0.7 cm. anguste lanceolati subacuti basim versus ut in lobis longioribus. Nux c. 2.5×1.8 cm. ovoidea glabra in stylopodio -7 mm. longo attenuata.

Collections.—S. 9470 (Smythies) S. Iran, Pelagus (Holotypus in herb. Kew); S. 22051, 22053 (Ashton) Ulu Segan, Bintulu.

This local species of Central Sarawak is locally frequent on sandstone knolls and ridges below 500 m. alt. There it is frequently found actually in association with its close ally *S. amplexicaulis*, but I have found no evidence of hybridisation in the forest.

Shorea sagittata Ashton sp. nov.

Plate 45.

S. ferrugineae Dyer ex Brandis affinis sed lamina subtus ramulisque conferte breviter persistente roseo-fusco-scabrido-tomentosis costis lateralibus utrinsecus $19-25$ differt.

Lamina supra plane caduce cremio-pubescent, folia aliter ramulique conferte breviter persistente roseo-fusco-scabrido-tomentosi. Ramuli apices versus c. 2 mm. diam. teretes costati dein rufescentes verruculoscentes; internodis -3 cm. longis; cicatricibus stipularibus brevibus ascensis. Gemmae -7×7 mm. late ovoideae. Stipulae -10×8 mm. ovatae subacutae saccatae caducae. Lamina $7-14.5 \times 3-6$ cm. anguste oblonga vel lanceolata, basi obtusa, apice in acumen -1.5 cm. longum gracile attenuata; costis lateralibus utrinsecus $19-25$ gracilibus subtus prominentibus basim versus angulo $70^\circ-80^\circ$ apicem versus angulo -50° exorientibus; intercostis gracilibus conferte scalariformibus; costa media supra depressa subtus prominenti. Petiolus $9-17$ mm. longus $2-3$ mm. diam. persistente roseo-fusco-scabrido-tomentosus. Flores ignoti. Racemi -6 cm. longi, stipitis basi in fructu c. 2 mm. diam., conferte persistente roseo-fusco-scabrido-tomentosi semel ramosi. Calyx in

fructu sparsim puberulens; lobis longioribus 3, -11×2.5 cm. lorato-spatulatis obtusis basim versus -8 mm. latis vix attenuatis prominente sagittato-auriculatis in media parte saccatis incrassatis, lobis longioribus 2, -20×3 mm. linearibus acutis basim versus haud auriculatis. Nux -15×8 mm. ellipsoidea breviter apiculata apicem versus puberulens.

Collection.—S. 15882 (Ilias) Nyabau F.R.; FA. 566 (Wright) Ulu Gedong, Sadong; S. 18316 (Ashton) Ulu Sinrok, Similajau F.R.; FA. 420 (Wright) Baleh; S. 7608, 7609 (Brunig) Bungoh range; Hotta 15714, Minah camp, Kakus; S. 23616 (Sibat) (Holotypus in herb. Kew), S. 23720 (Jugah) Bt. Iju, Arip; S. 22727 (Murthy and Ashton) G. Dulit.

With close affinities to *S. ferruginea* Brandis, *S. sagittata* is in leaf characters almost indistinguishable from *Shorea ovalis* (Korth) Bl. ssp. *ovalis* of southern Kalimantan, Sumatra and Malaya, though the auriculate fruit calyx is entirely different from that species. The similarity to *S. ferruginea* extends to the bark morphology, which is overall smooth, later patchily shallowly cracking and flaking to leave a secondary smooth surface.

Recently flowering material of *S. ferruginea*, SA. 622, has come to light; the flowers are typical of section *Muticæ* Brandis.

With the addition of the present species, and with the systematic position of *S. ferruginea* now confirmed, it is all the more clear that *S. ferruginea* Brandis, *S. macroptera* Dyer, *S. slooteni* Wood ex Ashton, *S. myrionerva* Ashton, *S. acuta* Ashton and *S. sagittata* Ashton form a well defined natural group within section *Muticæ* Brandis characterised by their auriculate fruits and very different bark morphology from other species. Whitmore (Gard. Bull. Sing. 19 (1962) 358) has already anticipated this in his bark studies. I therefore propose to designate this unit as a new subsection. *Shorea* sect. **Muticæ** Brandis, subsect. **Auriculatae** Ashton subsect. nov.

Type species: *S. macroptera* Dyer.

Flores ut in Sect. *Muticæ* Brandis sed lobi calycis in fructu basim versus auriculatae.

6 species: Malaya (1), Sumatra (1), Borneo (6).

On the basis of the bark morphology Whitmore places *S. macroptera* in the same group as the species of Section *Pachycarpæ*, calling the group as a whole the Kawang subgroup. The bark of these species characteristically remains smooth, and of Whitmore's Bark Manifestation Smoth C, at least until maturity.

The definition of this manifestation is as follows (quoted from Whitmore):

'Periderms: 1-2 present together. Inner bark structure: expansion tissue of tangentially elongate stone cells and parenchyma; phloem proliferation tissue usually widespread, of parenchyma and large circular stone cells. Outer bark structure: thin rhytidome layers to 1-2 mm. thick. Sloughing: apparently absent. Surface: either finely sculptured rugose, rugulose, or not sculptured, smooth with small lenticels.' At maturity, unlike numbers of sect. *Pachycarpæ*, members of this subsection may become shallowly fissured,

exhibiting bark manifestation shallowly fissured C. This manifestation differs from that of the characteristic manifestation as follows: 'Expansion tissue in uniformly distributed fingers, — uniseriate files of tangentially elongate stone cells; fissures not penetrating into inner bark.'

Shorea sect. **Muticae** Brandis, subsect. **Muticae**.

Lobi calycis in fructu haud auriculata.

Bark surface early becoming fissured, of Bark Manifestation shallow fissured A, sometimes becoming flaky on the butt in old trees. This manifestation is defined by Whitmore as follows:—

'Periderms: multiple structure, thickness variable (0.03–0.20 mm.), phellem black and usually leathery, phelloderm either apparently absent, or 0.25 mm. thick; several, close (0.5–1.0 mm. apart, rarely more); not parallel to cambium for more than 1–3 cm. on T.S. Inner bark structure: pseudocortex present; expansion at first by fingers and wedges, then by wedges only. Outer bark structure: essentially a superficial skin, 3 mm. or less, usually dipping in at, and bounding the fissures. Sloughing: on poles usually absent; in crown absent or as layer thick, brittle, thin, scales, adherent before sloughing. Surface closely, more or less regularly, V-section fissured; fissures penetrating inner bark; ridges smooth, sometimes micro-lichen flecked; surface firm, dark coloured, at a periderm; bole smooth-fissured, becoming coarsely fissured in old trees'.

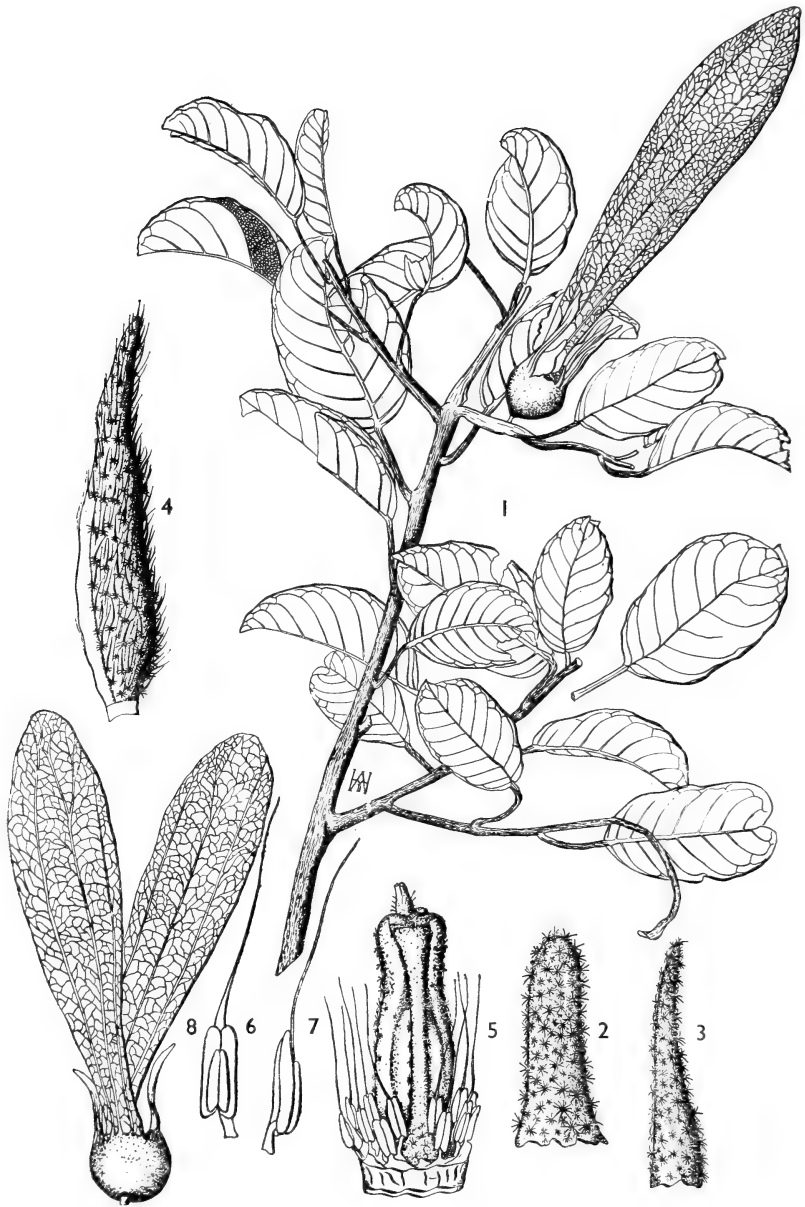


Plate 1. *Anisoptera reticulata*.

1, Fructing branchlet; 2, minor, 3, major flower sepal; 4, petal; 5, androecium and gynoecium; 6, posterior, 7, lateral view of stamens; 8, fruit. From SAN. 12864. 1, 8 = $\times \frac{1}{2}$; 2-5 = $\times 10$; 6, 7 = $\times 20$.



Plate 2. *Dipterocarpus cuspidatus*.

1, Fruiting branchlet; 2-4 fruit; 5, apex of nut. From S. 15821.
1-4 = $\times \frac{1}{2}$; 5 = $\times 1$.



Plate 3. *Vatica oblongifolia* ssp. *oblongifolia*.

1, Leafy twig; 2, 4-9, fruit; 3, surface configuration of pericarp. From S. 12816. 1, 2, 4-9 = $\times \frac{1}{2}$; 3 = $\times 2$.

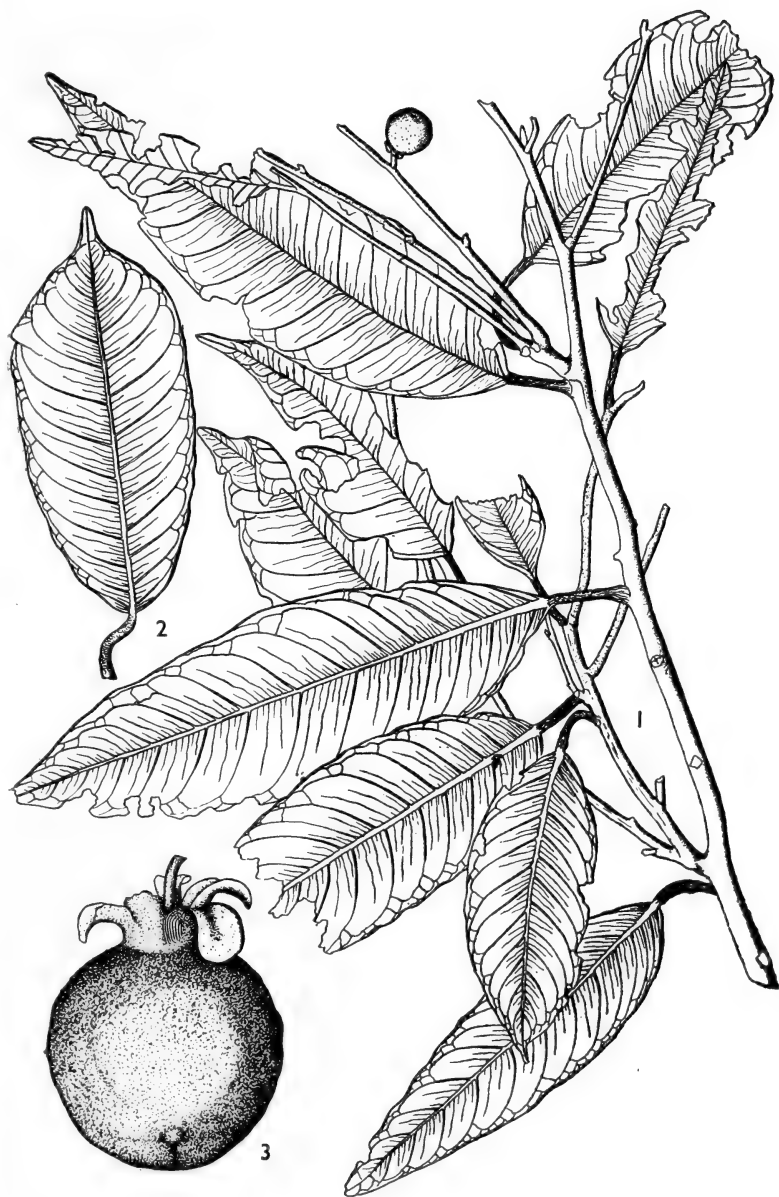


Plate 4. *Vatica oblongifolia* ssp. *selakoensis*.

1, Fruiting twig; 2, fallen leaf; 3, fruit. From S. 13340. 1, 2 = $\times \frac{1}{2}$;
3 = $\times 1$.



Plate 5. *Vatica oglongifolia* ssp. *crassilobata*.

1, branchlet with young fruit; 2, fruit; 3, fruit calyx. 1 from Brun. 614, 2, 3 from S. 2246. 1 = $\times \frac{1}{3}$, 2 = $\times \frac{1}{2}$, 3 = $\times 1$.

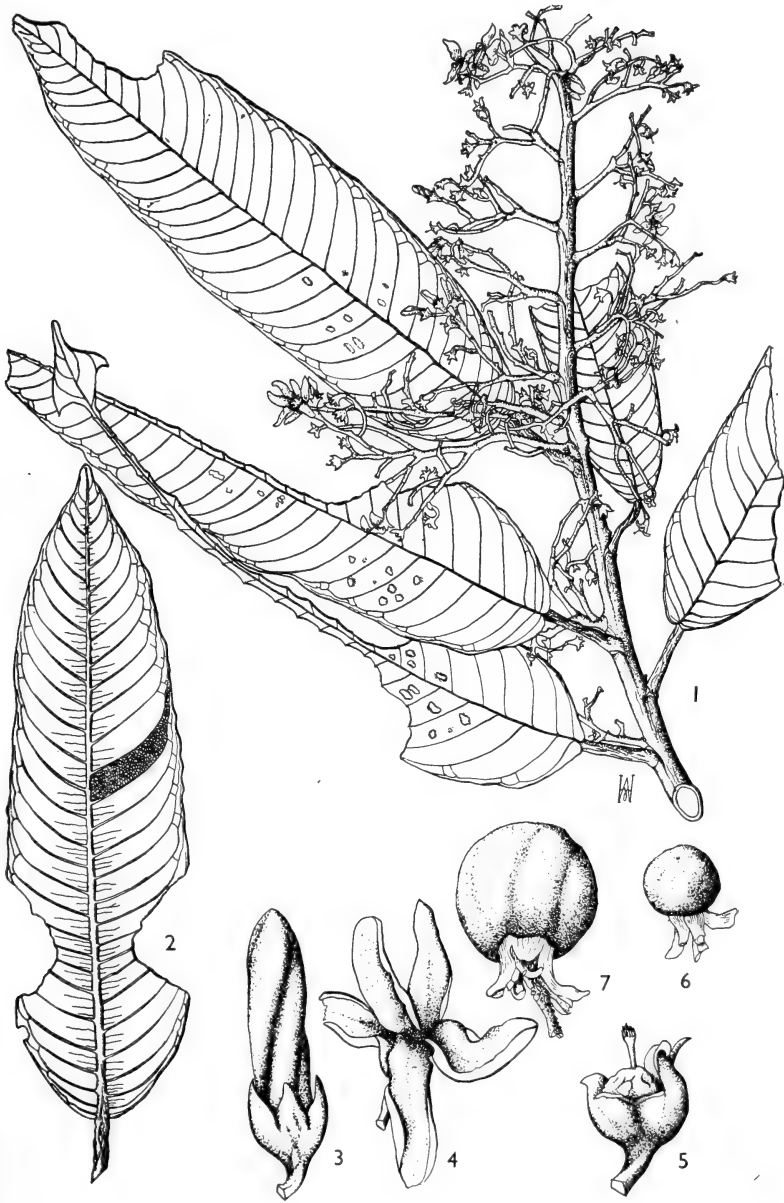


Plate 6. *Vatica oblongifolia* ssp. *multinervosa*.

1, flowering branchlet; 2, fallen leaf; 3, flower bud; 4, open flower;
 5, gynoeceum; 6, 7, fruit. 1-5 from SAN. 18475; 6, 7, from SAN.
 26029. 1, 2 = x ½; 3, 4 = x 5; 5 = x 8; 6, 7 = x 1.

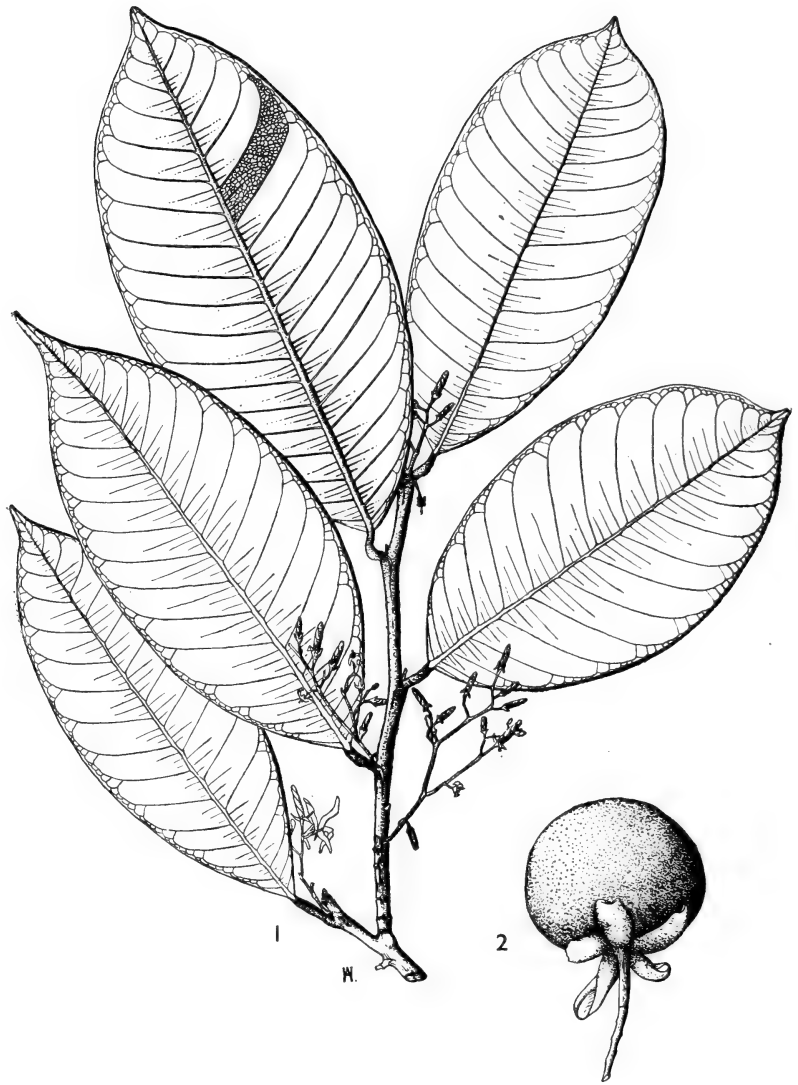


Plate 7. *Vatica oblongifolia* ssp. *elliptifolia*.

1, Flowering branchlet ($\times \frac{1}{2}$, from S. 23225); 2, fruit ($\times 2$, from Brun 925).

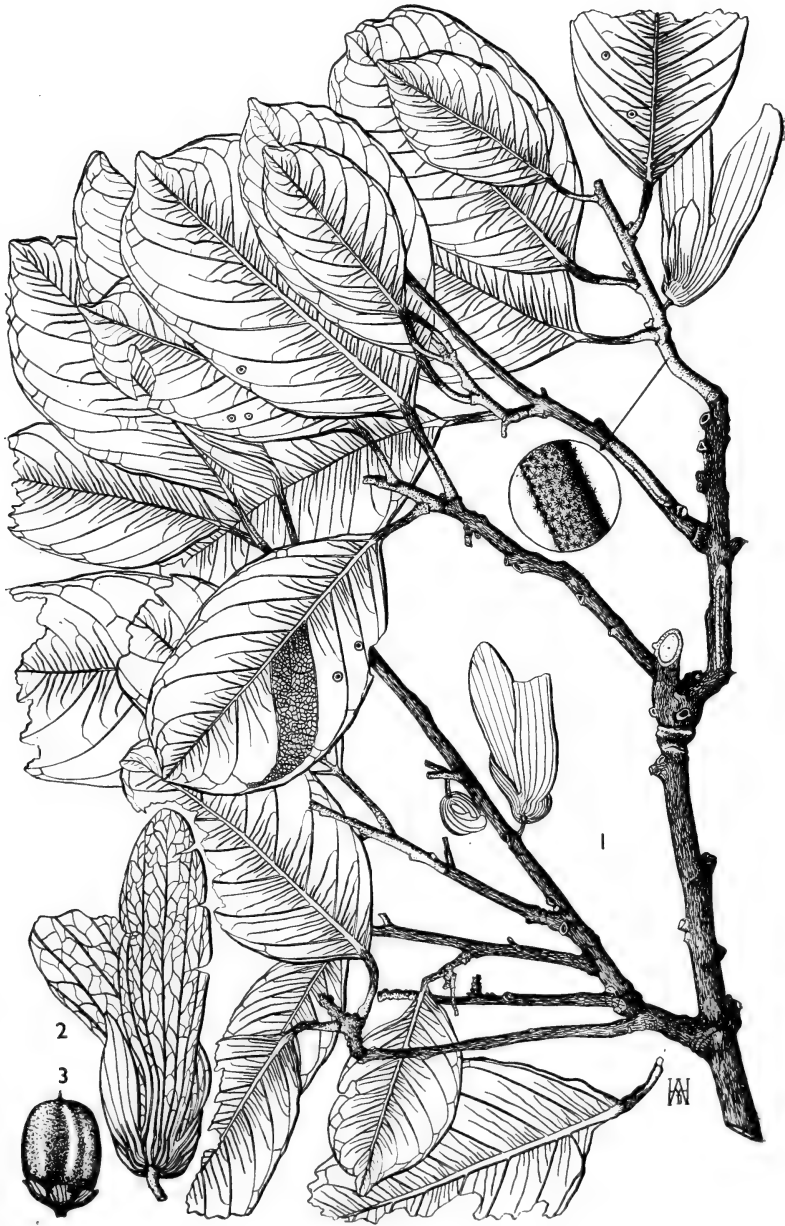


Plate 8. *Vatica badiifolia*.

1, Fruiting branchlet; 2, fruit; 3, ripe nut. From S. 15857. 1 = $\times \frac{1}{2}$,
2 = $\times \frac{2}{3}$, 3 = $\times 2$.



Plate 9. *Vatica brunigi*.

1, fructing branchlet; 2, fallen leaf; 3, flowering inflorescence; 4, 6, major, 5, minor floral sepals; 7, petal; 8, androecium and gynoecium; 9, lateral view of stamens; 10, gynoecium; 11, ripe nut. 1, 11 from S. 17045; 2-10 from S. 17885. 1, 3 = $\times 1/3$; 2 = $\times 1/2$; 4-8, 10 = $\times 10$; 9 = $\times 20$; 11 = $\times 2$.

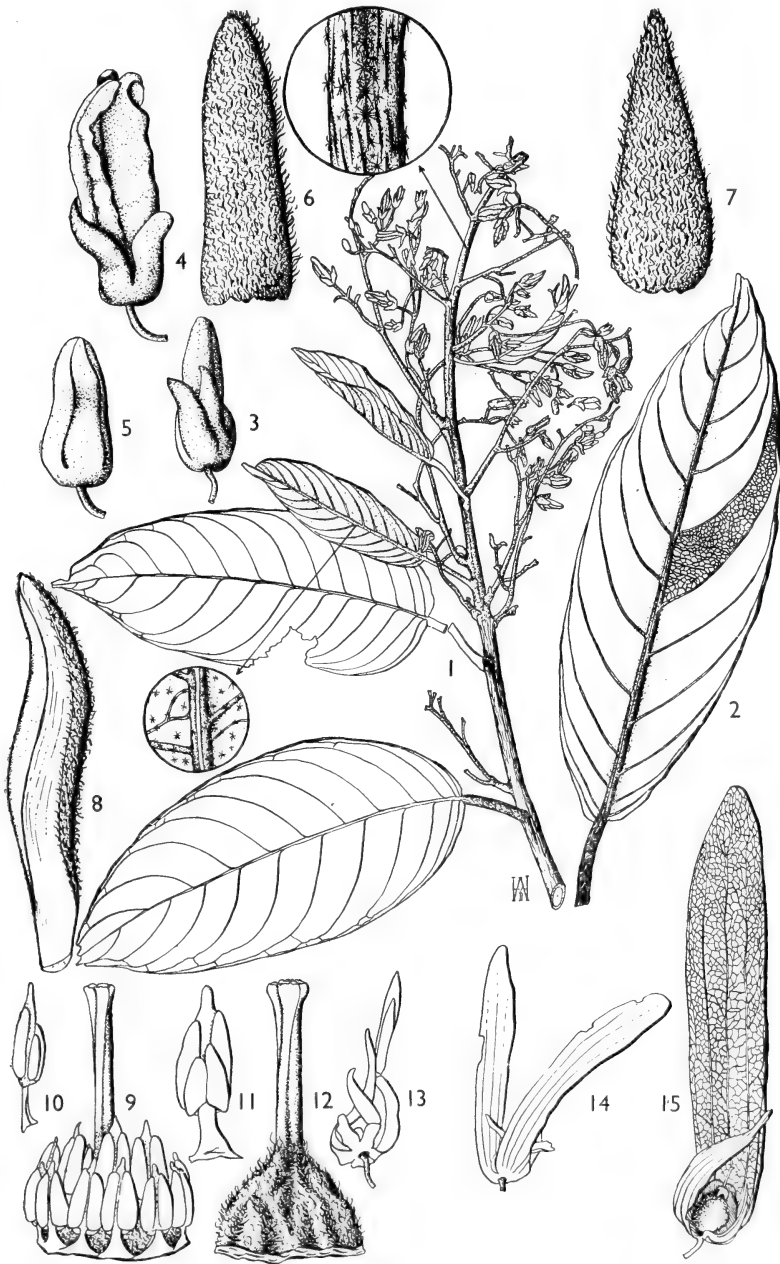


Plate 10. *Vařica compressa*.

1, flowering branchlet; 2, fallen leaf; 3-5, flower buds; 6, major, 7, minor floral sepals; 8, petal; 9, androecium and gynoecium; 10, lateral, 11, posterior view of stamen; 12 gynoecium; 13, 14, young; 15, mature fruit. 1-12 from SA. 604; 13-15, from SFN. 35618. 1, 2 — $\times \frac{1}{2}$; 3-5 — $\times 3$; 6-9, 12 = $\times 10$; 10, 11 = $\times 15$; 13-15 = $\times 1$.

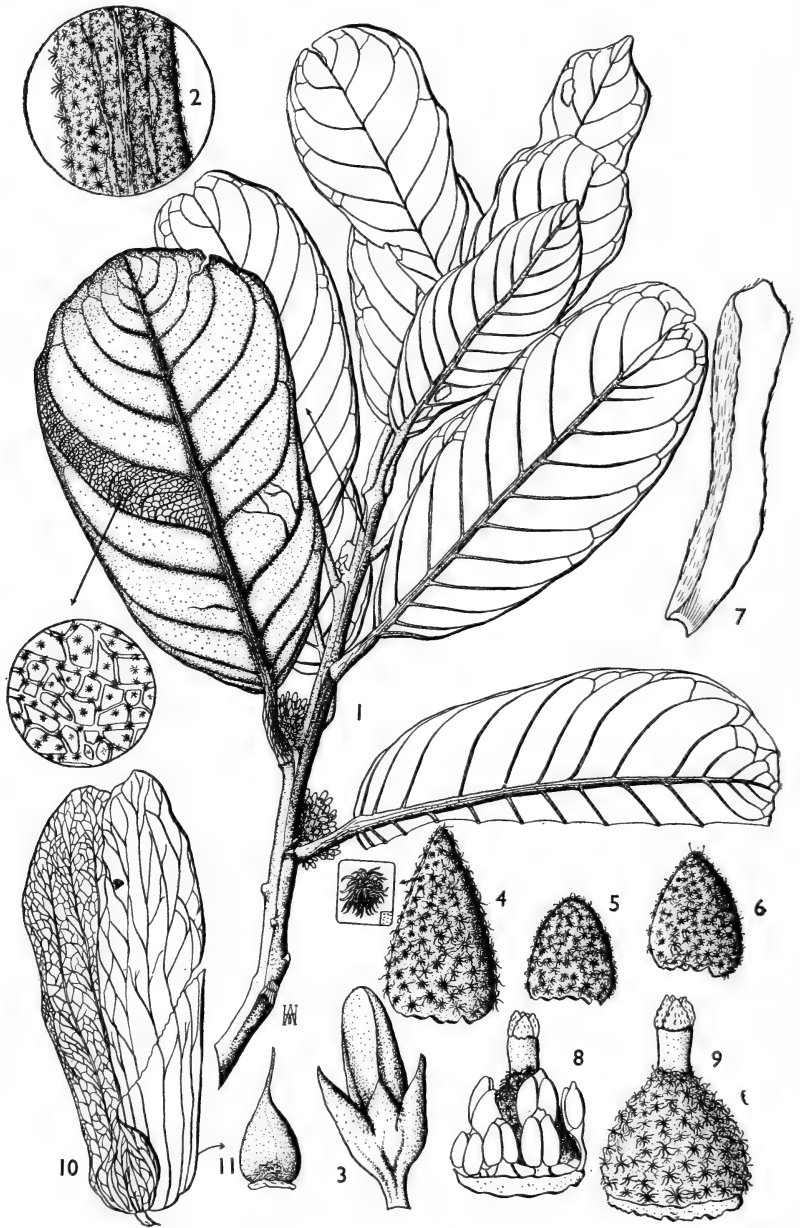
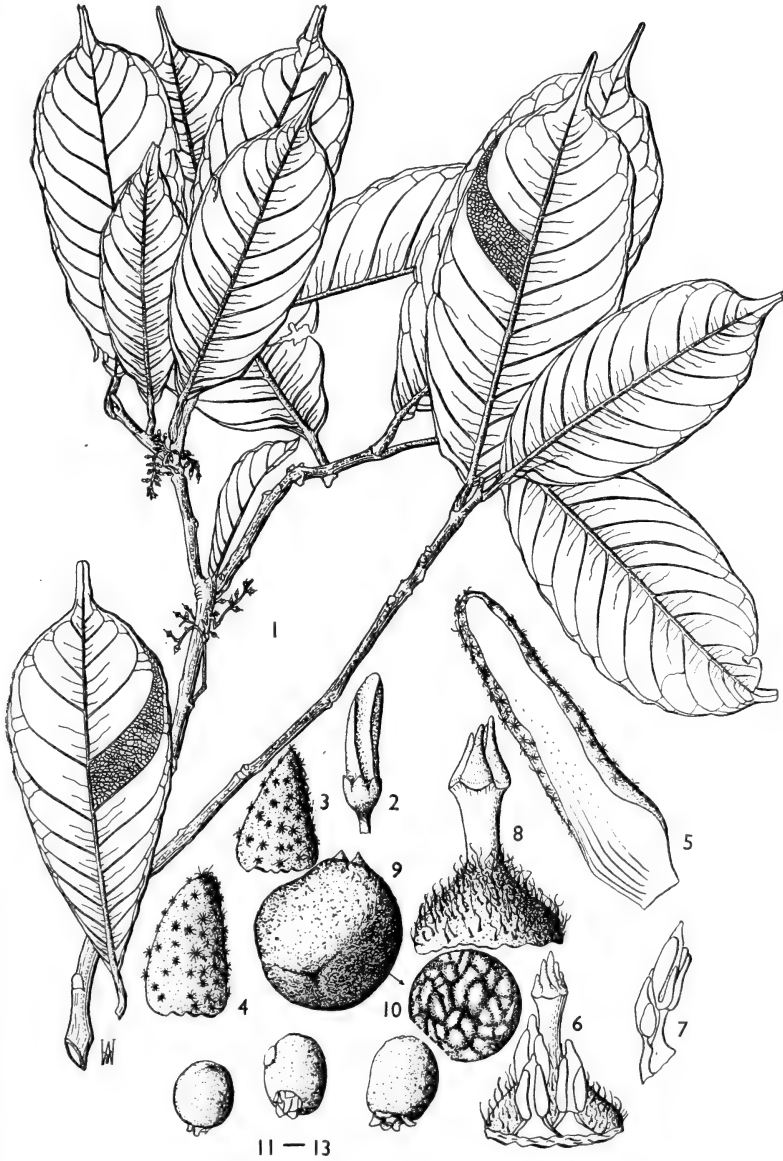


Plate 11. *Vatica congesta*.

1, flowering twig; 2, enlargement of young twig; 3, flower bud; 4, major, 5, 6, minor floral sepals; 7, petal; 8, androecium and gynoecium; 9, gynoecium; 10, fruit; 11, ripe nut. 1-9 from S. 9347; 10, 11 from S. 9347A. 1 = $\times \frac{1}{2}$; 2 = $\times 3$; 3 = $\times 4$; 4-9 = $\times 10$; 10 = $\times \frac{2}{3}$; 11 = $\times 1$.

Plate 12. *Vatica globosa*.

1, flowering branchlet; 2, flower bud; 3, minor; 4, major floral sepal; 5, petal; 6, androecium and gynoecium; 7, lateral view of stamens; 8, gynoecium; 9, 11-13, fruits; 10, surface configuration of pericarp. 1-8 from Haviland and Hose 3159; 9-13 from S 18091. 1 = $\times \frac{1}{2}$; 2 = $\times 4$; 3-8 = $\times 15$; 9-13 = $\times 1$.

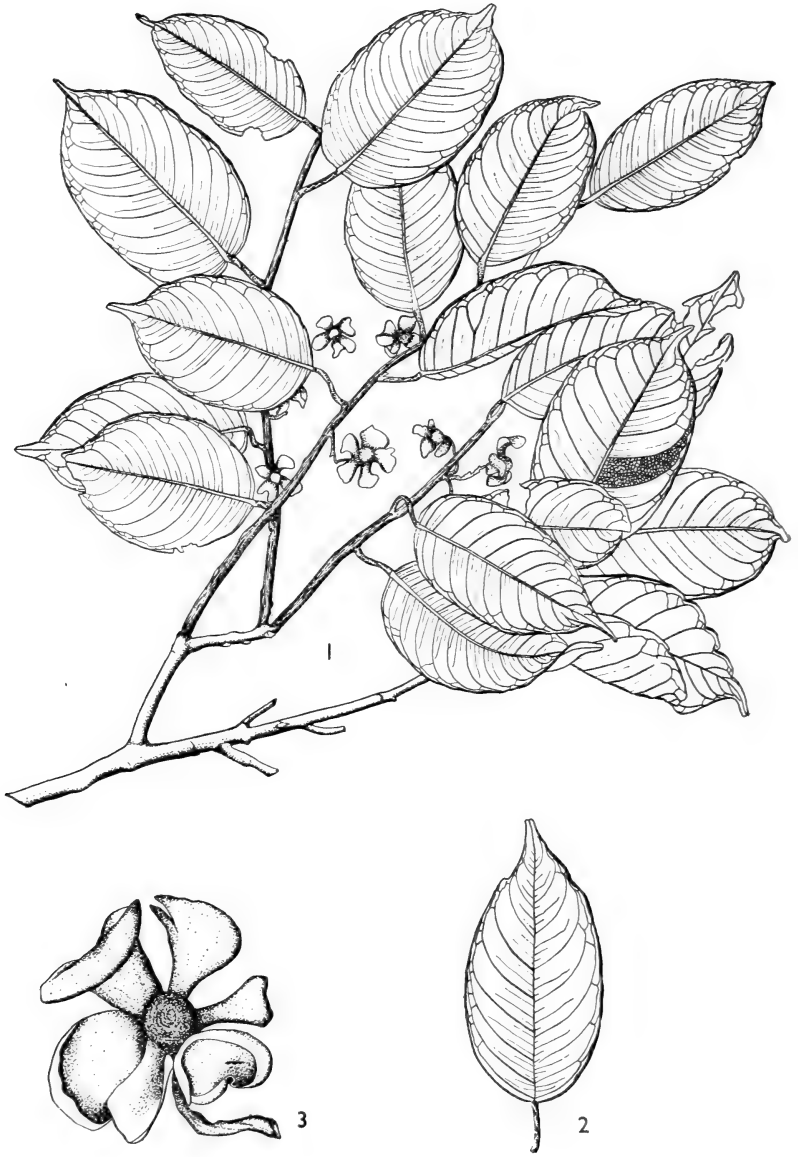


Plate 13. *Vatica rotata*.

1, fruiting branchlet; 2, fallen leaf; 3, fruit. 1, 2 = $\times \frac{1}{2}$; 3 = $\times 3$.

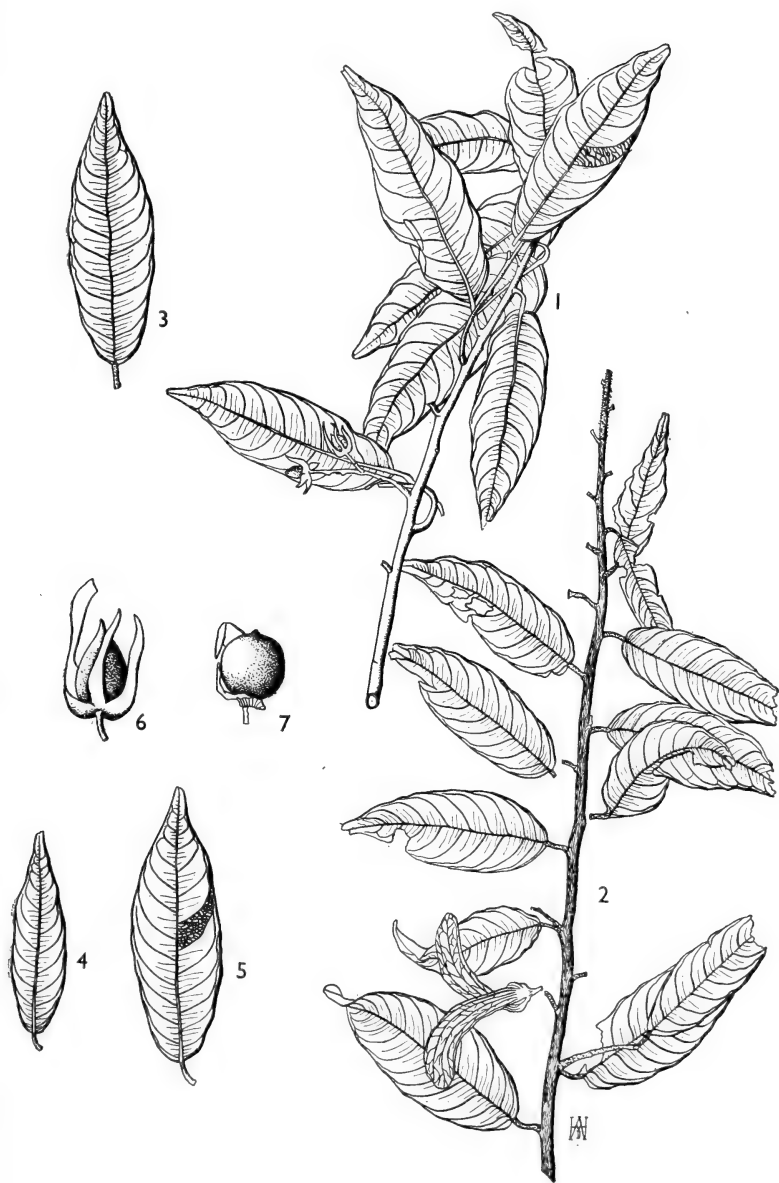


Plate 14. *Vatica rynchocarpa*.

1, branchlet with young, and 2, mature, fruit; 3-5, fallen leaf; 6, 7, ripe nut. From Brun. 3354. 1-5 = $\times \frac{1}{2}$; 6, 7, = $\times 1$.



Plate 15. *Hopea aequalis*.

1, fruiting branchlet ($\times \frac{1}{2}$); 2, fruit ($\times 2$). From S. 15881.



Plate 16. *Hopea altocollina*.

1, fruiting branchlet ($\times \frac{1}{2}$); 2, fruit ($\times 2$). From Brun. 1030.

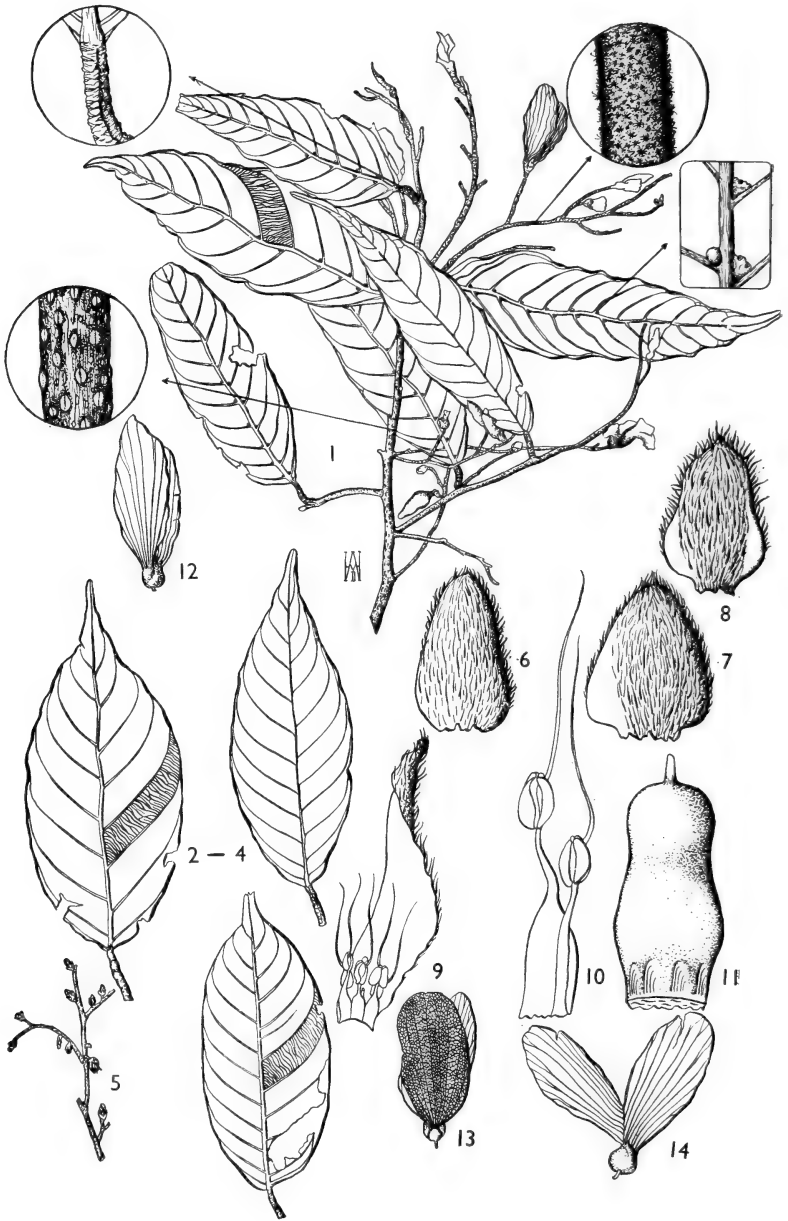


Plate 17. *Hopea andersoni*.

1, fruiting twig of *spp. basalticola*; 2-14, *spp. andersoni*. 2-4, faller leaves; 5, flowering raceme; 6, outer, 7-8, inner floral sepals; 9, petal and stamens; 10, stamens; 11, gynoecium; 12-14, fruit 1 from S. 25005; 2-14 from S. 10353. 1-5, 12-14, = $\times \frac{1}{2}$; 6-9 = $\times 10$; 10, 11 = $\times 25$.

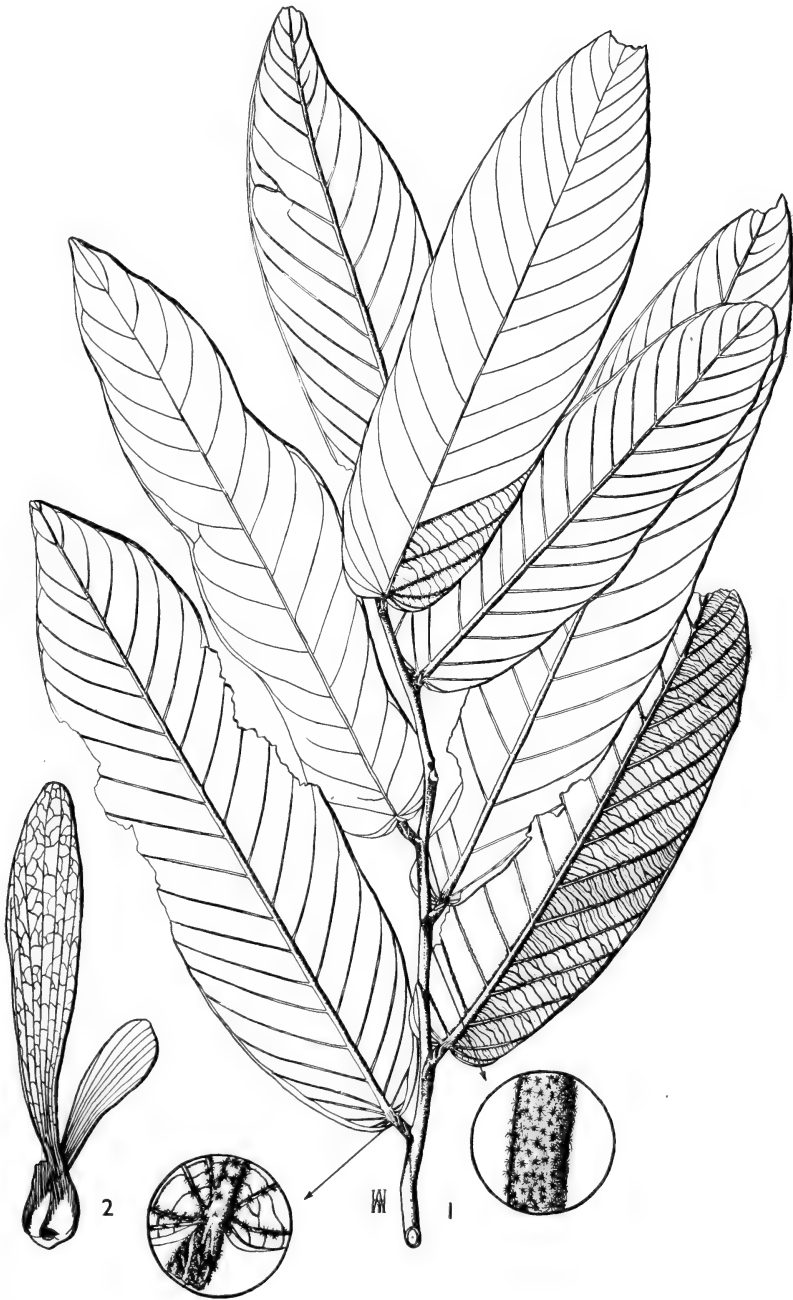


Plate 18. *Hopea bullatifolia*.

1, leafy branchlet (x 1/2); 2, fruit (x 2/3). From S. 522.

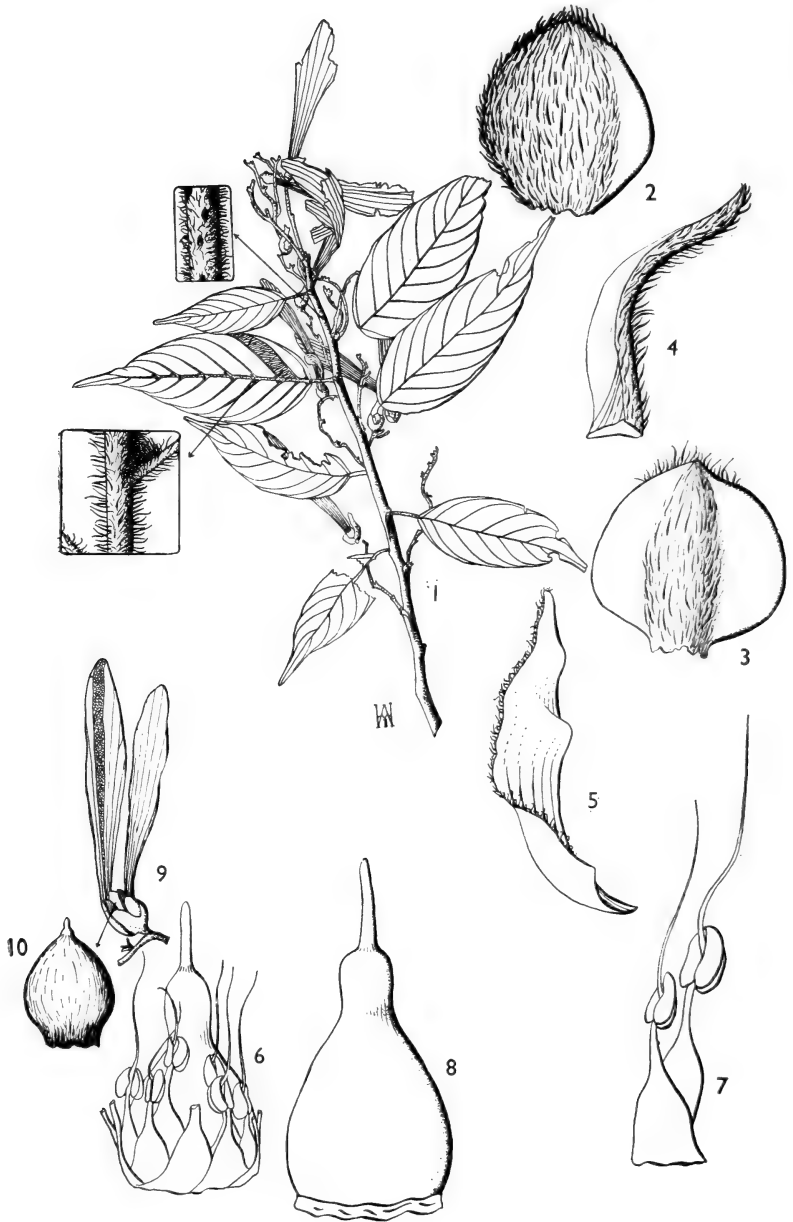


Plate 19. *Hepea centipeda*.

1, fruiting branchlet; 2, outer, 3, inner, floral sepals; 4, 5 petals; 6, androecium and gynoecium; 7, stamens; 8, gynoecium; 9, fruit; 10, ripe nut. 1, 9, 10 from S. 18440, 2-8 from S. 23342. 1 = 1/3; 2, 3, 6, 8 = x 10; 4, 5, 10 = x 5; 7 = x 20; 9 = x 2.



Plate 20. *Hopea depressinerva*.

1, flowering branchlets; 2, outer, 3, inner floral sepals; 4, petal; 5, petal with stamens; 6, androecium and gynoecium; 7, frontal; 8, lateral view of stamens. From S. 15439. 1 = $\times \frac{1}{2}$; 2-6 = $\times 10$; 7, 8 = $\times 20$.

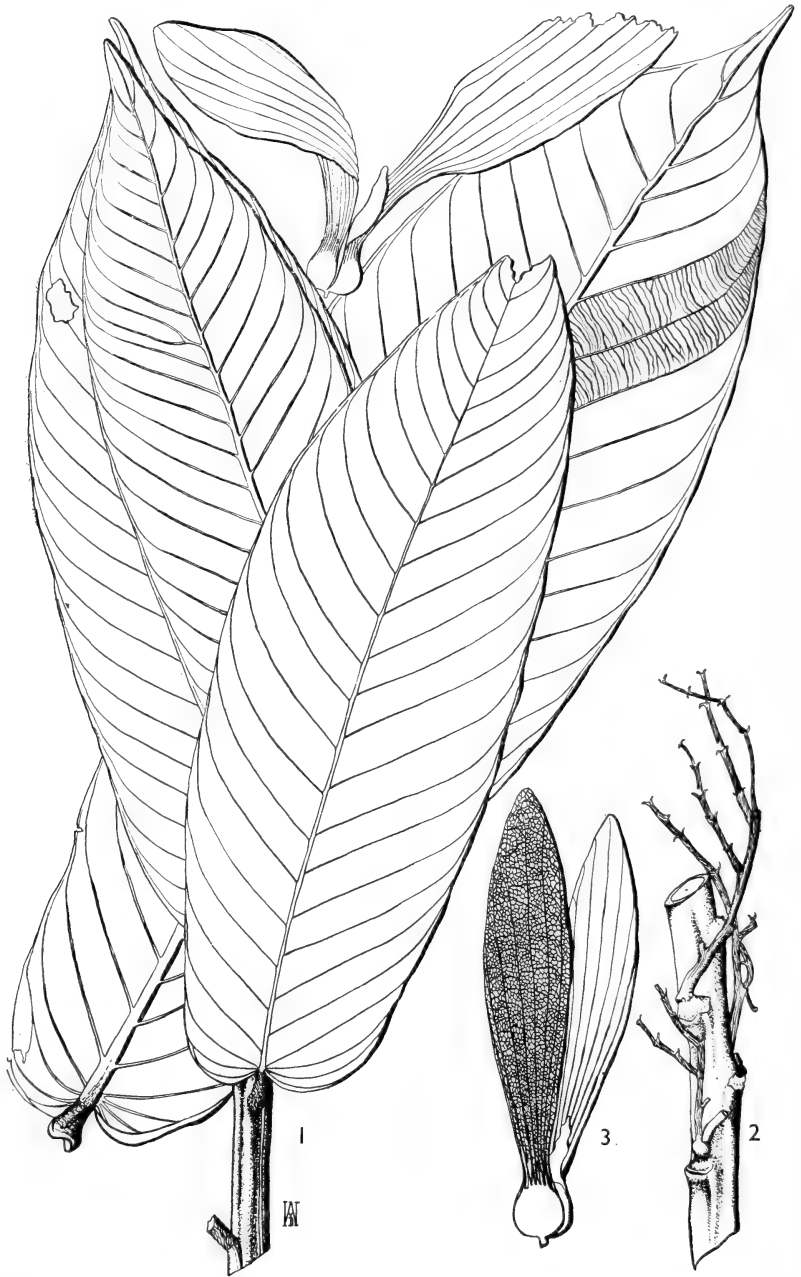


Plate 21. *Hopea enicosanthoides*.

1, fruiting branchlet; 2 fruiting inflorescences; 3, fruit. From S. 18116. ($\times \frac{1}{2}$).

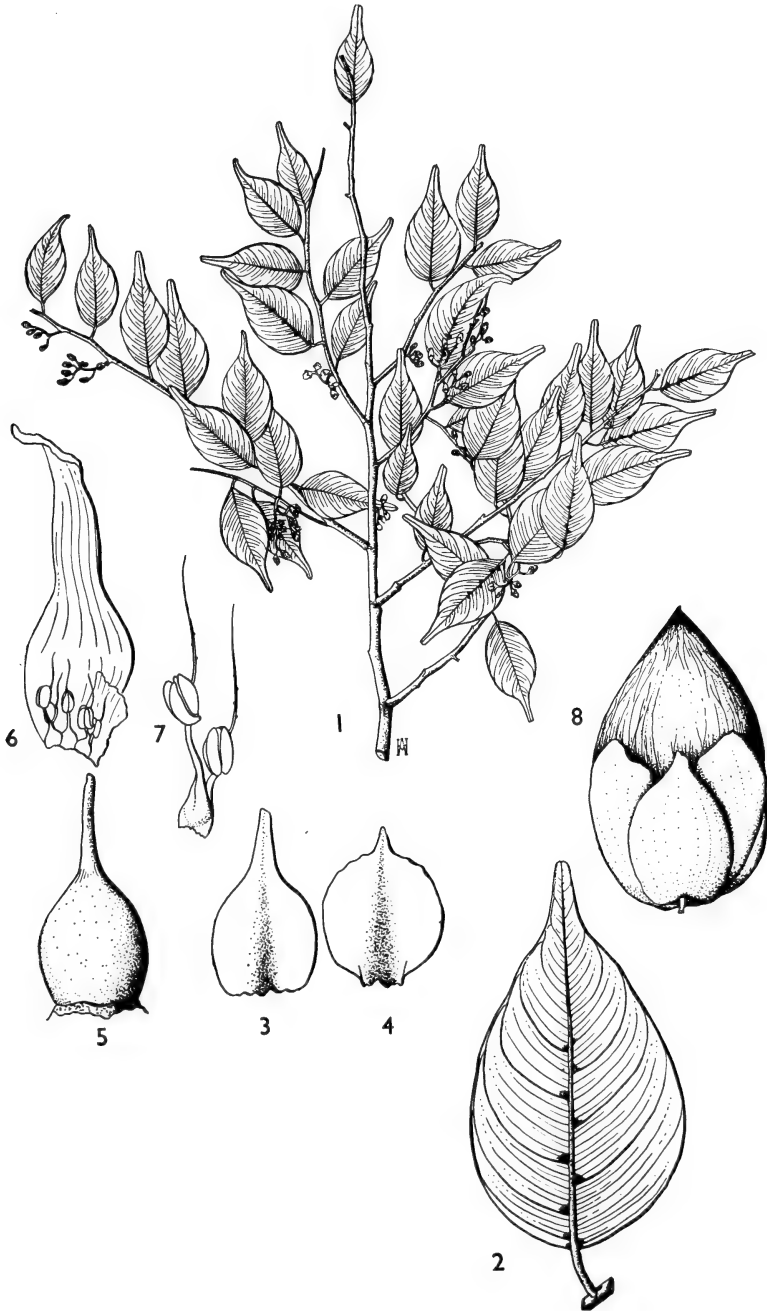


Plate 22. *Hopea kerangasensis*.

1, flowering twig; 2, fallen leaf; 3, outer, 4, inner, floral sepals; 6, petal with stamens; 7, stamens; 5, gynoecium; 8, fruit 1-7 from S. 21299; 8 from S. 8944. 1 = $\times \frac{1}{2}$; 2 = $\times 2$; 3-4, 6 = $\times 8$; 5, 7 = $\times 20$; 8 = $\times 5$.



Plate 23. *Hopea longirostrata*.

1, fruiting twig; 2 = fruit; 3 = nut. From S. 17742. 1 = x $\frac{1}{2}$;
23 = x 2.



Plate 24. *Hopea megacarpa*.

1, flowering and fruiting twigs; 2, flower bud; 3, outer, 4, 5, inner, floral sepals; 6, petal; 7, androecium and gynoecium; 8, stamens. Fruiting twig from SA. 639, otherwise from S. 14743. 1 = $\times \frac{1}{2}$; 2 = $\times 4$; 3 = $\times 5$, 7 = $\times 20$; 6 = $\times 15$; 8 = $\times 30$.

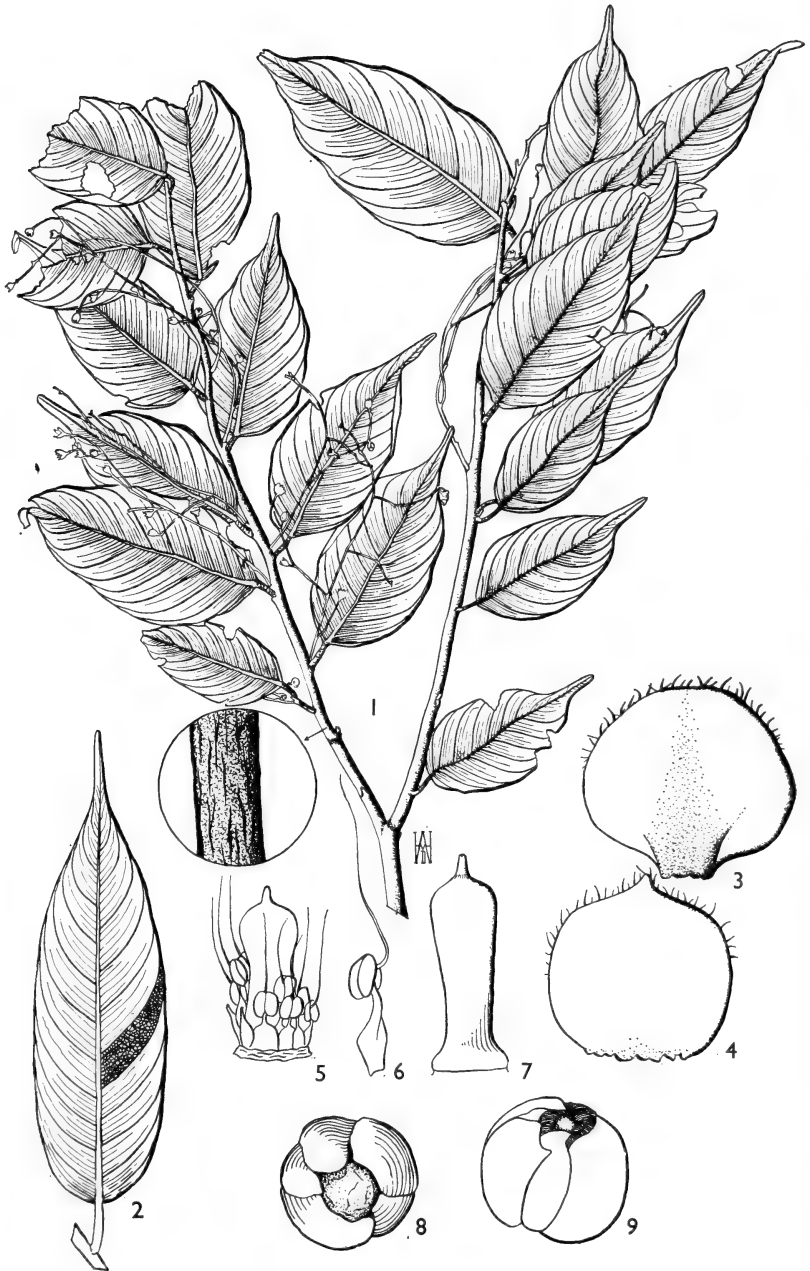


Plate 25. *Hopea mesuoides*.

1, flowering branchlet; 2, leaf of young tree; 3, inner, 4, outer floral sepals; 5, androecium and gynoecium; 6, stamen; 7, gynoecium; 8, 9, fruit. 1, 3-7 from S. 11247; 2, 8, 9 from S. 15551. 1, 2 = x 1/3; 3, 4, 6, 7 = x 10; 5 = x 7; 8, 9 = x 1.

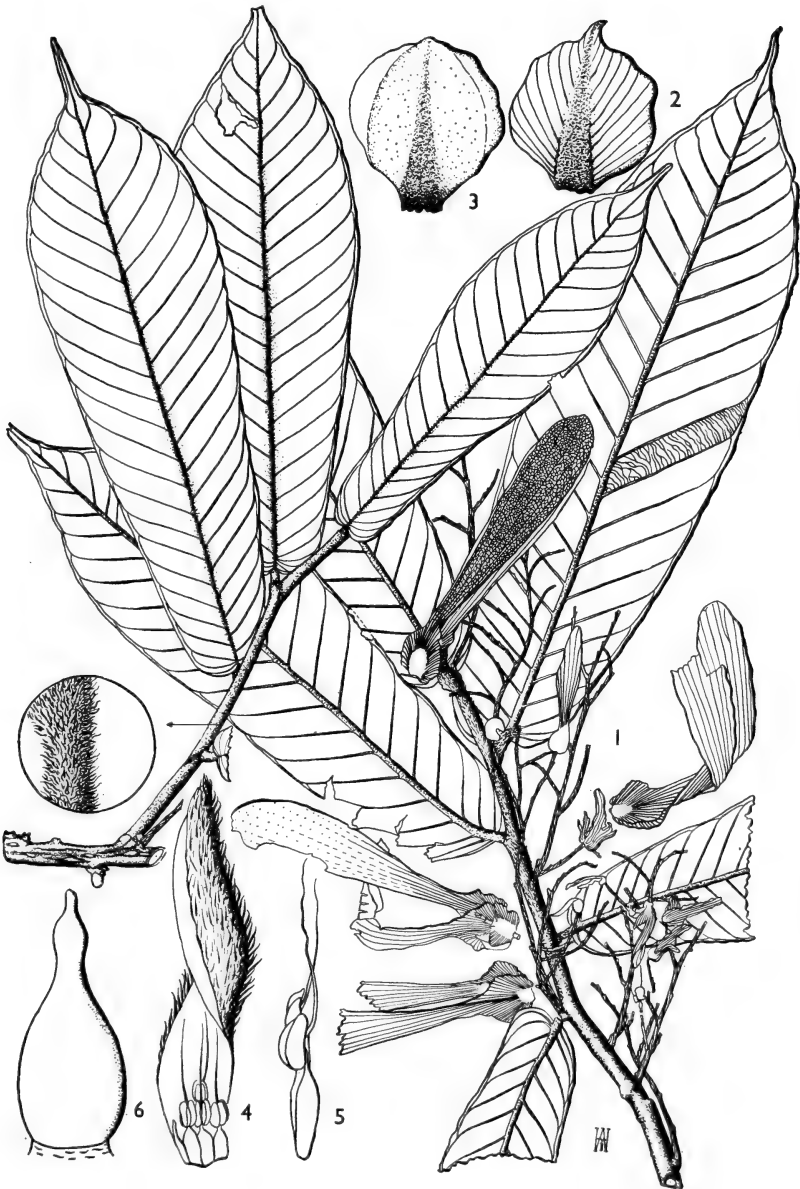


Plate 26. *Hopea pterygota*.

1, fruiting branchlet; 2, outer, 3, inner floral sepals; 4, petal and stamens; 5, lateral view of stamens; 6, gynoecium. From S. 15206.
1 = x $\frac{1}{2}$; 2-4 = x 10; 5-6 = x 20.

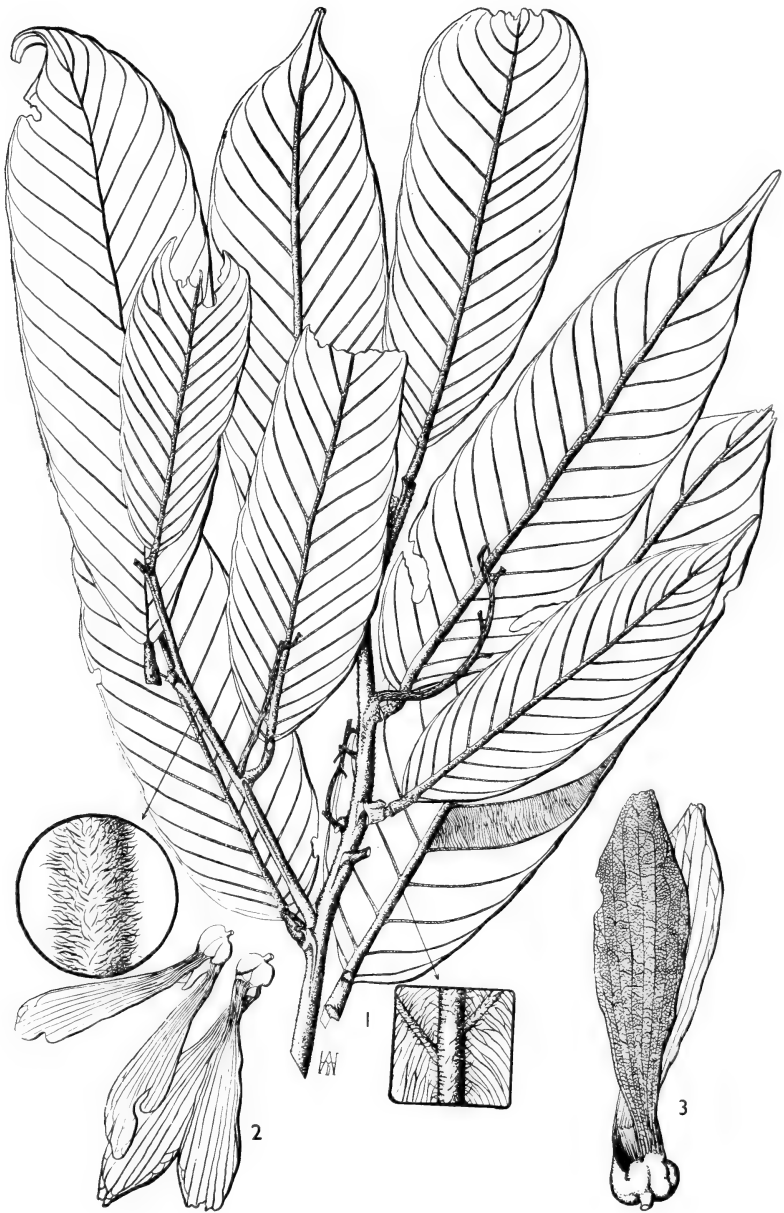


Plate 27. *Hopea tenuinervula*.

1, leafy branchlet, 2, 3, fruit. From S. 9616. 1, 2 = $\times \frac{1}{2}$; 3 = $\times 1$.

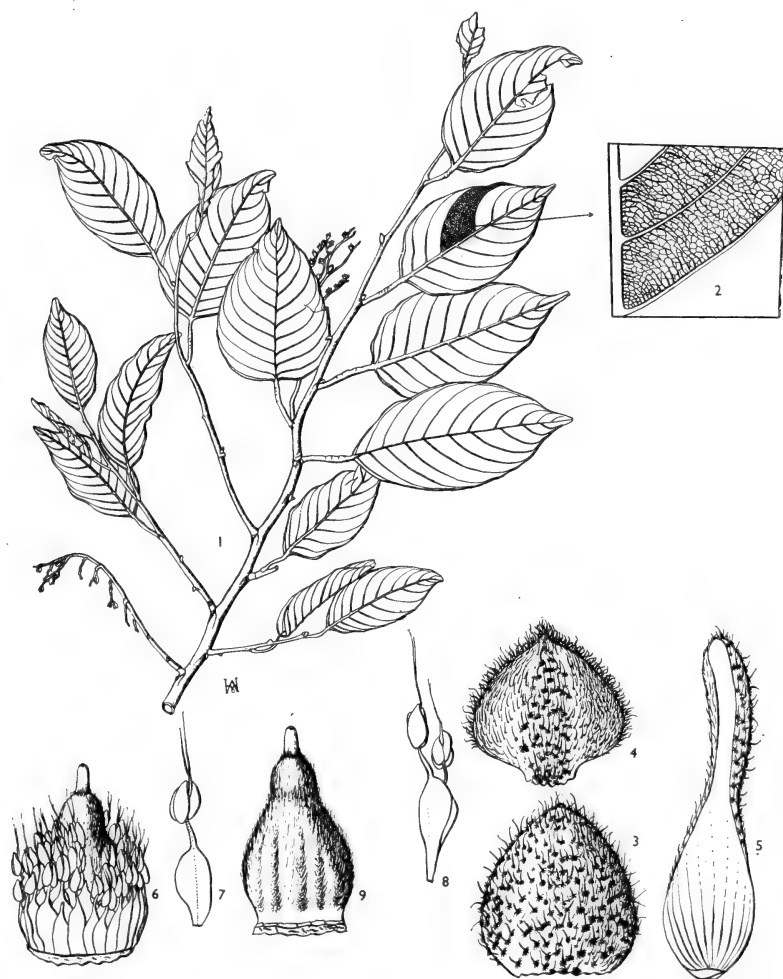


Plate 28. *Shorea brunnescens*.

1, flowering twig; 2, detail of lamina nervation below; 3, outer, 4, inner, flower sepals; 5, petal, 6, ovary and gynoecium; 7, 8, stamens; 9, gynoecium. From S. 15218, 1 = x 1/3, 2 = x 1, 5, 6, 9 = x 10; 3, 4, 7, 8 = x 15.

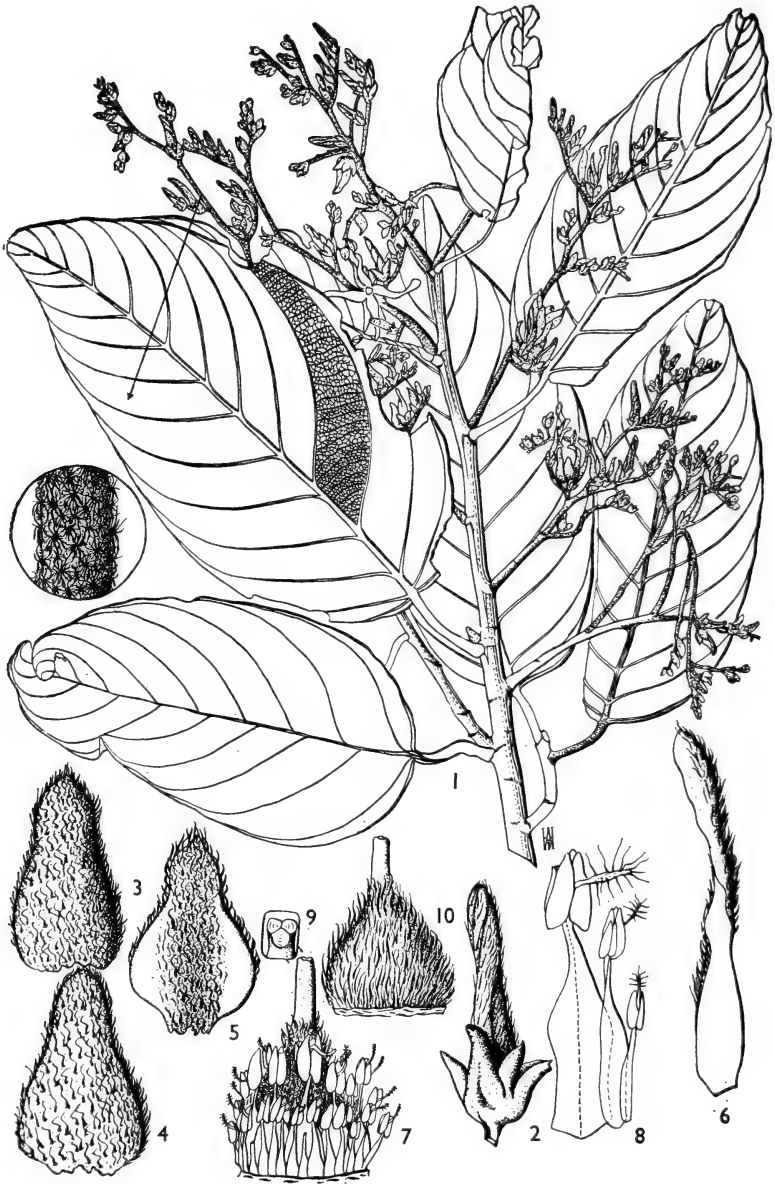


Plate 29. *Shorea lunduensis*.

1, flowering branchlet; 2, flower bud; 3, 4, outer, 5, inner sepals; 6, petal; 7, androecium and gynoecium; 8, stamens, frontal view; 9, stigma; 10, gynoecium. From S. 15396. 1 = $\times \frac{1}{2}$; 2 = $\times 4$; 3-5 = $\times 15$; 6, 7 = $\times 10$; 8 = $\times 20$.

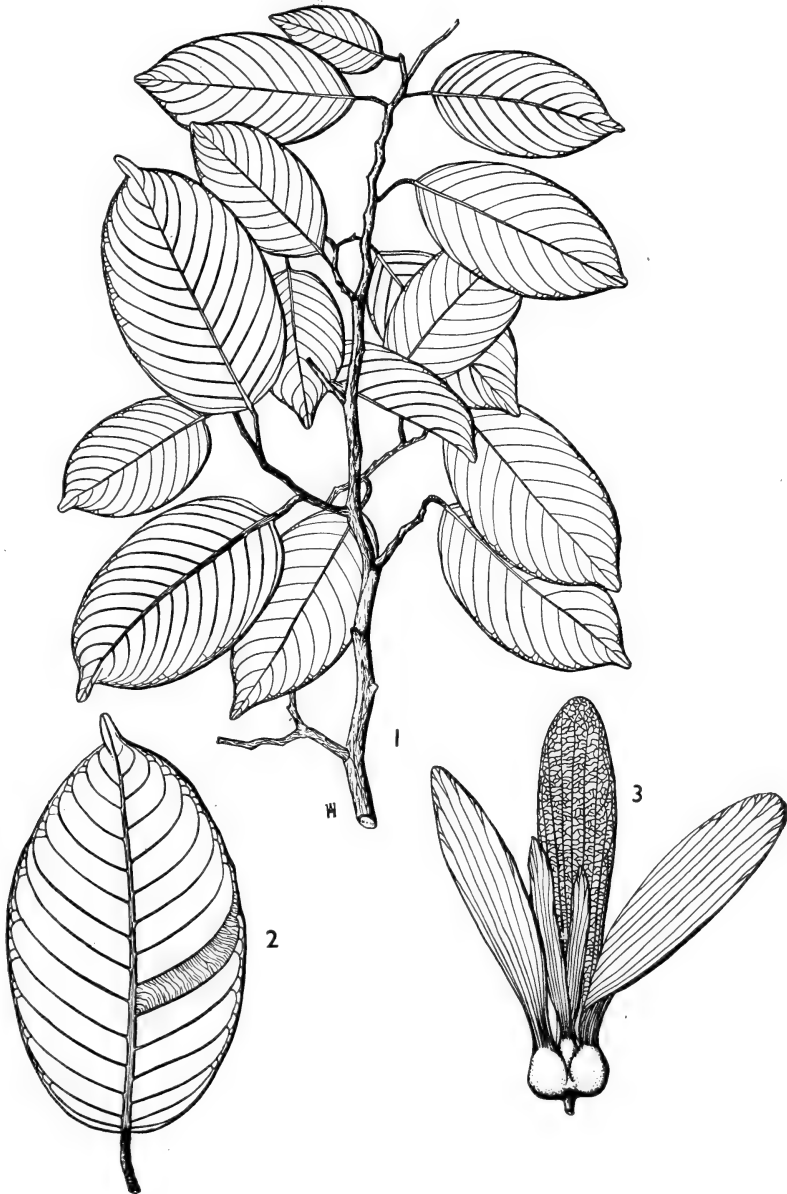


Plate 30. *Shorea agami* ssp. *diminuta*.

1, leafy twig; 2, fallen leaf; 3, fruit. From S. 25027. 1, 3 = x $\frac{1}{2}$; 2 = x 1.

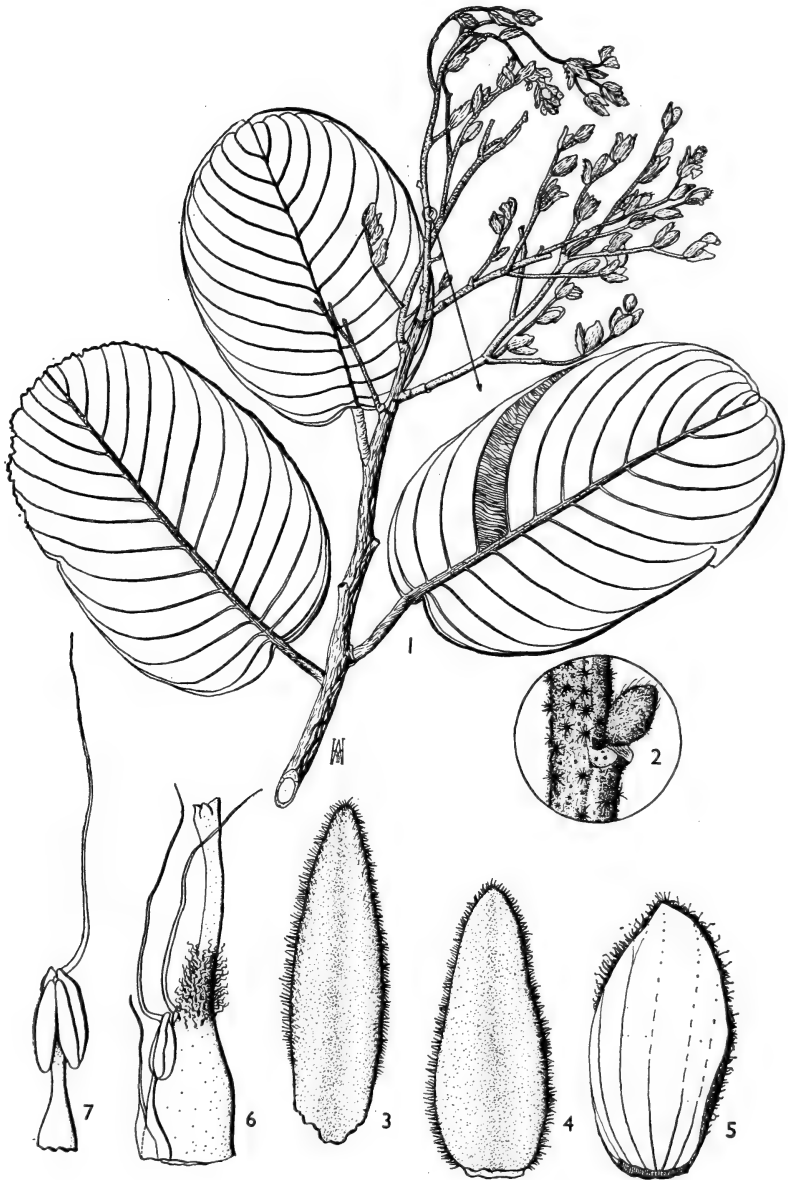


Plate 31. *Shorea cordata*.

1, flowering branchlet; 2, detail of young twig; 3, outer, 4, inner, floral sepals; 5, petal; 6, stamens and gynoecium; 7, posterior view of stamen. From SA. 678. 1 = $\times \frac{1}{2}$; 2 = $\times 3$; 3-6 = $\times 10$; 7 = $\times 15$.

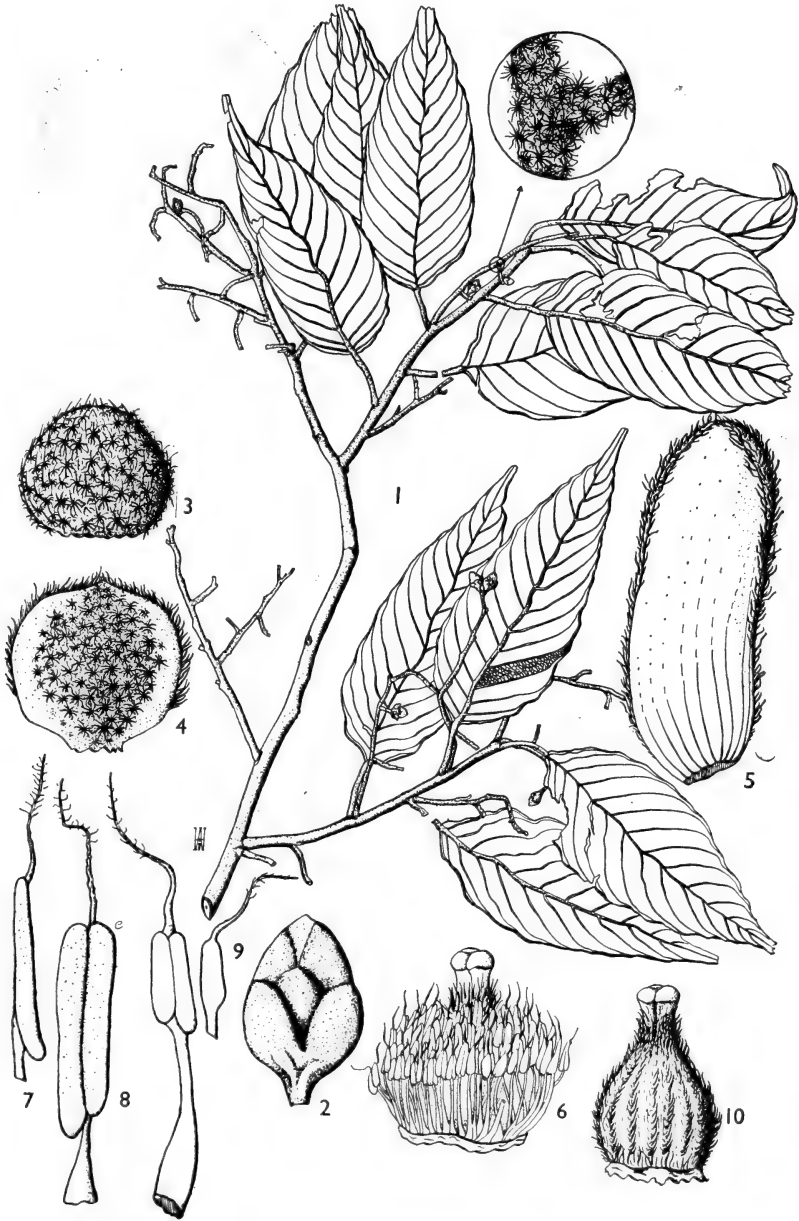


Plate 32. *Shorea polyandra*.

1, flowering branchlet; 2, flower bud; 3, outer, 4 inner floral sepal; 5, petal; 6, androecium and gynoecium; 7, lateral, 8, frontal view of outer, 9 same of inner, stamens; 10, gynoecium. From S. 10171. 1 = x $\frac{1}{2}$; 2 = x 5; 3-6, 10, = x 10; 7-9 = x 30.



Plate 33. *Shorea alutacea*.

1, flowering branchlet; 2, fallen leaf; 3, flower bud; 4, opened flower; 5, outer, 6, inner floral sepal; 7, androecium and gynoecium; 8, stigma; 9, stamen, lateral view; 10, gynoecium; 11, fruit; 12, ripe nut. 1-10 from S. 7975; 11, 12 from S. 10170. 1, 2, 11, 12 = $\times \frac{1}{2}$; 3, 4 = $\times 5$; 5-7, 10 = $\times 10$; 8 = $\times 40$; 9 = $\times 15$.

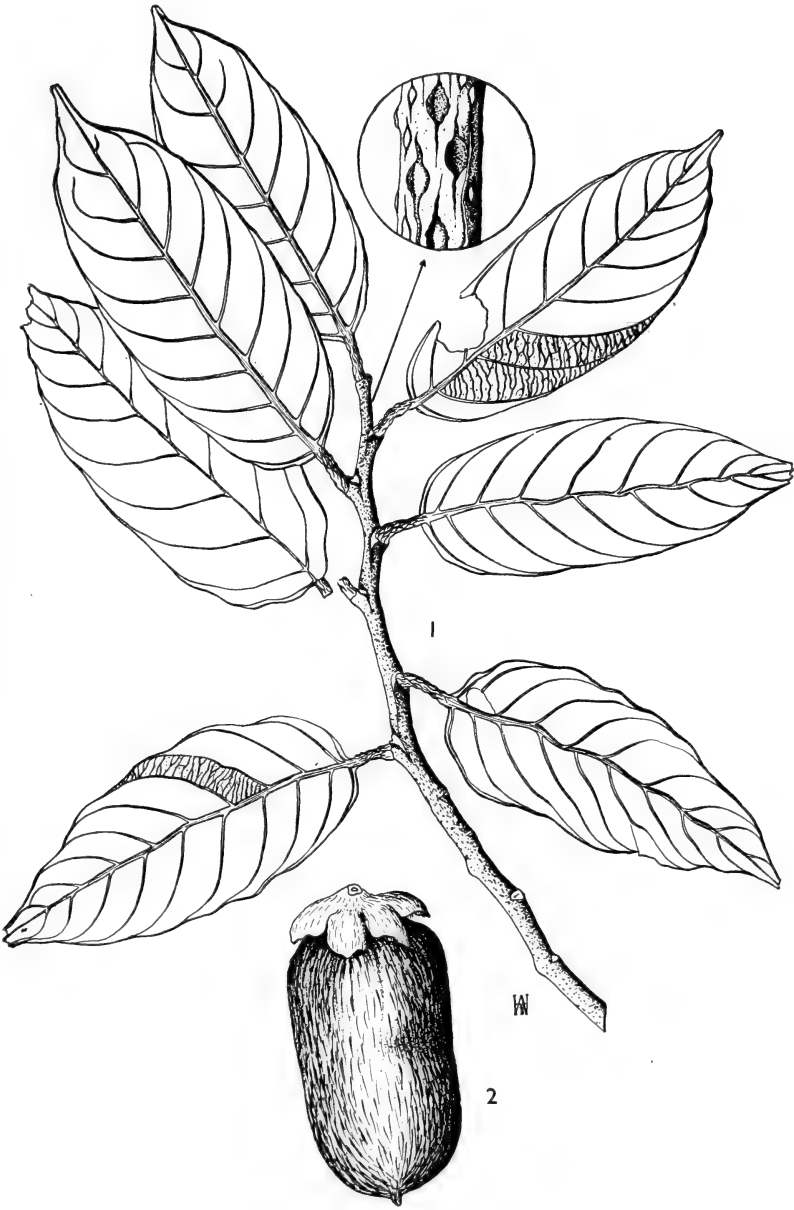


Plate 34. *Shorea bakoensis*.
1, leafy branchlet; (x 1/4); 2, fruit (x 2).

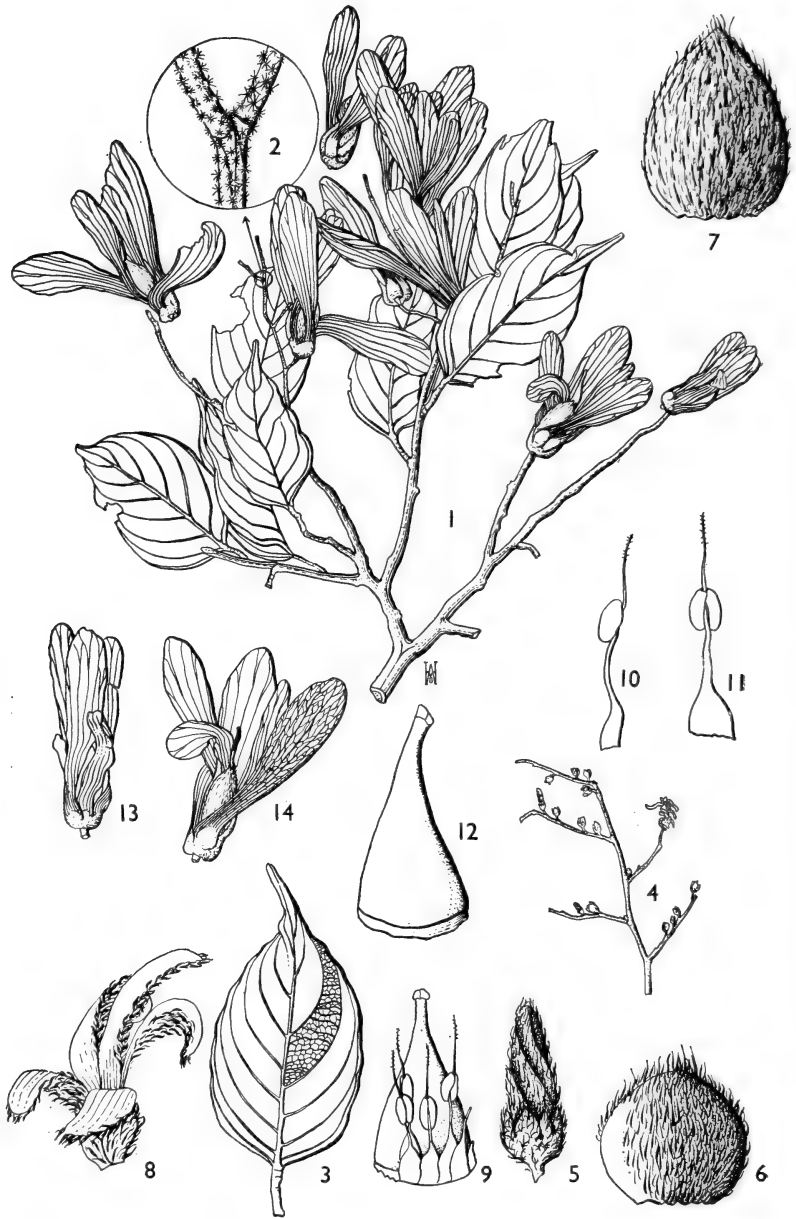


Plate 35. *Shorea cuspidata*.

1, fruiting branchlet; 2, detail of young twig; 3, fallen leaf; 4, flowering raceme; 5, flower bud; 6 inner, 7, outer floral sepal; 8, corolla; 9, androecium and gynoecium; 10, lateral; 11, posterior view of stamen; 12, gynoecium; 13, 14, fruit. 1-3, 13, 14 from S. 15258, 4-12 from tree no. 603. 1, 3, 4, 13, 14 = $\times \frac{1}{2}$; 2 = $\times 2$; 5, 8 = $\times 8$; 6, 7, 10, 11 = $\times 25$; 9, 12 = $\times 15$.

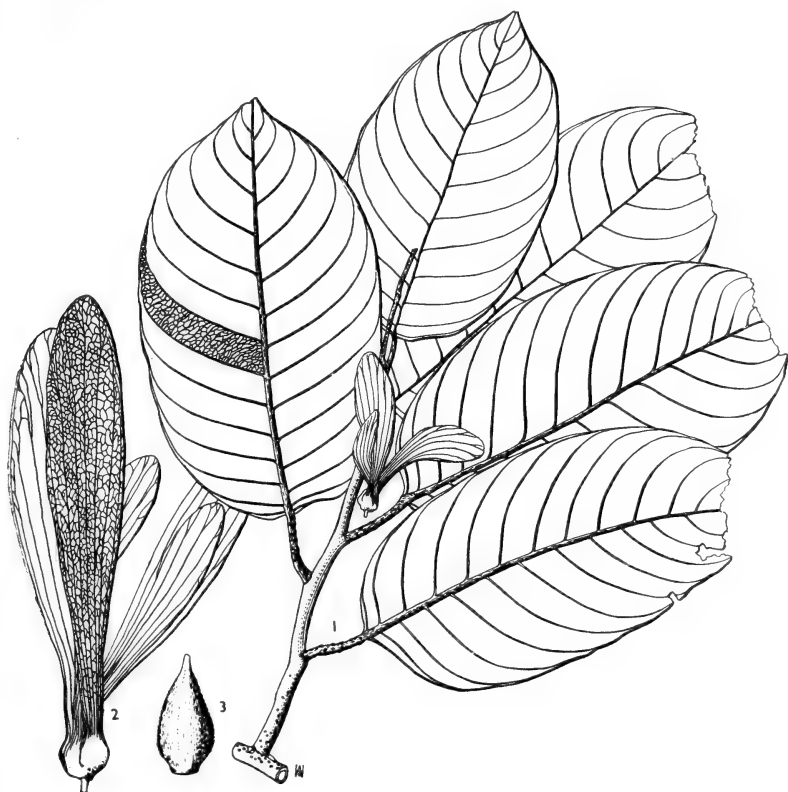


Plate 36. *Shorea iliasii*.

1, fruiting branchlet; 2 fruit; 3, ripe nut. From S. 15102. 1, 2 = 1/3;
3 = x 1/2.



Plate 37. *Shorea macrobalanos*.

1, fruiting branchlet; 2 young, 3 mature fruit. From S. 13712. 1, 3 = $\times \frac{1}{2}$; 2 = $\times 1$.

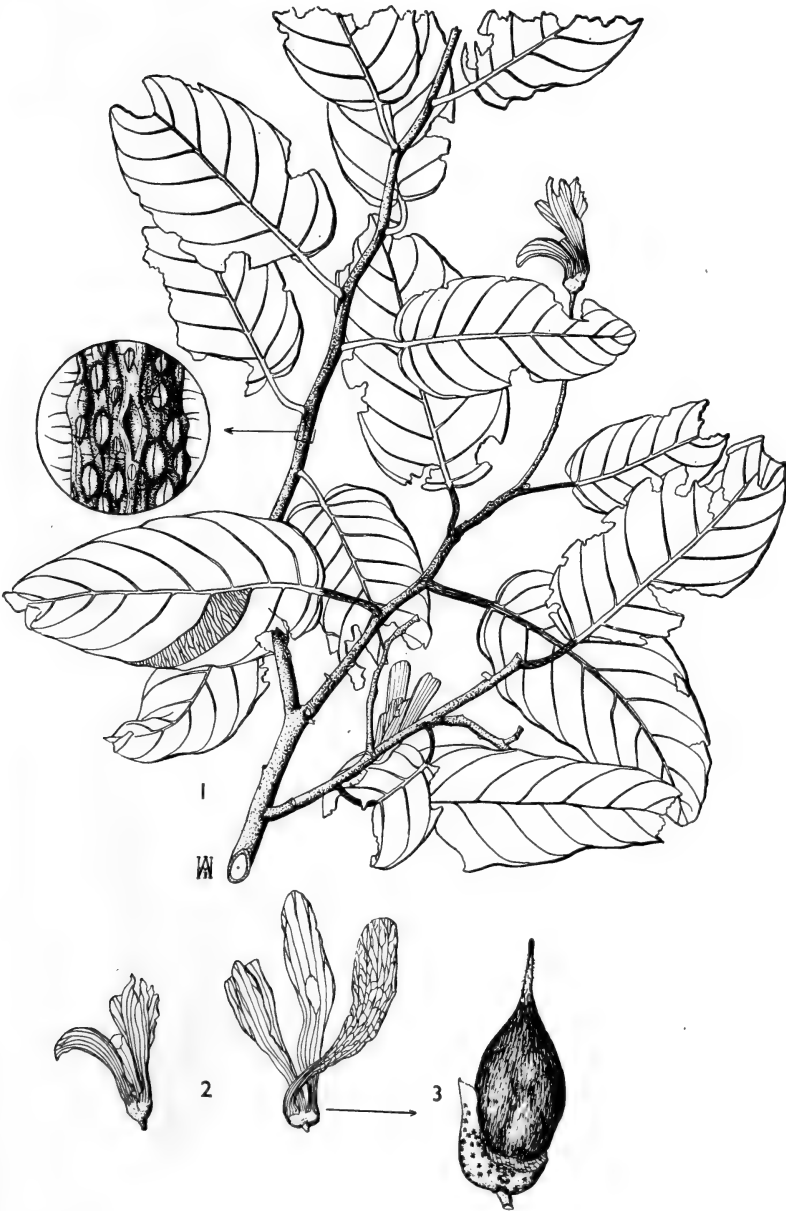


Plate 38. *Shorea mujongensis*.

1, fruiting twig; 2, fruits; 3, ripe nut; from S. 19038. 1, 2 = x ½;
3 = x 2.

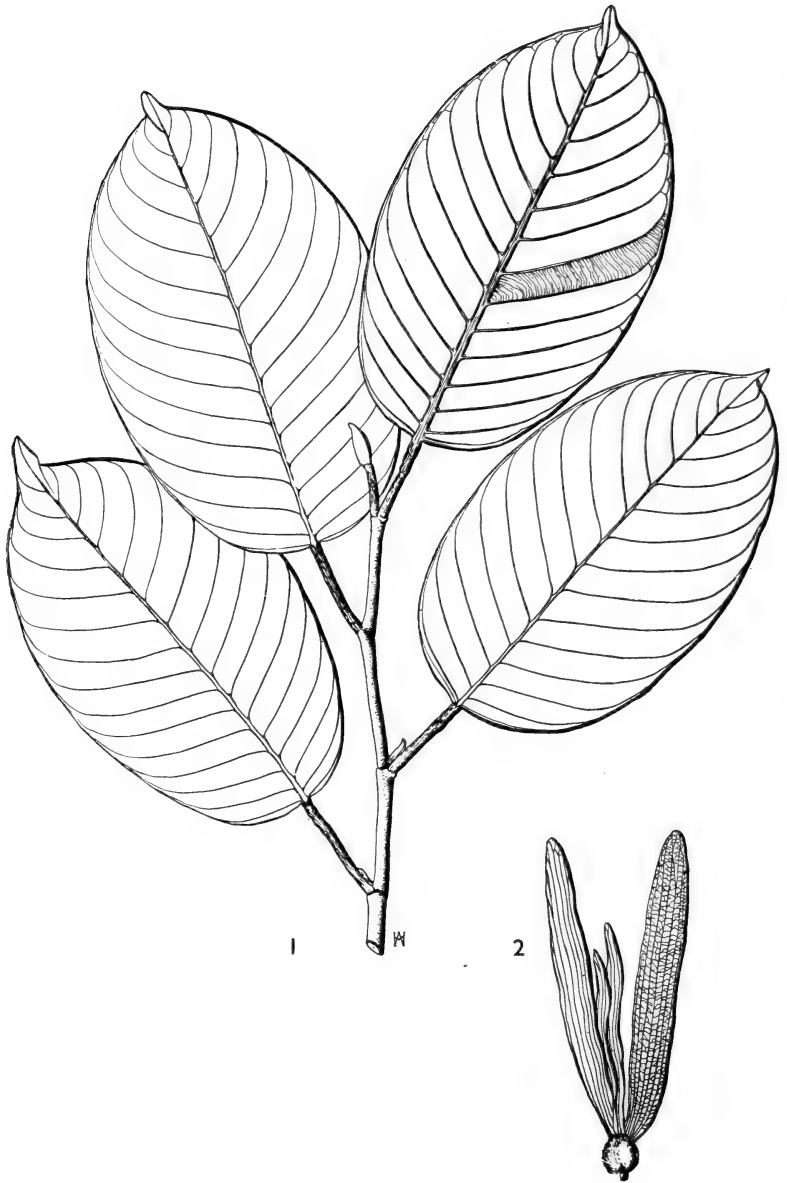


Plate 39. *Shorea carapae*.

1, leafy twig; 2, young fruit. 1 from S. 13991; 2 from SAN. 39323;
1, 2 = x $\frac{1}{2}$.

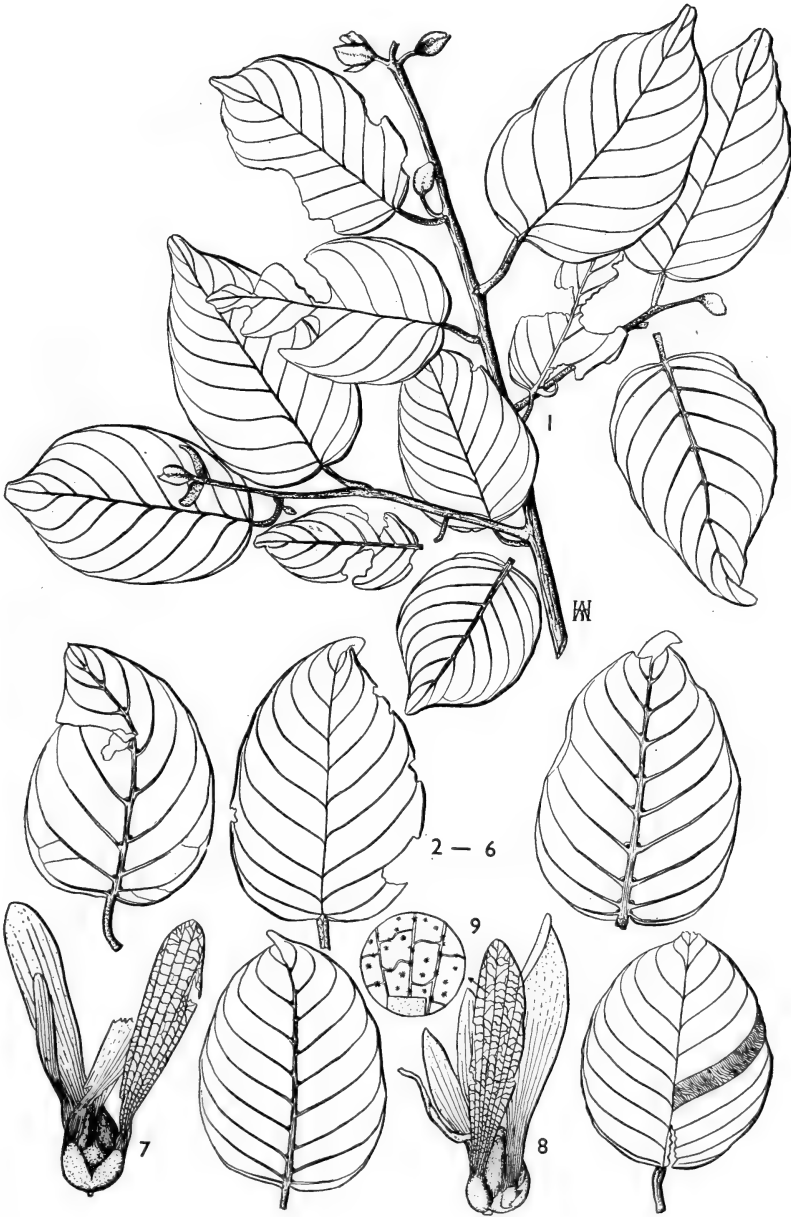


Plate 40. *Shorea foraminifera*.

1, leafy branchlet; 2-6, fallen leaves; 7, 8, fruit; 9, detail of outer surface of fruit calyx lobe. 1 from Brun. 243; 2-9 from S. 1916. 1-8 = $\times \frac{1}{2}$; 9 = $\times 1$.

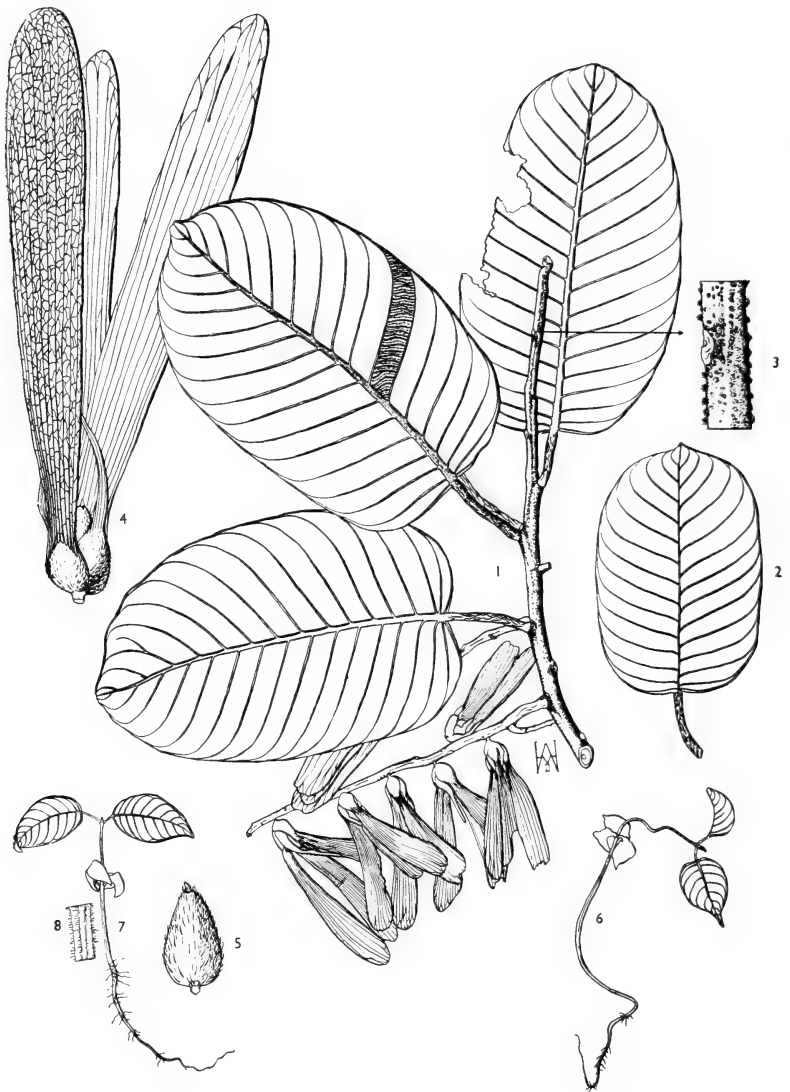


Plate 41. *Shorea pallidifolia*.

1, fruiting branchlet; 2, fallen leaf; 3, detail of young twig; 4, fruit; 5, ripe nut; 6, 7, germinating seedlings; 8, detail of seedling stem.
From S. 16054. 1, 2, 6, 7 = x 1/3; 3-5, 8 = x 1.5.

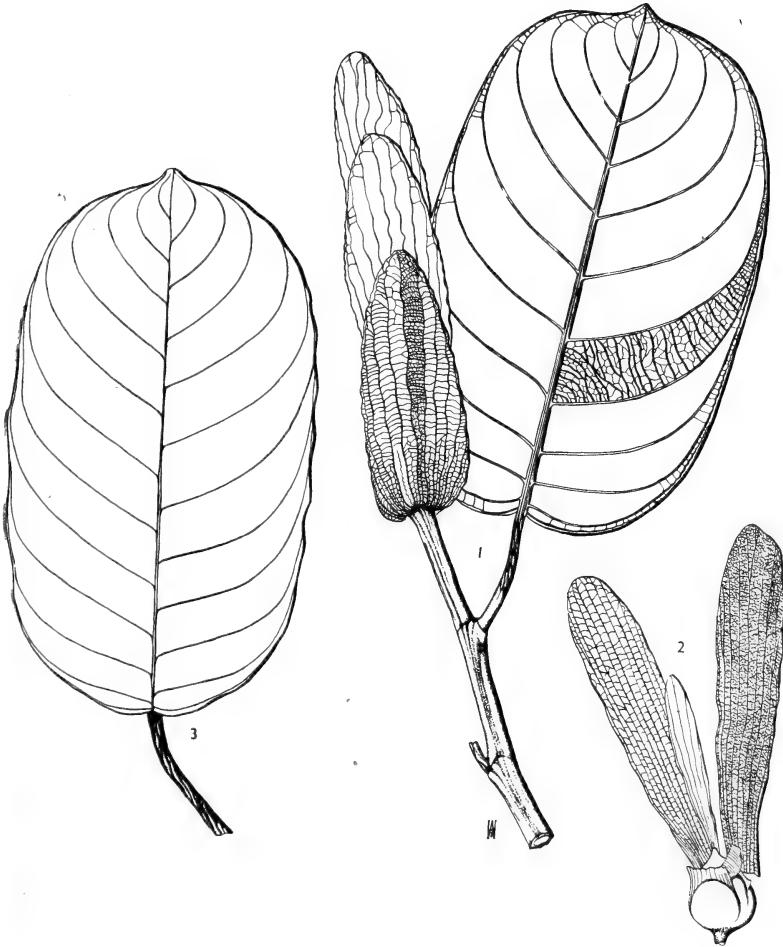


Plate 42. *Shorea praestans*.

1, leafy branchlet; 2, fallen leaf; 3, young fruit. 1, 3 from S. 19598; 2 from s.n. (Brunig). x 1/4.

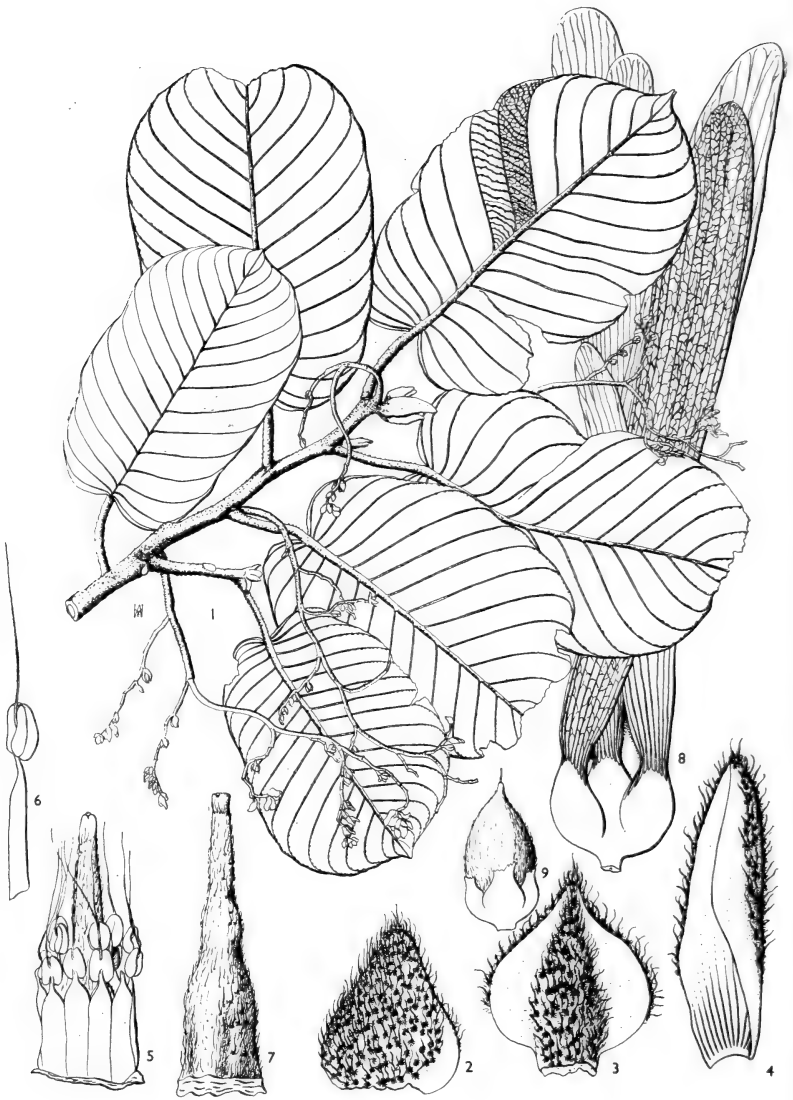


Plate 43. *Shorea pubistyla*.

1, flowering branchlet; 2, outer, 3, inner, floral sepals; 4, petal;
 5, androecium and gynoecium; 6, lateral view of stamen; 7, gynoecium;
 8, fruit; 9, ripe nut. 1-7 from S. 14930; 8, 9 from FA. 1301.
 1, 9 = x 1/3; 2, 3, 6 = x 15; 4, 5, 7 = x 10; 8 = x 1.

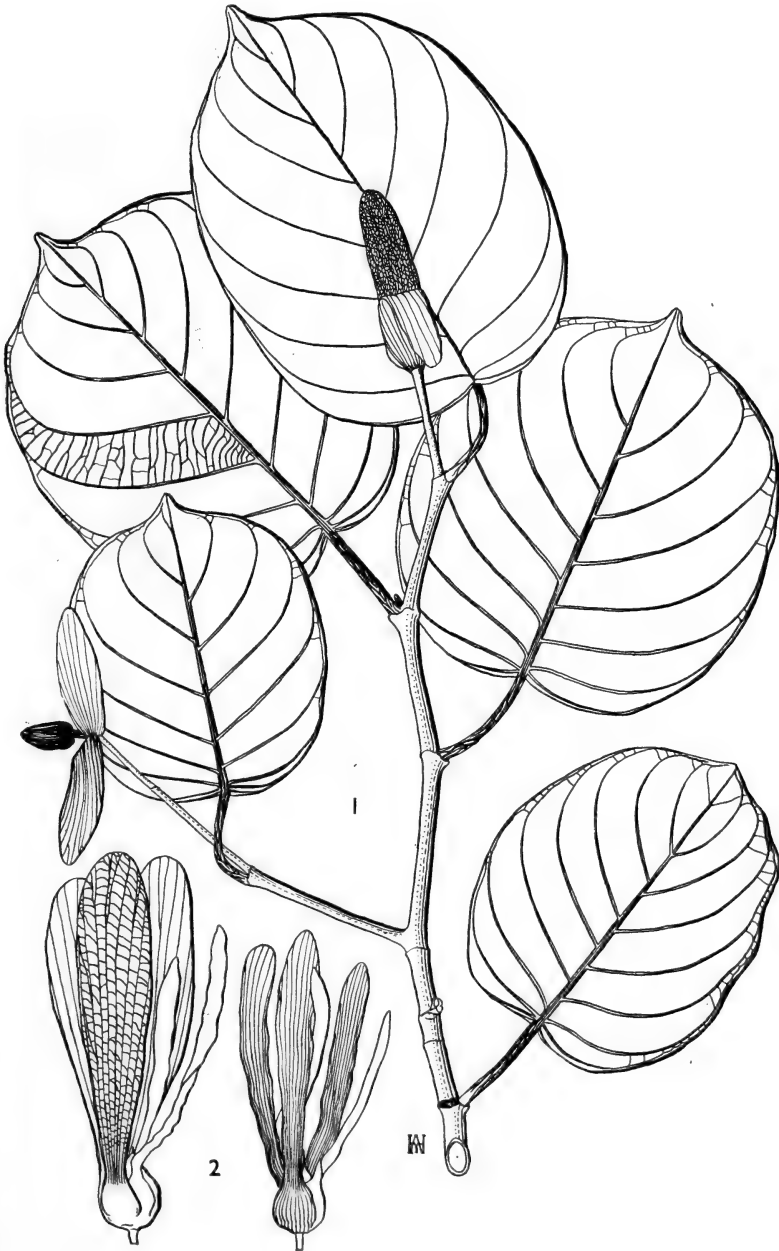


Plate 44. *Shorea rotundifolia*.

1, leafy branch; 2 young fruit. 1 from S. 22051; 2 from S. 9470.
x 1/3.

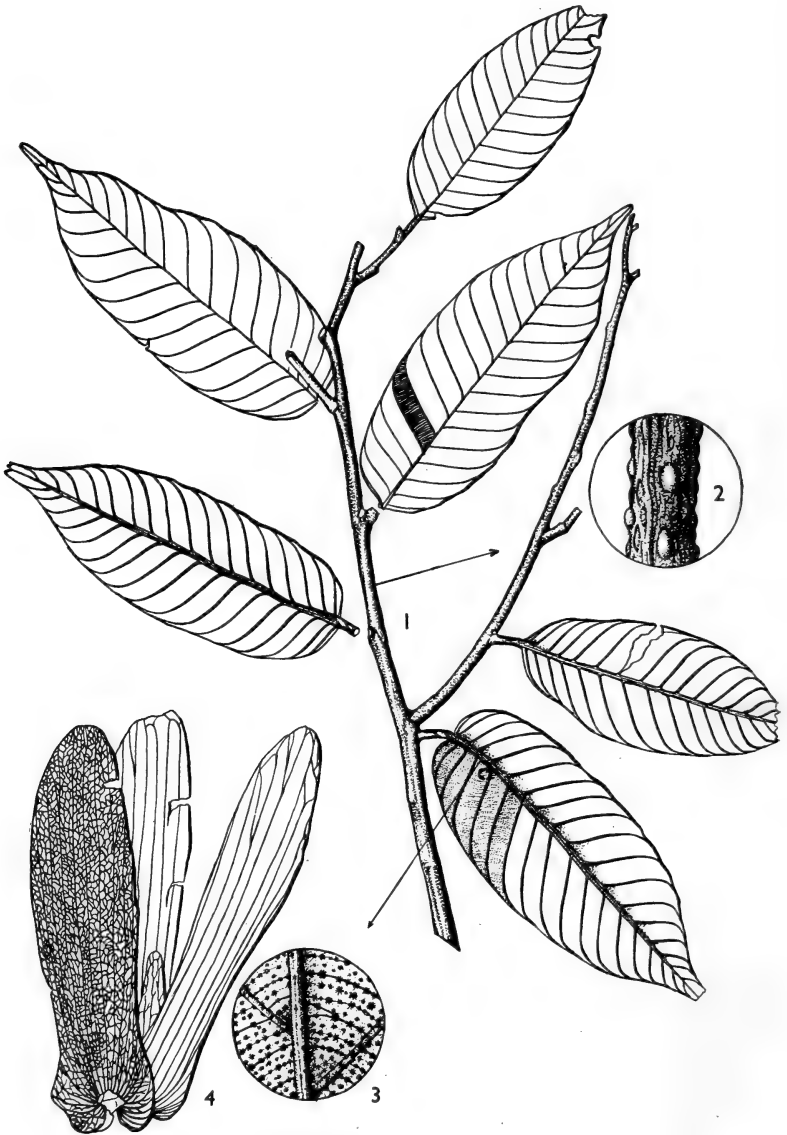


Plate 45. *Shorea sagittata*.

1, leafy branchlet; 2, detail of twig; 3, detail of leaf undersurface; 4, fruit; from S. 15882. 1 = $\times \frac{1}{2}$; 2, 3 = $\times 4$; 4 = $\times \frac{2}{3}$.



Fruits of *Dryobalanops oblongifolius* Dyer picked up from the type locality (S.19652, G. Matang); note the lenticellate pericarp and the variation in shape of the calyx tube.



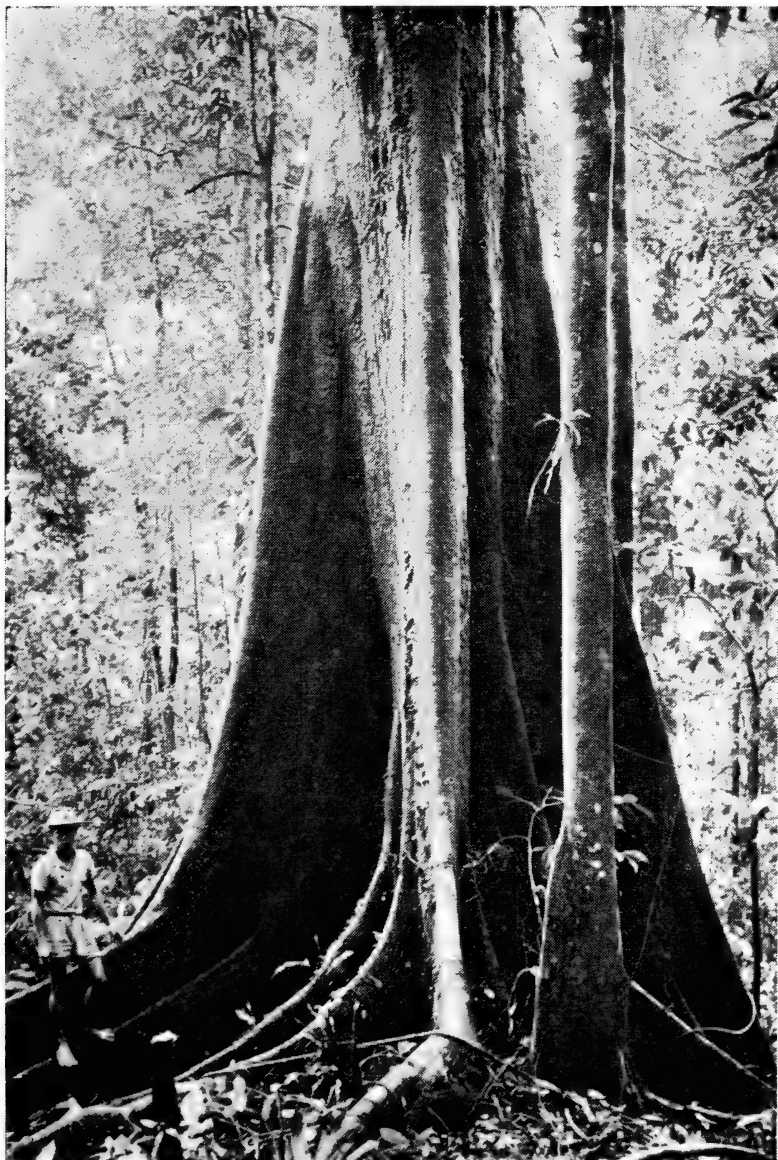
Bole of *Hopea altocollina* sp. nov.; Hose mountains, Sarawak. April 1964.



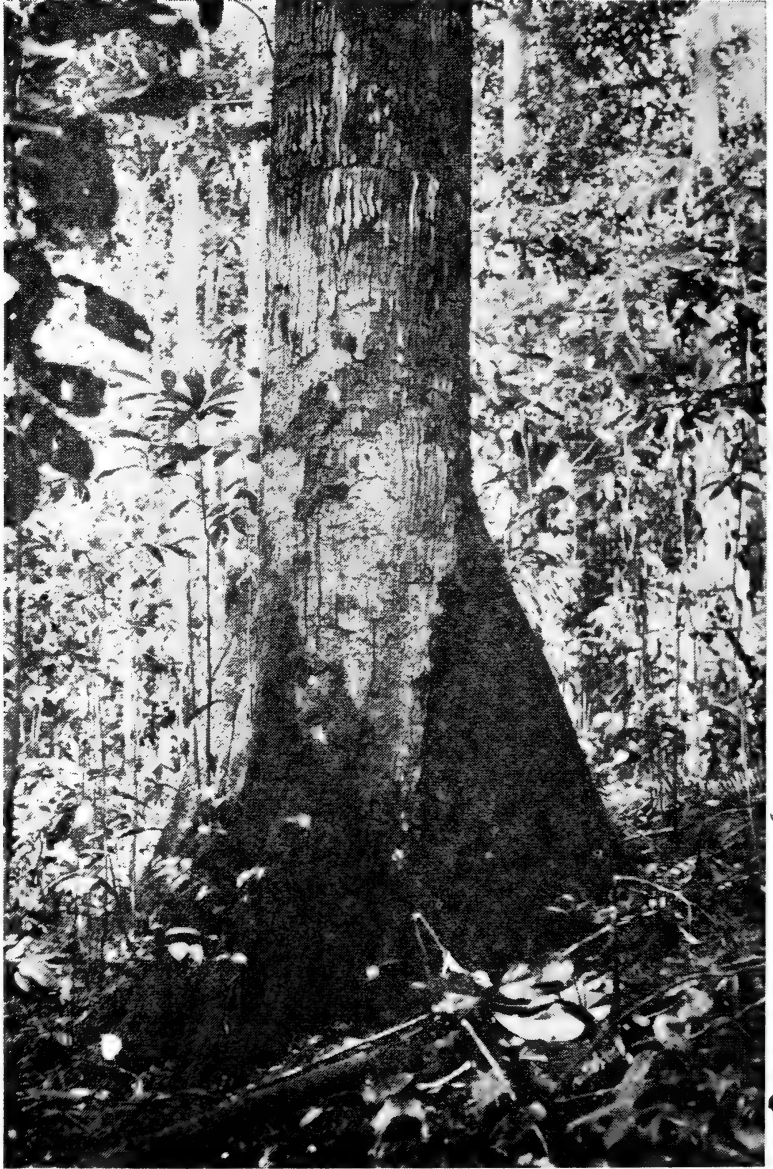
Bole of *Hopea tenuivervula* sp. nov.; Semengoh arboretum, Kuching. November 1963.



Bole of *Shorea cuspidata* sp. nov.; Semengoh arboretum, Kuching. November 1963.



Bole of a giant *Shorea mujongensis* sp. nov.: on the Mujong-Balui divide, Rejang, Sarawak. April 1964.



Bole of *Shorea sagittata* sp. nov.; Similajau F.R.; Bintulu. March 1963.

Reprinting of Burkill's Dictionary of the Economic Products of the Malay Peninsula

This work, published in 1935, quickly became a standard reference book for scientist and administrator alike concerned with utilisation of natural resources of Malaya. Its usefulness is acknowledged generally throughout the Tropics and wherever tropical plant products are studied. After being unavailable for the past 15 years, except at an exorbitant price for the very few second-hand copies coming onto the market, the Federation of Malaysia Government is doing an extremely useful service to tropical agri-horticulture and forestry in reprinting this book. A number of amendments and corrections on the original edition were prepared by the author before he died in 1965, and these have been incorporated in the new edition.

The work in two volumes was published near the end of 1966 at a price of M\$59 for both volumes. Inquiries should be directed to the Publications Officer, Ministry of Agriculture and Co-operatives, Federation of Malaya, Swettenham Road, Kuala Lumpur, Malaysia.



1870
The first of the year was a very cold one
and the snow was very deep.

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THE
GARDENS' BULLETIN
SINGAPORE

Vol. XXII, Part III

29th June, 1968

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1968



A Revision of the Genus *Quercus* L. Subgen. *Cyclobalanopsis* (Oersted) Schneider* in Malesia

by

E. SOEPADMO

(Herbarium Bogoriense, Bogor, Java, Indonesia)

SUMMARY

Quercus L. is here compared with and regarded as a separate genus from *Lithocarpus* Bl., differing from the latter by its inflorescence, flower and pollen characters. The genus is subdivided into two subgenera, viz. subgen. *Quercus* (=subgen. *Eu-Quercus* A. Camus) and *Cyclobalanopsis* (Oersted) Schneider. The cupule in the former is beset with imbricate scales, and the male flowers are solitary along the rachis. In the subgen. *Cyclobalanopsis* the cupule is lamellate, and the male flowers are in 4-1-flowered dichasial clusters. The generic splits in *Quercus* proposed by Oersted (1867, 1871), Schottky (1912), and Schwarz (1936 a, b) are not accepted.

Quercus subgen. *Cyclobalanopsis* extends from Japan (Kanto Prov., C. Honshu) south- and westwards to Korea, China, Formosa, Indo-China (Vietnam, Laos, Cambodia), Thailand, Burma, N.E. India, and Western Malesia, with Indo-China as the centre. In Malesia the distribution does not extend further East than Borneo nor further North than Palawan. The centre of distribution in Malesia is in Borneo, from where 17 of the 19 species have been recorded.

Q. kerangasensis and *kinabaluensis* are described for the first time. *Q. valdinervosa* is a new species based on *Q. mespilifolia* Wall. ex A.DC. var. *borneensis* Heine.

The characters in the group, in particular the nature of the cupule in various genera, are extensively discussed. The questions on the identity of several species are explained. Keys, synonyms, and descriptions are given.

INTRODUCTION

This paper is the first contribution towards a revision of the *Fagaceae* in Malesia, represented by five of the seven genera currently recognized in the family. These five genera are *Castanopsis* Spach, *Lithocarpus* Bl., *Nothofagus* Bl., *Quercus* L. and *Trigonobalanus* Forman. Of these five genera no less than 200 species have been attributed to Malesia.

Quercus is the largest and the most widely distributed genus. In 1938, A. Camus monographed the genus, recognizing no less than 500 species. She followed Schneider (1906) by dividing the genus into two different subgenera, viz. *Eu-Quercus* and *Cyclobalanopsis*; in the former the cupule is armored with imbricate scales, whilst in the latter the cupule is lamellate. In her monograph, and also in 1948, A. Camus credited 17 species to Malesia. Of these only 11 are here acknowledged. In April 1966 I described five new species, and in the present paper I have added two and have proposed a new name which make the total number of species known from Malesia amount to 19. According to Schneider's circumscription all of these species belong to the subgen. *Cyclobalanopsis*.

* In April 1966, I erroneously referred to this subgenus under the name *Quercus* L. subgen. *Cyclobalanopsis* (Oersted) A. Camus.

The major point of interest in the genus *Quercus* lies in the controversy over its clear difference from the genus *Lithocarpus*, and also over the question on the generic splits as proposed by Oersted (1867, 1871), Schottky (1912), and Schwarz (1936 a, b).

A. DeCandolle (1863, 1964), Miquel (1863), Oudemans (1865), Baillon (1877), Bentham & Hooker f. (1880), Wenzig (1886), Hooker f. (1888), Koorders & Valetton (1904), O. von Seemen (1906), Brandis (1906), Hosseus (1911), Merrill (1908, 1921, 1923), Burkill (1935), Corner (1939, 1940), and Backer & Bakhuizen van den Brink Jr. (1965) were of the opinion that the genera *Quercus* (incl. *Cyclobalanopsis*, *Macrobalanus*, and *Erythrobalanus*) and *Lithocarpus* (incl. *Pasania*, *Cyclobalanus*, and *Synaedrys*) should be regarded as a single genus, namely *Quercus*, as these genera possess a similar type of cupule.

The opposite view was introduced by Oersted in 1867, in which *Quercus* was treated as a distinct genus, differing from *Lithocarpus* by its inflorescence and flower characters. This view was accepted by Prantl (1887, 1894), Schneider (1906), Dalla Torre & Harms (1900–1907), Schottky (1912), Gamble (1915), Koidzumi (1916), Rehder & Wilson (1916), Rehder (1919, 1929), Ridley (1924), Markgraf (1924), Henderson (1930), Lemée (1932, 1934, 1939), Schwarz (1936 a, b), Camus (1938, 1954), Barnett (1943, 1944), Hjelmqvist (1948), Brett (1964), Forman (1964), Melchior (1964), and many others.

Before deciding which of these two opposite views should be adopted here, I have carried out a comparative study on the morphology of the inflorescence, flower, cupule, and pollen grains, and also on the anatomical structure of the cupule and the fruit wall of both genera. The main conclusions should be drawn here are as follows:

(1) I fully agree with Oersted and others in separating *Lithocarpus* from *Quercus*. These two genera may be distinguished from one another by the following characters:

<i>Quercus</i>	<i>Lithocarpus</i>
a. Inflorescence unisexual.	... Inflorescence usually androgynous or mixed.
b. Male inflorescence flexuous, pendent.	... Male inflorescence rigid, thick or slender, erect.
c. Male flower normally with 6 stamens and without a pistillode.	... Male flower normally with 12 stamens, and always with a pistillode.
d. Anthers basifixed, c. 0.5–1 mm long.	... Anthers dorsifixed, c. 0.20–0.25 mm long.
e. Female flower mostly without staminodes.	... Female flower with 12 staminodes.
f. Styles flattened, bearing broad stigmatic surface, or cylindrical and grooved with capitate stigmas.	... Styles terete, bearing minute, terminal, punctiform stigmas.

<i>Quercus</i>	<i>Lithocarpus</i>
g. Pollen grains prolate-spheroidal, c. $30 \times 20 \mu$, mostly 3-colpate, rarely 3-colporate; exine more or less scabrate.	Pollen grains prolate-perprolate, c. $18 \times 10 \mu$, always 3-colporate; exine relatively smooth (seen under light-microscope).
h. Cupule normally solitary along the rachis.	Cupule solitary or aggregated in dichasial clusters along the rachis.

(2) In its general form and also in its anatomical structure, the cupule of *Quercus* is exactly the same as that of *Lithocarpus*. The similarity even extends to the type of external emergences (scales or lamellae) covering the cupule. The cupule of these two genera represents a distinct type and differs from the other type recognized in the *Fagaceae*, viz. *Fagus-Castanea*-type, by being open, cup- or saucer-shaped or completely covering the solitary fruit, indehiscent, not spiny but covered with imbricate scales or concentric lamellae. I do not think, however, that the characters of the cupule alone are sufficient to merge *Lithocarpus* with *Quercus*.

(3) Three different types of anatomical structure of the fruit wall in the *Fagaceae* are distinguished, viz. Quercoid-type (*Quercus*, *Castanea*, *Castanopsis*, *Lithocarpus*), Fagoid-type (*Fagus*, *Triglobalanus*), and Nothofagoid-type (*Nothofagus*). The descriptions of these anatomical structures are given on p. 369 and figured in Plates 3–5.

(4) With respect to the generic splits in *Quercus*, it may be pointed out here that Oersted (1867) was the first who suggested splitting the genus into two smaller genera, viz. *Quercus* and *Cyclobalanopsis*. Amongst the later authors who accepted this subdivision are: Schottky (1912), Markgraf (1924), Kudo & Masamune (1930), Nakai (1939), Hjelmqvist (1948), Li (1953, 1963), and Brett (1964). In 1936 Schwarz even proposed subdividing the genus into four genera, namely *Quercus* s.s., *Macrobalanus*, *Erythrobalanus*, and *Cyclobalanopsis*. No subsequent author has accepted this suggestion.

The characters used by the above mentioned authors, to distinguish the two or four smaller genera, are that of the cupule, abortive ovules, male inflorescence and flower, and the styles. In the present study however it was found that except for the presence of a lamellate cupule in *Cyclobalanopsis*, all the differing characters are too inconsistent to be regarded as generically important. There are too many intermediate characters which obscure a clear distinction between those smaller genera. Therefore, I am of the opinion that it is not worthwhile to split the genus *Quercus* into two or four smaller genera. Amongst the previous authors who have accepted this idea are: Gamble (1915), Koidzumi (1916), Rehder & Wilson (1916), Ridley (1924), Trelease (1924), Handel-Mazzetti (1929), A. Camus (1938), Lemée (1939), Rehder (1940), Müller (1942 a, b), Barnett (1943, 1944), Hutchinson (1959), Forman (1964), Ohwi (1965), and many others.

ACKNOWLEDGEMENTS

I would like to express my deep gratitude to the Authority of the Colombo-Plan Scheme, and to the British Council for the scholarship which enabled me to carry out the present work.

To Dr. J. Barker, the Secretary of the Gordon Wigan Fund of the University of Cambridge, England, and to Professor C.G.G.J. van Steenis, the Director of the Flora Malesiana Foundation, Leiden, the Netherlands, I would like to thank them for the financial support which made my visits to the Botanisches Museum in Berlin-Dahlem and to the Rijksherbarium, Leiden, in Summer 1965, possible.

I am very grateful to the Directors of the following Herbaria for the loan of specimens or for their hospitality given to me during my visits to their Institutions:

- Botanisches Museum, Berlin-Dahlem, Germany (B).
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- Sarawak Forest Department, Kuching, Sarawak, Malaysia (SARF).
- Botanic Gardens, Singapore (SING).
- Botanical Museum & Herbarium, Utrecht, the Netherlands (U).

In particular, I am very much indebted to Professor E.J.H. Corner, F.R.S., Professor of Tropical Botany, at the University of Cambridge, England, for his advice and guidance during my four years research work in the University.

My gratitude also extends to the following for their invaluable advice and information: Dr. J.A.R. Anderson (Kuching, Sarawak), Mr. H.M. Burkill and Dr. Chew Wee Lek (Singapore), Dr. D.M. Churchill (Monash University, Australia), Mrs. C. Dikson (formerly Botany School, Cambridge, England), Mr. L.L. Forman (Kew), Dr. M. Jacobs (Leiden), Dr. S.M. Walters (Botany School, Cambridge, England), and Dr. F. White (Oxford).

Finally I would like to thank also to Dr. P.S. Ashton (formerly Kuching, Sarawak), Mr. K. Kartawinata (formerly Department of Botany, the University of Singapore), Prof. Dr. A.J.G.H. Kostermans and Mr. N. Wirawan (Bogor, Indonesia) for their assistance to collect material.

CHARACTERS

Habit: in Malesia species of *Quercus* are trees of medium to large size. Under favourable conditions an individual tree may reach c. 40 m in height and 1.20 m in diameter. In each species there is a general tendency for the plant to attain a smaller size at a higher elevation. This is probably due to the more favourable ecological conditions in the lowland forests. The ecological variation also extends to the size, texture and indumentum of the leaves. In *Q. elmeri*, *gemelliflora*, *lineata*, *lowii*, *subsericea*, and *valdinervosa*, for example, the leaves of the plant growing at lower altitude are larger, thinner and less pubescent than those of a tree inhabiting a higher altitude. The trunk is usually straight, very rarely stunted. In most species buttresses are absent, but in *Q. argentata*, *elmeri*, *gemelliflora*, *percoriacea*, *pseudo-verticillata*, and *treubiana*, it may reach c. 1–3 m in height. The crown is usually dense, spreading, and makes up about one third or one half of the total height of the tree.

Bark: in the nineteen species from Malesia, three different types of bark may be distinguished, viz. the smooth and lenticellate bark (*Q. argentata*, *kerangasensis*, *kinabaluensis*, *nivea*, *percoriacea*, and *valdinervosa*), the finely fissured bark (*Q. chrysotricha*, *lowii*, and *subsericea*), and the scaly bark which peels off profusely into rectangular pieces (*Q. oidocarpa*, *pseudo-verticillata*, and *treubiana*). The bark in *Q. gemelliflora* and *linedta* may be smooth and lenticellate or finely fissured. In all species the outer bark is usually thin and hard, and pale yellow to greyish-brown in colour; the inner bark is sometimes as thick as 2.5 cm, brittle, fibrous, ridged on its inner surface, and pale yellow to reddish-brown in colour. The tannin content may be up to 20 per cent of the dry weight.

Wood: from the available information it seems to be impossible to distinguish species of *Quercus* by the wood characters alone. According to Cutler (1964), the wood of some species of *Quercus* is almost indistinguishable from that of *Lithocarpus* and *Trigonobalanus*. The wood of these three genera differs from that of *Fagus*, *Nothofagus*, *Castanea* and *Castanopsis* by its dendritic distribution of the solitary vessels, uni- to multi-seriate rays, concentric bands of parenchyma, bordered pitting in the wall of vessels and ray-cells, and by its frequency of the libriform fibres. Cutler also mentioned however that the genera in the *Fagaceae* are not always clearly defined from one another by the wood characters alone. There are many overlapping characters between some species, not only of the same genus but also of different genera. In the Malesian species the wood is usually pale yellow to yellowish-brown in colour, moderately hard and heavy, but not durable, splitting very easily, and difficult to work with. The growth rings are indistinct, and the sapwood is not sharply defined from the heartwood.

Twigs: in the Malesian species the new shoots are as a rule conferted. Young twigs are densely covered with yellowish-brown, either simple or stellate-adpressed hairs. Older twigs are glabrous and densely or sparsely lenticellate. Though the twigs are terete, the pith is always star-shaped with 4-5 lobes in cross-section.

Vegetative buds: in most of the Malesian species the vegetative buds are not characteristic for a particular species, but usually small, c. 0.2-1 by 0.2-0.5 cm, ovoid-globose or ovoid-conical, with the scales ovate-acute and densely simple or stellate tomentellous. The arrangement of the scales is as a rule imbricate, but in *Q. valdinervosa* it is sometimes in four symmetrical rows. In *Q. subsericea* and *treubiana*, the vegetative buds are elongated, ovoid-ellipsoid, and the scales are linear-acute.

Stipules: in Malesia the stipules are extrapetiolar, caducous, linear-acute, c. 0.2-1 by 0.1-0.2 cm, with simple or stellate tomentum or with woolly or stiff pubescence. These characters are however not specific.

Leaves: the simple leaves are spirally arranged, usually crowded near the tip of the twig, or occasionally in a pseudo-whorled arrangement (*Q. pseudo-verticillata*); venation pinnate, with the midrib and lateral nerves usually flattened or impressed on the upper surface and more or less prominent on the lower surface. The petiole, whether it is long and slender or short and thick, is always thickened at the base; glabrous or more commonly densely or sparsely tomentose or densely stiff or woolly pubescent. In *Q. chrysotricha*, *merrillii*, *pseudo-verticillata*, and *steenisii*, the petiole is c. (0.1)-0.3-0.5-(1.0) cm long, whilst in the other fifteen species it is slender, c. (1.0)-2-3-(4.5) cm long. The adaxial side of the petiole in *Q. lowii*, *nivea*, *oidocarpa*, *percoriacea*, and *subsericea*, is deeply sulcate at least in the upper part near the leaf-base. In the other species the adaxial side of the petiole is either flattened or rounded. The petiole of the mature leaf may be completely glabrous (*Q. argentata*, *oidocarpa*, *percoriacea*, and *valdinervosa*), densely stellate tomentose (*Q. gaharuensis*, *lowii*, and *nivea*), densely sericeous (*Q. chrysotricha*, *gemelliflora*, *merrillii*, *pseudo-verticillata*, *subsericea*, and *sumatrana*), or densely stiff or woolly pubescent (*Q. elmeri*, *kerangasensis*, *kinabaluensis*, *lineata*, *steenisii*, and *treubiana*). In a combination with the other characters of the leaf the petiole morphology is very useful for identification.

In Malesia the leaf-blade is either elliptic- to lanceolate-oblong (*Q. argentata*, *elmeri*, *gaharuensis*, *gemelliflora*, *lineata*, *nivea*, *oidocarpa*, *pseudo-verticillata*, *sumatrana*, *valdinervosa*, and occasionally also in *subsericea*), or ovate-elliptic to ovate-lanceolate (*Q. chrysotricha*, *kerangasensis*, *kinabaluensis*, *lowii*, *merrillii*, *percoriacea*, *steenisii*, and occasionally also in *subsericea*), or rarely linear-lanceolate (*Q. treubiana*). The leaf varies from 2 to 24 cm in length and from 1 to 9 cm in width. On account of this character, three different species groups may be distinguished in Malesia, namely *Q. argentata*, *nivea*, *oidocarpa*, *percoriacea*, *pseudo-verticillata*, *sumatrana*, and occasionally also *subsericea*, which have

relatively large leaves, c. 10–17 by 3–5 cm; *Q. elmeri*, *gemelliflora*, *kerangasensis*, *kinabaluensis*, *lineata*, *lowii*, *steenisi*, and usually *subsericea*, which have medium sized leaves, c. 5–10 by 2–4 cm; and *Q. chrysotricha*, *merrillii* and *treubiana*, which have small leaves, c. 2–4 by 1.5–3 cm. There is however some overlapping, so that the size of the leaf should be used in conjunction with the other characters. The base of the leaf may be rounded, subcordate or auriculate (*Q. lowii*, *percoriacea*, *pseudo-verticillata* and *steenisi*), or attenuate-rounded or attenuate-acute in the other species. The margin is either entire as in *Q. argentata*, *chrysotricha*, *kerangasensis*, *kinabaluensis*, *nivea*, and *pseudo-verticillata*, or entire in the basal half and distantly serrulate in the apical half. The apex of the leaf is rounded, bluntly acute or rounded emarginate in *Q. chrysotricha*, *merrillii*, *pseudo-verticillata*, and *steenisi*, or more commonly shortly acute, acuminate to caudate. The texture of the leaf in *Q. kinabaluensis*, *nivea*, *percoriacea*, *pseudo-verticillata*, *steenisi*, and *valdinervosa* is thickly coriaceous, whilst in *Q. argentata*, *chrysotricha*, *elmeri*, *gaharuensis*, *gemelliflora*, *kerangasensis*, *lineata*, *merrillii*, *oidocarpa*, and *subsericea* is thinly coriaceous. In *Q. sumatrana* and *treubiana*, the texture is thinly chartaceous.

Except for *Q. chrysotricha*, *kinabaluensis*, *lowii*, and *subsericea*, the midrib and lateral nerves are strongly prominent beneath. On the upper surface, these nerves are either slightly raised (*Q. elmeri*, *gaharuensis*, *gemelliflora*, *kinabaluensis*, *lineata*, *steenisi* and *treubiana*), or flattened to impressed in the other species. The number of lateral nerves varies considerably in the species, but fairly consistent numbers may be found in three species groups, viz. *Q. argentata*, *lineata*, *oidocarpa*, *pseudo-verticillata*, and *valdinervosa* which have c. 10–20 pairs; *Q. chrysotricha*, *kinabaluensis*, *lowii*, and *merrillii* which have c. 4–6 pairs, and the rest of the species which have c. 8–15 pairs. The angles between the lateral nerves and the midrib vary from 30° to 75°, with the majority of the species falling between 45° and 60°. In *Q. oidocarpa* and *pseudo-verticillata* the angle is about 30°–45°, whilst in *Q. argentata*, *chrysotricha*, *elmeri*, *gemelliflora*, *kerangasensis*, *nivea*, and *valdinervosa* is c. 60°–70°. The reticulation between the lateral nerves is generally parallel, very rarely more or less anastomosing (*Q. lowii*), and it is either distinct beneath (*Q. gaharuensis*, *lineata*, *oidocarpa*, *percoriacea*, *steenisi*, and *valdinervosa*) or more commonly obscure. In *Q. lineata*, *oidocarpa* and *steenisi* the reticulation is parallel and dense, whilst in the other species it is lax.

The type and density of the pubescence on the lower surface of the leaf is in some species rather consistent. This character however should be used with a great caution. In *Q. argentata*, *chrysotricha*, *gemelliflora*, *kerangasensis*, and *valdinervosa*, the mature

leaves are completely glabrous on both surfaces, whilst in *Q. gaharuensis*, *lowii*, *nivea*, *oidocarpa*, *percoriacea*, and *subsericea*, the lower surface of the adult leaf is densely or sparsely adpressed tomentose. In *Q. elmeri*, *kinabaluensis*, *lineata*, *merrillii*, *pseudoverticillata*, *steenisii*, *sumatrana*, and *treubiana*, the lower leaf surface is densely or sparsely stiff or woolly pubescent. On account of this character *Q. lineata* may be distinguished from the other species by its dense layer of straight, adpressed, simple hairs on the lower surface of the leaf, and *Q. steenisii* differs from the other species by its thick layer of yellowish-brown, woolly hairs which are caducous.

Inflorescence (Fig. 1, f. 1-3): Similar to that of the other anemophilous genera in *Fagaceae* (*Fagus*, *Nothofagus*), the inflorescence in the genus *Quercus* is either male or female. In *Quercus*, however, the inflorescence is catkin-like (condensed raceme of cymes), whilst in *Fagus* and *Nothofagus* it is simply a 1-many-flowered, somewhat modified dichasium. In the Malesian species the male inflorescence is as a rule compound, i.e. the flowers are in 3-4-flowered dichasial clusters, and very rarely simple, i.e. when the flowers are solitary along the catkin-axis; it is either solitary in the axil of a lower leaf (*Q. gaharuensis*, *gemelliflora*, *kinabaluensis*, *lineata*, *lowii*, *steenisii*, *subsericea*, *treubiana*, and *valdinervosa*) or in a paniculate clusters on the lateral or subterminal new shoot (*Q. argentata*, *kerangasensis*, *nivea*, and *oidocarpa*). The rachis may be very thin and slender (*Q. lowii*), or more commonly rather thick; in both cases it is either stellate tomentellous or sericeous. The female inflorescence is always simple, solitary in the axil of a higher leaf, unbranched and densely minutely tomentose.

Flowers (Fig. 1, f. 4-7): in each dichasial cluster, the flowers are always protected by ovate-acute, caducous bracts. *Male flower*: the perianth is densely minutely simple tomentose, 4-6-lobed, with the lobes connate at base; stamens 4-6, rarely up to 9 (*Q. valdinervosa*); filaments slender, filiform, glabrous or minutely puberulous at base; anthers c. 0.5-1 mm long, globular reniform, basifixed, longitudinally dehiscent, 2-locular, 4-lobed; ovary usually absent or abortive and represented by a cluster of stiff-simple hairs (*Q. gaharuensis*, *lineata*, *lowii*, *steenisii* and *treubiana*). *Female flowers*: the ovary is obtusely triangular, 3-locular, each locule contains 2 ovules; perianth (4)-6-(9)-lobed; staminodes absent in most species but 5-7 in *Q. gemelliflora*, *nivea*, *steenisii*, and *valdinervosa*; styles 3-(6), recurved and free or rarely connate (*Q. nivea*); stigmas always broadly capitate.

Pollen grains: from the study of no less than 100 species of *Fagaceae*, belonging to seven different genera, it appears that three different types of pollen grains exist,* namely *Quercus*-type (*Fagus*, *Quercus*, *Trigonobalanus*), *Castanea*-type (*Castanea*, *Castanopsis*, *Lithocarpus*) and *Nothofagus*-type.

* The characters used here are the size, general appearance of the pollen, the structure of the exine, and the number of apertures and pores.

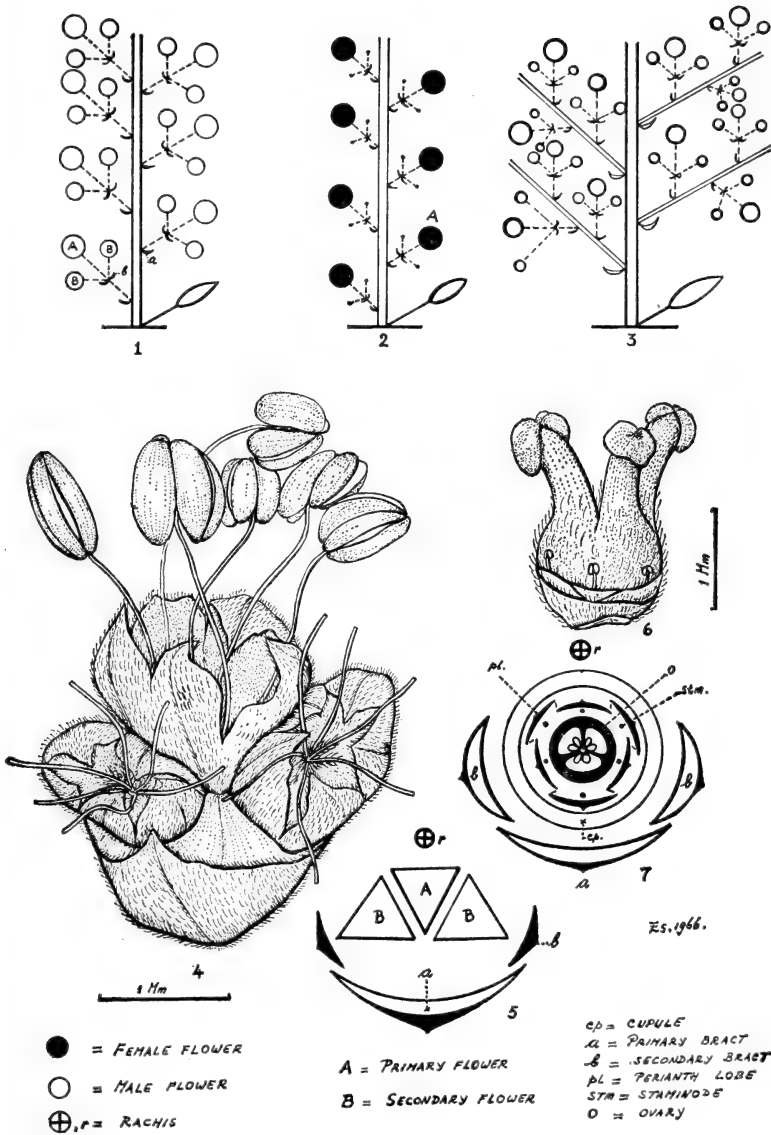


Fig. 1:

- 1 = diagram of a male inflorescence.
- 2 = diagram of a female inflorescence.
- 3 = diagram of a panicle cluster of male inflorescences.
- 4 = 3-flowered male dichasium.
- 5 = diagram of figure 4.
- 6 = a pistillate flower with the perianth removed.
- 7 = diagram of a female flower.

Except for the pollen type in the genus *Fagus* therefore this generic grouping concurs with that based on the inflorescence and floral characters. In the *Quercus*-group the pollen is prolate-spheroidal to suboblate, 3- or rarely 4-angular in polar view; usually with 3 apertures only, or with 3 apertures and 3 pores as well; average size c. $30 \times 20 \mu$. The exine c. $1-2.5 \mu$ thick, more or less scabrate. Furrows elongate and the pores are simple or in *Trigonobalanus doichangensis* it is striate in equatorial optical section; circular or more or less obtuse-triangular in outline. In the *Castanea*-group the pollen is prolate-perprolate to ellipsoid, c. $18 \times 10 \mu$; always with 3 apertures and 3 pores. The exine is c. $0.4-1 \mu$ thick, and relatively smooth. The furrows are narrow and usually with pointed ends. The pores are always simple, well-defined and equatorially elongated. In *Nothofagus*, the pollen is distinctly oblate to peroblate (flattened) in equatorial view, and 4-9-angular in polar view. Polar diameter ranges from 9 to 16μ , equatorial diameter from 20 to 65μ . The exine c. $0.7-1.6 \mu$ in thickness, and distinctly echinate. The furrows are simple, meridionally elongated, and usually with rounded ends.

The pollen of *Quercus* differs from that of *Fagus* by its smaller size and its finer reticulation; from that of *Trigonobalanus* by its thinner exine, simpler and sometimes vestigial pores, and to some extent also by its more circular outline in polar view. The pollen in *Q. lowii* has very well-developed pores and apertures, whilst that of *Q. lineata*, *steenisi*, and *valdinervosa* have vestigial pores and well-defined apertures. In the other Malesian species investigated the pollen has no pore. From this brief survey it seems that pollen morphology supports the separation of *Lithocarpus* from *Quercus*, *Nothofagus* from *Fagus*, but it does not support the generic splits proposed by various workers in *Castanopsis*, *Lithocarpus*, *Nothofagus* and *Quercus*. Pollen morphology also supports Forman's idea to place *Quercus* and *Trigonobalanus* in the subfamily *Quercoideae*, and *Castanea*, *Castanopsis* and *Lithocarpus* in the subfamily *Castaneoideae*.

Cupule: similar to the other genera of *Fagaceae*, the most characteristic feature of the genus *Quercus*, is the presence of cupule enclosing the basal part of the fruit. In the earlier works, this cupule has been interpreted as an involucre of bracts fused together with only their tips appearing as scales, lamellae or spines; or as an axial structure formed by an intercalary outgrowth of the meristematic tissue below the flower bearing modified leaves (scales or spines). In 1878 Eichler suggested a rather different interpretation, in which the cupule was regarded as a structure built up by the modification of the four bracteoles in the dichasium, and the scales or spines as simply external emergences. In the most recent works (Berridge, 1914, Langdon 1939, 1947, and Brett 1964) the cupule is considered as an axial structure formed by the modified axes of the next higher order flowers in the dichasium, and the scales, lamellae or spines as external appendages.

Development of the cupule: in the earlier stages of the pistillate flower development, the cupule primodium in *Quercus*, appears as a collar subtending the flower, and it is situated between the flower and the bracts. The growth of the cupule is at first faster than that of the flower, so that the partly developed fruit is completely enclosed by the cupule, except for the perianthodium and the styles. The faster growth of the cupule in the earlier stages gives rise to the ring-like marks on the perianthodium. Soon after fertilization, the elongation of the cupule slows down or stops before the fruit is fully developed. At maturity therefore the cupule usually covers not more than a quarter to two thirds of the fruit. As a rule the cupule in *Quercus* encloses one fruit only, but in *Q. lowii* it has been observed that in some specimens the cupule contains more than one fruit, usually two. There is, however, a clear evidence that this abnormality is caused by injury during the development of the fruit and cupule. A similar condition has been reported by Hjelmqvist in 1948 in *Q. acuta* from Japan, which induced him to conclude that the cupule in *Quercus* subgen. *Cyclobalanopsis* must have a different origin from that of subgenus *Quercus*. Another abnormality which should be mentioned here is that, while in most species the cupules are solitary along the rachis, in a few specimens of *Q. gemelliflora* from Java two or three cupules are grouped together in a dichasial cluster as normally occur in the genus *Lithocarpus*. It is not certain, however, whether this abnormality is a product of a teratological growth or that it is a genuine morphological feature.

Anatomy of the cupule: this investigation was performed mainly to find out whether the distribution of the vascular bundles in the cupule gives any clue towards a better understanding on the nature and probable evolutionary lines of the cupule in *Fagaceae*. The cupules were cut by razorblades in three different planes, viz. longitudinal sections following the axis of the catkin, longitudinal sections across the axis, and cross-sections through the cupules. The 0.5 to 2 mm thick sections then were treated with lactic acid and heated for about five minutes. By this simple method clear sections showing the distribution of the vascular supply were obtained.

In a series of longitudinal sections following the axis of the catkin (Fig. 2, f. 1), the vascular tissue at first appears as a central cylinder (M) originating from the vascular tissue supplying the rachis. Outside this main vascular cylinder, several smaller traces may be seen. These smaller traces supply the bracts and bracteoles, whilst the main vascular cylinder is leading to the flower and cupule. At the level above the insertion of the bract (a), i.e. from the lower part of the main vascular column, arise several ascendant lateral traces which are orientated and branched off towards the cupule. At the level of the insertion of the flower on the cupule, the main vascular cylinder is further subdivided into several separate bundles which supply the ovary, perianth, staminodes (if present) and the styles. In a series of longitudinal sections across the rachis (Fig. 2, f. 2) the organization of the vascular tissue is

exactly the same. In a cross-section through the basal part of the cupule (or peduncle), the vascular cylinder appears as a triangular ring of loose vascular traces (Fig. 2, f. 3). At the level of the insertion of the bracteoles (*b*) this vascular column becomes laterally elongated (Fig. 2, f. 4). Above this level, i.e. at the basal part of the cupule proper, the main vascular cylinder is subdivided into a central tract (M1) which directly supplies the flower, and numerous scattered traces which give rise to the vascularization of the cupule (Fig. 2, f. 5). At the region of the insertion of the fruits (Fig. 2, f. 6) the central vascular tract undergoes a further reorganization and is divided into at least 13 smaller groups of vascular traces. One of these vascular traces supplies the placental tissue, and the others are distributed in the periphery of the fruit wall and leading to the perianth, staminodes and styles. Further up from this level, where the fruit wall is completely free from the cupule, the separation of the central vascular tract is more prominent. In the fruit wall the vascular traces situated at the corners of the locules are clustered in threes, whilst those placed between the corners of the locules are solitary (Fig. 2, f. 7). At this level it may be noticed that the traces distributed in the cupule send off more smaller branches from which the vascular supply of the lamellae covering the cupule originates. It may be mentioned here that the pattern of vascular distribution in the cupule of *Quercus* just described is exactly the same as that of a solitary cupule in the genus *Lithocarpus*.

The nature of the cupule: The cup- or saucer-shaped, solitary cupule in *Quercus* is here regarded as an axial structure formed by the intercalary outgrowth of the meristematic tissue below the flower, bearing scales or lamellae as external emergences.

The evolutionary interpretation of the cupule: in 1878 Eichler assumed that the cupule in *Quercus* must have been derived from that of *Fagus-Castanea*-type, through a complete loss of the two lateral flowers in the originally 3-flowered dichasium, followed by a complete fusion of the four modified bracteoles. Prantl (1887), Celakovsky (1887, 1890, 1893), Palibin (1909), Lendner (1916), Troll (1926), Hjelmqvist (1948), on the other hand, regarded the cupule in *Quercus* as a type derived from a dichasial cluster of 3 cupules in the genus *Lithocarpus*, by means of complete reduction of the two lateral flowers and their cupules. Recently Brett (1964) suggested a different interpretation in which the cupule in *Quercus* subgen. *Cyclobalanopsis* (considered by him as a distinct genus) is regarded as derived from a cupule type occurring in *Castanopsis*, through a similar process of reduction to that of *Castanopsis fissa*-group, and that of the subgenus *Quercus* from a 3-flowered dichasial cluster of cupules in *Lithocarpus* through a similar way of reduction as has been proposed by Prantl and others. In his recent paper, Forman (1966, in press) considers the cupule in *Quercus* (incl. *Cyclobalanopsis*) as derived from a 3-lobed, 1-flowered cupule like that in *Trigonobalanus doichangensis*, by a complete fusion of the cupule lobes.

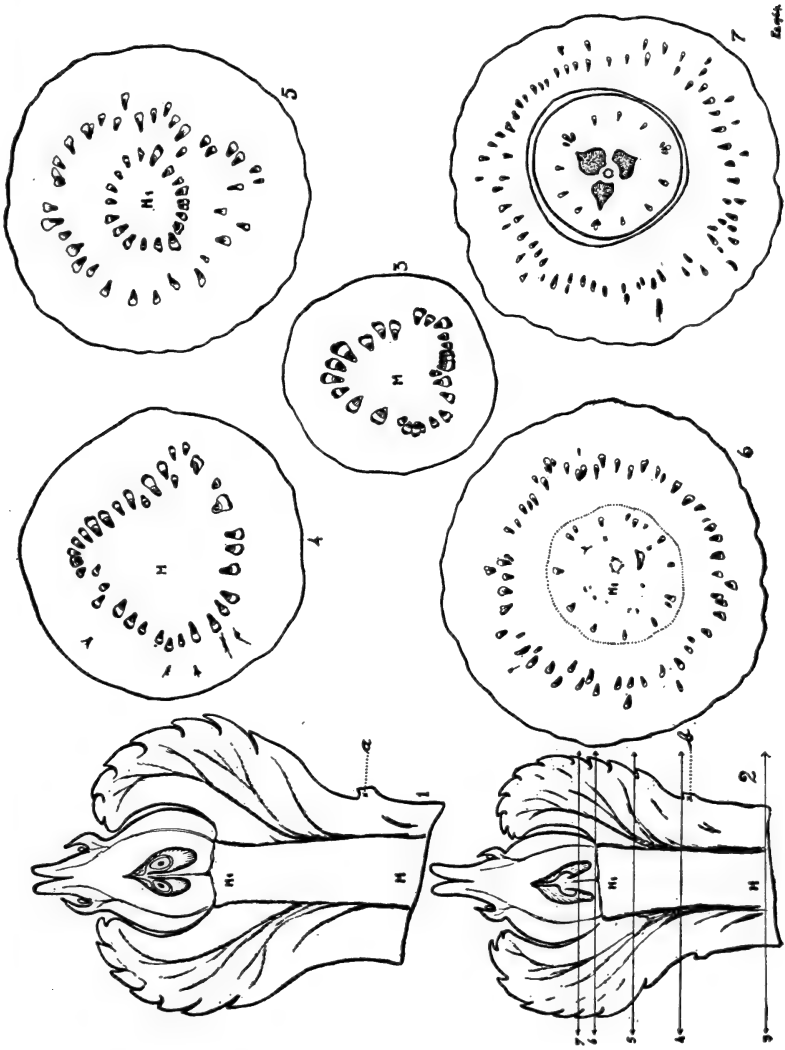


Fig. 2:

- 1 = a longitudinal section through the rachis of a young cupule.
- 2 = a longitudinal section across the rachis of a young cupule.
- 3-7 = cross-sections of a young cupule through the planes shown in figure 2.

I have pointed out elsewhere that from the earlier stages of development, there is no indication that the cupule in *Quercus* consists of separate lobes or that the cupule normally encloses more than one fruit. I also mentioned that the anatomical feature of the cupule in *Quercus* is exactly the same as that of a solitary cupule in *Lithocarpus*. Moreover, in *Lithocarpus* there is a gradual reduction from a dichasial cluster of cupules to a solitary condition by a complete abortion of the higher order flowers and their cupules. Therefore I conclude that the cupule in *Quercus* is closely allied to that of *Lithocarpus*, and it must have been derived from one of the types occurring in the latter. The cupule in these two genera represents a type distinct from that of the other genera in *Fagaceae*. The cupule in *Quercus* and *Lithocarpus* I consider as a flower-cupule, but that of *Castanea*, *Castanopsis*, *Fagus*, *Nothofagus*, and *Trigonobalanus* as a dichasium-cupule.*

The taxonomic significance of the cupule: in Malesia the characters of the cupule are very useful for identification. The cupule is either saucer-shaped (*Q. elmeri*, *percoriacea*, *steenisii*, *subsericea* and *sumatrana*) or deeply cup-shaped with rounded or attenuate base (in the other species). In *Q. argentata*, *gaharuensis*, *gemelliflora*, *lineata*, *nivea*, *oidocarpa*, *pseudo-verticillata*, *treubiana*, and *valdinervosa*, the cupule is c. 1.5–3.5 cm deep and 2–4 cm in diameter, whilst in *Q. chrysotricha*, *kerangasensis*, *kinabaluensis*, *lowii* and *merrillii* the cupule is c. 0.7–1.2 cm deep and 1–1.5 cm in diameter. In the other species the cupule is c. 0.5–1.2 cm deep and 2–2.5 cm in diameter. The rim of the cupule is c. 0.5–4 mm thick in *Q. elmeri*, *gemelliflora*, *kerangasensis*, *kinabaluensis*, *lineata*, *steenisii*, *treubiana* and *valdinervosa*, and thinner than 0.5 mm in the other species. The lamellae are c. 8–12 in *Q. argentata*, *lineata*, *oidocarpa*, *pseudo-verticillata*, and *treubiana*, and c. 5–8 in the other species. The lower lamellae are usually denticulate, whilst the upper ones are entire. The margin of the lamellae may be free or sometimes slightly connate. In most species the outer surface of the cupule is densely puberulous or stellate-tomentose and early glabrescent; the inner surface is densely covered with thick layer of silky to dark-brown, stiff simple hairs.

Fruit: according to Trelease (1924), Camus (1938), and Schwarz (1936 a, b) the maturity of the fruit in the genus *Quercus* may be annual (subgen. *Cyclobalanopsis* and subgen. *Quercus* sect. *Macrobalanus*, *Mesobalanus* and *Lepidobalanus*) or biennial (subgen. *Quercus* sect. *Erythrobalanus*, *Protobalanus*, and *Cerris*). In Malesia the data on this particular character are too scanty for a conclusion.

*(See Forman 1966, in press).

In the Malesian species the fruit is ovoid-globose, ovoid-conical or ovoid-cylindrical. The young fruit is usually densely sericeous, and gradually becomes glabrous towards maturity. In *Q. argentata*, *chrysotricha*, *gaharuensis*, *gemelliflora*, *lineata*, *merillii*, *sumatrana* and *valdinervosa* the apex of the fruit is distinctly attenuate-acute, whilst in the other species it is either attenuate-rounded or depressed. The base of the fruit in most species is convex, in *Q. sumatrana* it is concave, and in *Q. elmeri*, *oidocarpa* and *pseudo-verticillata* it is either convex or flat. The fruit-wall is c. 1–2 mm thick, and usually woolly tomentose inside. The anatomical structure of the fruit-wall in *Quercus* is the same as that of *Castanea*, *Castanopsis* and *Lithocarpus*, i.e. composed of at least five different layers of cells. These layers are, from outside inwards: 1). the outer epidermal layer consisting of a single row of rectangular cells; 2). the palisade layer which consists of several rows of radially elongated, thick-walled cells; 3). the outer parenchymatous layer which is usually very much thicker than the other layers and composed of more or less isodiametric, thin-walled cells, and containing the vascular tissue of the fruit-wall and the other floral parts; 4). the inner parenchymatous layer which has smaller cells than that of the former; 5). the inner epidermal layer consisting of a row of flattened, rectangular, thin-walled cells (Fig. 3 & 4). The anatomical structure of the fruit-wall just described differs from that of the other genera in *Fagaceae* by the position and type of the supporting layer, i.e. the layer which is composed of thick-walled cells. In *Nothofagus* (Fig. 5, f. 1–2) this supporting layer is situated near the centre of the fruit-wall, and consists of several rows of transversely elongated thick-walled cells. In *Fagus* and *Trigonobalanus*, the supporting tissue is situated directly beneath the outer epidermal layer, and is composed of several rows of more or less isodiametric, polygonal, thick-walled cells (Fig. 5, f. 3–4). In the examined specimens, the cotyledons are flat-convex, and fill the entire space of the surviving locule. The abortive ovules are apical, and the germination is hypogeal as in *Castanea*, *Castanopsis* and *Lithocarpus*.

Chromosomes number: chromosome counts in various species of *Quercus* subgen. *Quercus* have been made by several cytologists such as Ghimpu (1929), Sax (1930), Sugira (1931), Yamazaki (1936), and Duffield (1940). The diploid number reported is 24, similar to that of *Castanea* (Jaynes, 1962), and *Fagus* (Jaretsky, 1930). In the subgen. *Cyclobalanopsis* on the contrary no chromosome count has been made. The only information so far available is that given by Mr. Kwiton Jong (formerly Dept. of Botany, University of Malaya, Kuala Lumpur). He made some preliminary counts in several species of *Castanopsis*, *Lithocarpus*, *Quercus* (subgen. *Cyclobalanopsis*) and *Trigonobalanus*, and found that the diploid number in the first three genera is also 24, whilst that of *Trigonobalanus verticillata* is not yet fully understood. For comparison, it may be recalled here that in 1965, Armstrong & Wylie reported a diploid number of 26 in the four species of *Nothofagus* (*fusca*, *truncata*, *solandri*, and *menziesii*) from New Zealand.

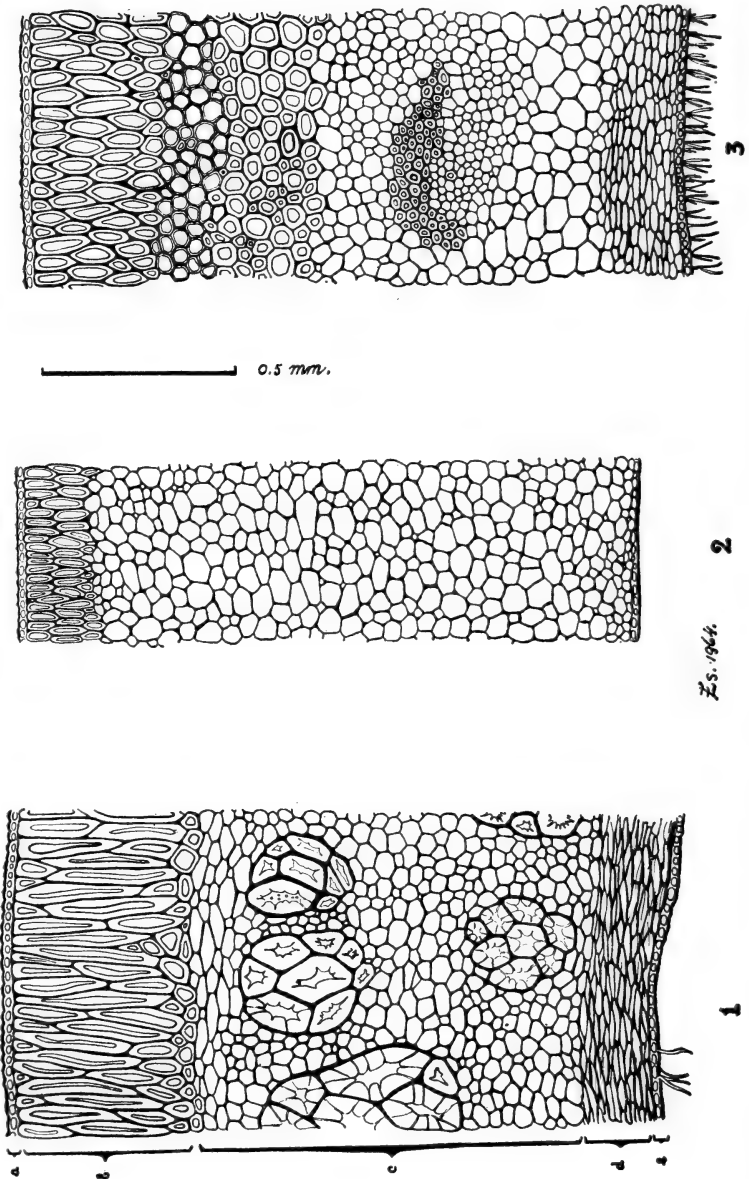


Fig. 3: cross-sections of the fruit-wall.

1 = *Q. oidocarpa*; 2 = *Q. suber*; 3 = *Castanopsis chrysophylla*; a = outer epidermal layer; b = pallisade layer; c = outer parenchymatous layer; d = inner parenchymatous layer; e = inner epidermal layer.

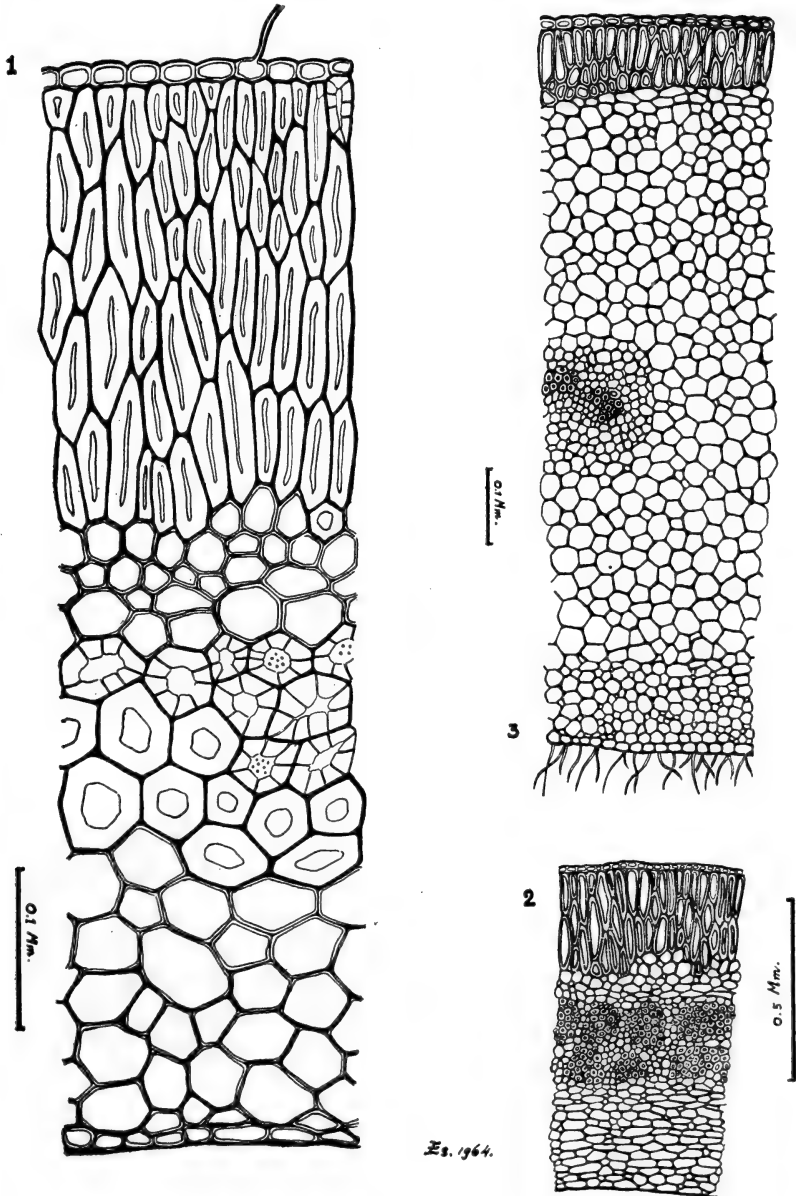


Fig. 4: cross-sections of the fruit-wall.

1 = *L. philippinensis*; 2 = *Castanopsis javanica*; 3 = *Castanea sativa*.

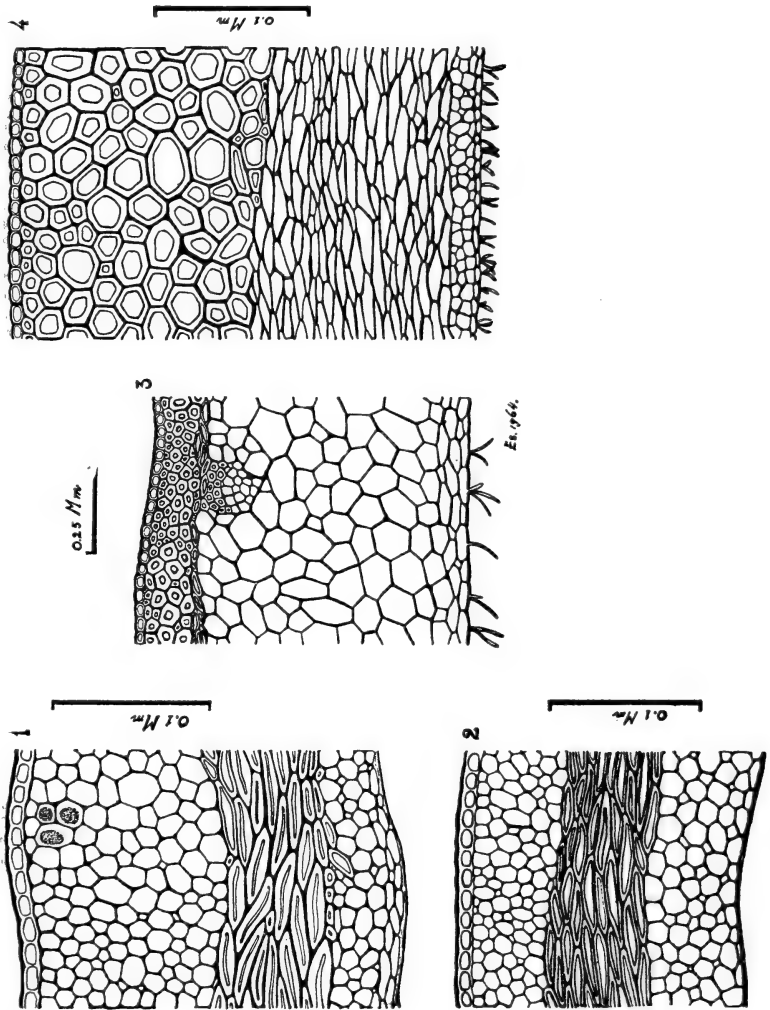


Fig. 5: cross-sections of the fruit-wall.

1 = *Nothofagus resinosa*; 2 = *Nothofagus antarctica*; 3 = *Trigonobalanus verticillata*; 4 = *Fagus sylvatica*.

TAXONOMY

The systematic position of the genus Quercus: on account of the inflorescence and stigma characters, Oersted (1867) subdivided the family *Fagaceae* into two subfamilies, viz. *Quercinae* and *Castaninae*. He included *Quercus*, *Cyclobalanopsis* and *Fagus* (incl. *Nothofagus*) in *Quercinae*, and *Castanea*, *Castanopsis*, *Pasania* and *Cyclobalanus* (incl. *Lithocarpus*) in the subfam. *Castaninae*. He distinguished the subfam. *Castaninae* from *Quercinae* by its rigid and erect male inflorescence and terminal punctiform stigmas.

In 1871, Oersted revised his classification and excluded *Fagus* and *Nothofagus* (in this paper *Nothofagus* was regarded as a separate genus) from the subfam. *Quercinae*, and placed them in a separate subfamily, *Fagineae*. In this new classification the subfam. *Quercinae* was maintained to include *Quercus* and *Cyclobalanopsis*. In the subfam. *Castaninae*, the genus *Castanopsis* was reduced to a subgeneric rank under *Castanea*, and *Pasania* was kept separate from *Cyclobalanus* (incl. *Lithocarpus*). Oersted distinguished the subfam. *Castaninae* from *Fagineae* and *Quercinae* by its terminal punctiform stigmas, and *Fagineae* from *Quercinae* by its plicate cotyledons and epigeal germination. Amongst later authors who basically accepted Oersted's subdivision of the family *Fagaceae* are Schwarz (1936 a, b), Melchior (1964), and Forman (1964). However, these later three workers added more characters which were not mentioned by Oersted or they used different combinations of characters to distinguish one subfamily from the others.

In 1894, Prantl introduced a rather different classification, in which he placed *Quercus* (incl. *Cyclobalanopsis*), *Castanea* (incl. *Castanopsis*) and *Pasania* (incl. *Cyclobalanus* and *Lithocarpus*) in the subfam. *Castaneae*, and included *Fagus* and *Nothofagus* in the subfam. *Fageae*. He distinguished these two subfamilies as follows:

Subfam. *Fageae*: flowers arranged in dichasial clusters, rarely solitary; fruit triangular; cotyledons plicate.

Subfam. *Castaneae*: flowers arranged in dichasial clusters or solitary along the catkin-axis; fruit rounded; cotyledons not plicate.

This classification was adopted by Dalla Torre & Harms (1907), Schottky (1912), and by Trelease (1924). A rather similar type of classification was proposed by Brett in 1964, though this author based his system mainly on the cupule characters.

In 1964, Forman suggested another type of classification which seems to represent a compromised scheme between Oersted's (1871) and Prantl's arrangements. Forman agreed with Oersted in subdividing the family *Fagaceae* into three different subfamilies,

but used the inflorescence and floral characters to distinguish subfam. *Fagoideae* from *Castaneoideae* and *Quercoidae* as was done by Prantl. Forman distinguished subfam. *Fagoideae* from the other subfamilies by the inflorescence which consists of a 1-many-flowered, axillary dichasial cluster, in contrast to that of subfam. *Castaneoideae* and *Quercoidae* which is catkin-like, and composed of dichasial clusters of flowers or solitary flowers. Subfamily *Castaneoideae* was distinguished from *Quercoidae* by the characters of the styles, stigmas, male inflorescence and flower, anthers, and the cupule. *Trigonobalanus* and *Quercus* were placed in the subfam. *Quercoidae*.

From the preceding discussion it is clear that the main difference between Oersted's (1871) and Prantl's classifications hinges on the question whether the genus *Quercus* (incl. *Cyclobalanopsis*) should be regarded as representing a distinct subfamily or should it be included in the same subfamily with *Castanea*, *Castanopsis*, and *Lithocarpus* (incl. *Pasania* and *Cyclobalanus*). It is also evident that though at the subfamily level Forman's classification is essentially similar to that of Oersted, at the generic level, except for the status of *Castanopsis*, it agrees better with Prantl's system.

Before deciding which of these three different classifications should be adopted here, it is necessary to discuss the generic affinity between *Quercus* and the other genera in *Fagaceae*. I have indicated elsewhere that *Quercus* possess many important consistent characters, viz. that of the inflorescence, flower, pollen grains, which distinguish this genus not only from *Lithocarpus* (s.l.) but also from *Castanea* and *Castanopsis*. The difference between *Quercus* and *Castanea-Castanopsis* are further strengthened by the characters of the cupule. In *Quercus* the cupule is always cup- or saucer-shaped, not lobed nor spiny; it encloses one fruit only, and is here regarded as flower cupule. In the genera *Castanea* and *Castanopsis* the cupule is a dichasium cupule, and in most species it is neither cup- nor saucer-shaped, but completely covering the fruits and eventually splits either into a definite number of lobes or irregularly; it encloses one to many fruits, and in the majority of the species it is either spiny or tubercled. In the earlier works, however, there has been some confusion with regard to the generic limit between *Quercus* and *Castanopsis*.

Species of *Quercus* are readily distinguished from those of *Fagus* and *Nothofagus* by their catkin-like inflorescence, cup- or saucer-shaped, not lobed cupule enclosing one fruit only, rounded ovary, flat-convex cotyledons, hypogeal germination, anatomical structure of the fruit-wall and the wood, and pollen characters. Taking all these characters into consideration, the genus *Quercus* should be placed in a different subfamily from *Fagus* and *Nothofagus*.

The affinity between *Quercus* and *Trigonobalanus* has been discussed in detail by Forman (1964). Amongst the characters mentioned by him which indicate the close relationship between these two genera are the presence of the catkin-like inflorescence, capitate stigmas, male flower with 6 stamens, anthers which are c. 0.5–1 mm long and more or less basifixed, and the absence of pistillode in the male flower. It is interesting to note here that the conclusion reached by Forman which was based on the characters just mentioned was subsequently supported by Cutler, who in 1964 investigated the wood anatomy of these two genera. Cutler, however, also stressed that the genera of *Fagaceae* are not always clearly defined from one another by the wood characters alone. In his classification, Forman regarded the lobed cupule and the triangular fruit in *Trigonobalanus*, and also the presence of androgynous and rigid and much branched male inflorescence in *T. verticillata* as ancient characters persisting in the subfam. *Quercoideae* rather than as evidence for a closed generic affinity between *Trigonobalanus* and the genera included in the subfam. *Fagoideae* or *Castaneoideae*. I have mentioned elsewhere that except for the detailed structure of the pores in the pollen of *T. doichangensis*, as for the pollen, *Trigonobalanus* agrees better with *Quercus* or *Fagus* than with the other genera of *Fagaceae*. As far as the characters of the flower are concerned therefore Forman's classification seems to be well-founded. As for the cupule and fruit characters, however, *Trigonobalanus* has nothing in common with *Quercus*, but it possess many characters in common with the subfam. *Fagoideae*. These characters are: the lobed cupule enclosing one to many fruits, trigonous and almost winged fruits, epigeal germination, and probably also the plicate cotyledons. Melchior (1964) included *Trigonobalanus* in subfam. *Fagoideae*, but his argument is not very convincing, as he indiscriminately mixed up the characters of the inflorescence, flower, cupule and fruit, which in combination are not always clearly defined in the subfamilies recognized by him. Great credit, however, should be given to Professor Melchior for suggesting the alternative systematic position of this enigmatic new genus.

Other characters which seem to contradict the disposition of *Trigonobalanus* in subfam. *Quercoideae* are the presence of androgynous and much-branched, erect, male inflorescences in *T. verticillata*. These characters which are usually associated with entomophily, persist in *Fagaceae* only in the *Castaneoideae*. Taking all the known characters into consideration, however, it is clear that placing *Trigonobalanus* in the subfam. *Castaneoideae* is out of question. It remains to be settled in the future, therefore, whether the genus *Trigonobalanus* should be placed in *Fagoideae* or *Quercoideae*.

Conclusion: on account of the inflorescence and floral characters, I agree with Forman (1964) to recognize in the family *Fagaceae* three subfamilies, viz. *Castaneoideae* (*Castanea*, *Castanopsis*, and *Lithocarpus* s.l.), *Fagoideae* (*Fagus* and *Nothofagus*), and *Quercoideae* (*Quercus* incl. *Cyclobalanopsis*, *Macrobalanus* and *Erythrobalanus*). A reservation should be made with regard to the position of *Trigonobalanus* until this genus is better understood.

NOTE ON THE IDENTITY OF SEVERAL MALESIAN SPECIES

Q. oidocarpa Korth., *Q. brevistyla* A. Camus, and *Q. gaharuensis* Soepadmo: the type of *Q. oidocarpa*, preserved in the Rijksherbarium, Leiden, was collected by Korthals in 1835 from the vicinity of Mt. Malintang in Central Sumatra. In 1888, Hooker f. cited several specimens from Malaya and Borneo under this species, which were accepted by most of the subsequent authors such as King (1889), Brandis (1906), Gamble (1915), Ridley (1924), Merrill (1921), and A. Camus (1938). In the present study, however, it was found that these specimens are quite different from Korthals' species, and they agree very well with *Q. gaharuensis* I described in April 1966. In 1933, A. Camus described a new species, viz. *Q. brevistyla*, based on specimens collected by Syed Ali (Kep. 22574) from Fraser's Hill, Malaya. She apparently did not see Korthals' specimens; I found that Syed Ali's specimens match very well those of Korthals. Therefore, I reduce *Q. brevistyla* to *Q. oidocarpa*.

Q. semiserrata Roxb.

In his account on the Indo-Malayan species of *Quercus* and *Castanopsis*, King (1889) erroneously reduced *Q. horsfieldii* Miquel (1856) from Bangka (Horsfield 11) and Sumatra (Diepenhorst 42) to *Q. semiserrata* Roxb. After comparing these two specimens with those of *Q. semiserrata*, I came to the conclusion that the Sumatran plants do not belong here, but should be included in *Q. gemelliflora* Bl. In 1904, Koorders & Valetton accepted King's reduction and credited several specimens from Java collected by Koorders to *Q. semiserrata*. I place Koorders' specimens in *Q. oidocarpa*.

Q. lowii King

King's original description of this species was based on the specimens collected by Low (*s.n.*, in Herbarium Calcutta) from Mt. Kinabalu in North Borneo. King (1889) indicated that this species may be distinguished by its coriaceous leaves which are narrowly ovate, bluntly acuminate, remotely serrate in the apical half, and with the base either rounded or slightly cordate. The lower surface of the leaf was described as minutely cinereous-tomentose, and the cupule as cup-shaped, c. 1.5 cm in diameter and 0.75 cm in height, minutely tomentose and covering c. $\frac{1}{4}$ part of the ovoid-cylindrical fruit. In King's illustrations (*l.c.*, Plate 21 B, f. 4-6) the leaf is figured as sharply and deeply serrate in the upper half. In the actual specimen, however, the leaf margin is not sharply and deeply serrate as in King's figures, but it is either shallowly, remotely serrate in the apical half or almost entire. King's exaggerated figures on the leaf margin have given rise to some doubt to most later botanists who tried to identify specimens of *Quercus* recently collected from Mt. Kinabalu. One of these even thought that *Q. lowii* must be a very rare species. From the specimens examined, however, I found that this species is not very rare as

has been assumed, but is very common in Mt. Kinabalu, especially at 1000–2000 m altitude. In the specimens studied, it appears that there are two forms, which differ from one another by their leaf pubescence. In one form the leaf is densely, minutely stellate-tomentose beneath, and almost completely glabrous in the other. The pubescent form is represented by several specimens (including the type), e.g. Clemens 10936, 32448, Meijer SAN. 24121, 28808, Chew & Corner RSNB. 4363, 4500, 4662, and Sow Kep. 71649. Except for Sow's specimen, all of these are from c. 1500–2500 m altitude. The majority of the examined specimens belong to the glabrous form, and most of them are from lower altitude. Clemens 30967, 32933, and 40231 are intermediates, with the leaf being neither glabrous nor densely, minutely stellate-tomentose, but sparsely stellate-tomentose. These three specimens were collected mainly between 1200 and 1500 m altitude. The cupules and fruits of the recently collected specimens (e.g. SAN. 28808 and RSNB. 4500) agree very well with King's description and illustration. Therefore, I consider the glabrous and pubescent forms as conspecific, representing King's *Q. lowii*. This species is closely allied to *Q. subsericea* A. Camus, which also occurs in Mt. Kinabalu, but *Q. lowii* differs from the latter by its thick-coriaceous leaves which have rounded to cordate base, sharply acuminate apex, more or less net-shaped reticulation, and by its cup-shaped, densely tomentose cupule.

• ***Q. mespilifolia* Wall. ex A.DC. var. *borneensis* Heine**

Q. mespilifolia was first mentioned as a nomen nudum in Wallich's Catalogue (no. 2766, 1828). It extends from S.W. China (Yunnan) to the Northern parts of Burma, Laos and Vietnam (Tonkin). In 1935, A. Camus renamed this species *Q. mespilifolioides*, as she was of the opinion that Wallich's name was invalidly published. In 1864, however, A. DeCandolle validated Wallich's name, so that *Q. mespilifolioides* A. Camus is a superfluous name for Wallich's species. In 1953, Heine described *Q. mespilifolia* var. *borneensis*, based on Clemens 31238, 31317, and 31459, from Mt. Kinabalu. Heine distinguished the new variety by its densely ferruginous-pubescent leaves which are serrate in the apical $\frac{1}{3}$ – $\frac{1}{2}$ part. Recent collections from North Borneo and Sarawak added more information about this new variety, in which female inflorescences and fruits were gathered, unknown to Heine. After comparing the type specimens of *Q. mespilifolia* from the Upper Burma and some other specimens credited by King (1889) to this species with the Bornean materials, I have come to the conclusion that the Bornean plant represent a distinct species. It differs from *Q. mespilifolia* by the characters of the cupule, fruit, and leaf. The specific epithet *borneensis*, however, is preoccupied by *Q. borneensis* Merr. (1922), the basionym of *Lithocarpus borneensis* (Merr.) Rehder. I recognize this species as *Q. valdinervosa* to indicate the strong nervation of the leaf. Clemens 31317 is chosen as the lectotype, and Anderson S. 4547 as the paratype (fruits).

Q. gemelliflora Bl.

This species was first described and figured by Blume (1823) based on mixed specimens consisting of a leafy twig which belong to *Quercus* and fruits represent a species of *Lithocarpus* (cf. Blume's illustration in Verh. Bat. Genootsch. 9, f. 6, 1823). In the type specimen at Leiden, I could not trace any fruit attached, and I discovered that the leaves are exactly the same as those of *Q. turbinata* Bl. (1825). Therefore, I reduce *Q. turbinata* to the synonymy of *Q. gemelliflora*, and choose the remaining sterile specimen (Blume s.n.) preserved at Leiden as the type.

In 1847, Endlicher erroneously renamed *Q. turbinata* Bl. as *Q. merkusii*, as he thought that the name *turbinata* had been used by Roxburgh (1832) for a different species from India, apparently not realizing that this was a later homonym. Therefore, *Q. merkusii* is a superfluous name for *Q. turbinata*, and accordingly it becomes another synonym of *Q. gemelliflora*. Roxburgh's *Q. turbinata* was eventually reduced by King (1889) to *Q. thomsonii* Miq. which in 1919 was transferred to the genus *Lithocarpus* by Rehder. In 1915, Gamble described under *Q. turbinata*, a new variety *crassimellata*, based on Wray 1532 from Johore, Malaya. A Camus (1931) raised this variety to a specific rank. I reduce this variety to *Q. gemelliflora* Bl.

Q. hendersoniana A. Camus

This species was published by A. Camus in 1932, based on Henderson 18053 from Cameron Highlands, Pahang, Malaya. I reduce this species to *Q. lineata* Bl.

The other species of *Quercus* from Malesia which are not described in this paper are included in the genus *Lithocarpus* Bl.

GEOGRAPHICAL DISTRIBUTION

The distribution of *Quercus* subgen. *Quercus* extends from southern Scandinavia throughout Europe to northern Africa (Morocco, Algeria and Tunisia), Lebanon, Turkey, and spreads eastwards to the Caucasus ranges, northern Syria, Iraq, Persia, Afghanistan, Pakistan, India, Burma, Thailand, Laos and then northwards to Hainan, China, Formosa, eastern Manchuria, Korea, Japan and Sakhalin Isl. In America the distribution ranges from the south-eastern parts of Canada, southwards and westwards to the United States, Mexico, Cuba, Guatamala, Honduras, Nicaragua, Costa Rica, Panama and the Columbian Andes (Map I). Species of *Quercus* subgen. *Quercus* may be found up to c. 4300 m altitude, and the boundary of the distribution lies as far north as latitude 62° N. In Asia the centre of speciation of this subgenus is in China, from where not less than 40 species have been described. This subgenus is not represented in Malesia.

Subgenus *Cyclobalanopsis* is confined to the south-eastern and eastern parts of Asia, viz. from Japan (Kanto Prov., Honshu) to Korea, China, Formosa, Indo-China, Thailand, N. Burma, N.E. India, and southwards to western Malesia (Malaya, Singapore, Sumatra, Anambas Isl., Palawan Isl., Borneo and Java), with a centre of speciation in Indo-China. In Malesia (Map II) the centre of distribution is in Borneo from where 17 of the 19 known species have been recorded. Species of this subgenus may be found up to 3500 m altitude, more commonly at about 1000 to 1500 m. The northernmost boundary of the distribution lies at latitude c. 35° N. (Central Japan) and the southernmost limit is in Java at c. latitude 10° S.

***Quercus* L. subgen. *Cyclobalanopsis* (Oersted) Schneider**

Quercus subgen. *Cyclobalanopsis* (Oersted) Schneider, Ill. Handb. Laubh. 1: 210. 1906; Nakai in Bot. Mag. Tokyo 29: 56. 1915; Koidzumi in Bot. Mag. Tokyo 30: 199. 1916; A. Camus, Les Chênes 1: 158. 1938; Rehder, Man. Cult. Trees & Shrubs, 2nd. ed.: 155. 1940. — *Quercus* sect. *Cyclobalanus* Endlicher, Gen. Pl., Suppl. 4, 2: 28. 1847, p.p.; A.DC. in Ann. Sc. nat. Bot., Sér. IV, 18: 55. 1862, p.p.; Prodr. 16, 2: 91. 1864, p.p.; Oudemans, Annot. Cupul. Jav.: 22. 1865, p.p. — *Quercus* sect. *Gyrolecana* Blume, Mus. Bot. Lugd. Bat. 1: 299. 1850, p.p.; Miquel, Fl. Ind. Bat. 1, 1: 855. 1856. — *Cyclobalanopsis* Oersted in Vidensk. Medd. naturh. För. Kjöbn. 8: 77. 1867; in Kong. Dansk. Vidensk. Selsk. Skr. 5, 9: 69. 1871; Schottky in Bot. Jahrb. 47: 645. 1912; Hayata, Icon. Pl. Form. 3: 185. 1913; Markgraf in Bot. Jahrb. 59: 59. 1924; Kudo & Masamune in J. Soc. Trop. Agr. 2: 148. 1930; in Trans. Nat. Hist. Soc. Form. 20: 161. 1930; Schwarz in Notizbl. Bot. Gart. Berlin-Dahlem 13: 5–8. 1936; in Fedde's Repert. Sonderbeihft D.: 31–35. 1936; Nakai in J. Jap. Botany 15: 201. 1939; Li in Bull. Torrey Bot. Club 80: 323. 1953; Wood, Fl. Taiwan: 99. 1963. — *Quercus* sect. *Cyclobalanopsis* (Oersted) Benth. & Hook. f., Gen. Pl. 3: 408. 1880; Hooker f., Fl. Brit. Ind. 5: 603. 1888; King Ann. Roy. Bot. Gard. Calc. 2: 27. 1889; Prantl in Engler & Prantl, Nat. Pfl. fam. 3, 1: 55. 1894; Koorders & Valetton, Bijdr. Booms. Java 10: 15. 1904; Brandis, Ind. Trees: 627. 1906; Gamble in J. As. Soc. Bengal 75: 408. 1915; Barnett in Trans. & Proc. Bot. Soc. Edinburgh 34: 164. 1994. — *Quercus* subgen. *Cyclothea* Nakai, in Bot. Mag. Tokyo 29: 57. 1915.

Type species: ***Q. velutina*** Lindl. ex Wall., non Lamarck.

Trees of medium to large size. *Buttresses* absent or up to 1–3 m in height, spreading. *Bark* smooth and lenticellate or finely fissured or scaly and peeling off profusely into rectangular pieces, pale grey to greenish-brown in colour; inner bark sometimes up to 2.5 cm in thickness, brittle, fibrous, ridged on the inner side, pale

yellow to reddish-brown. *Wood* pale yellow to pale brown, growth rings indistinct, heart-wood not well defined from the sapwood, hard but not durable, splitting very easily; vessel distribution denritic rarely solitary; rays uni- to multi-seriate, homogeneous; pitting of the vessel bordered; tannin content little to c. 20 per cent of dry weight. *Innovations* densely simple- or stellate-tomentose or densely brownish, stiff pubescent. *Branchlets* glabrous, smooth or shallowly fissured or markedly warty lenticellate. *Buds* ovoid-globose or ovoid-conical, rarely ovoid-ellipsoid; scales tomentose or densely brownish, woolly pubescent. *Stipules* extrapetiolar, linear-acute, densely tomentose or woolly pubescent, caducous. *Petiole* always thickened at its base, terete or flattened or sulcate on the adaxial side, densely tomentose or woolly pubescent or glabrous. *Leaves* spirally arranged or rarely pseudo-whorled, penninerved; midrib and lateral nerves flattened or impressed or slightly raised above, more or less prominent beneath; margin entire or remotely minutely serrate in the apical half; glabrous or densely or sparsely simple or stellate-tomentose or densely or sparsely stiff or woolly pubescent at least on the lower surface. *Male inflorescence* solitary in the axil of a lower leaf or in paniculate clusters on the lateral or subterminal new shoots, flexuous, pendent, compound or simple, unbranched or much branched. *Male flower* in 3-4-flowered dichasial clusters or solitary along the rachis. Bracts ovate-linear, acute, densely tomentose, caducous. *Perianth* (4)-6-lobed, the lobes connate at base, densely tomentose; stamens (4)-6-(9), filaments slender, filiform, glabrous or tomentose at base; anthers c. 0.5-1 mm long, basifixed, 2-locular, 4-lobed, longitudinally dehiscent; pistillode normally absent, sometimes present but reduced to a cluster of stiff simple hairs. *Pollen grains* prolate, prolate-spheroidal or very rarely suboblate, 3-colpate, 3-colporate or 3-colporoidate; polar diameter c. 22-33 μ , equatorial diameter c. 15-30 μ ; exine c. 1-1.5 μ thick, more or less scabrate; inner wall (endexine) thinner or thicker or as thick as the outer wall (ektexine); furrows elongate, tapering towards both ends; pores circular or elliptic. *Female inflorescence* solitary in the axil of a higher leaf, erect, densely woolly pubescent, few- to many-flowered. *Female flowers* always solitary along the rachis, sessile; bracts linear-acute, densely pubescent, caducous; perianth (4)-6-(9)-lobed; staminodes 0 or 5-7; styles 3-4-(6), cylindrical, glabrous or pubescent at base, free and recurved or connate at base; stigmas broadly capitate, glabrous; locules as many as styles; ovules 2 in each locule. *Cupule* cup- or saucer-shaped, obconical or obovoid-globose, lamellate, densely tomentose outside, densely silvery pubescent inside; lamellae c. 5-11, denticulate and free at the rim or more or less smooth and connate, thin or thick. *Fruit* ovoid-conical, ovoid-globose or ovoid-cylindrical; apex rounded, attenuate-acute or abruptly depressed, umbonate; perianthodium (umbo) ringed, well-developed; base rounded, truncate or concave; glabrous and shining or densely tomentose. *Cotyledons* flat-convex, filling the entire space of the surviving locule; germination hypogeal; abortive ovules apical; radicle vertical.

KEY TO THE SPECIES, BASED ON FLOWERING OR FRUITING SPECIMENS

1. Rim of the cupule thinner than 0.5 mm, lamellae with more or less free margin; female inflorescence usually many-flowered.
 2. Cupule deeply cup-shaped, covering c. $\frac{1}{4}$ part of the fruit, c. (1)–2–3–(3.5) cm deep and 2–4 cm in diameter.
 3. Cupule c. 2–3.5 cm deep and 2.5–4 cm in diameter. Fruit c. 3–5 cm long and 2–3 cm in diameter. Leaves pseudo-whorled, base cordate to auriculate; petiole c. 0.5–1 cm long 1. *Q. pseudo-verticillata*.
 3. Cupule c. (1)–1.5–2–(2.5) cm deep and c. (1)–1.5–2–(2.5) cm in diameter. Fruit c. 2–3–(3.5) cm long and c. 1.5–2–(3) cm in diameter. Leaves not pseudo-whorled, base not cordate nor auriculate; petiole c. 1.5–5 cm long.
 4. Cupule tapering towards the base. Leaves densely stellate-tomentellous, glaucous or silvery beneath; margin entire.
 5. Fruit elongate conical or ovoid-globose. Styles free and recurved. Stamines O. Leaves silvery beneath; petiole not deeply sulcate on the adaxial side 2. *Q. argentata*.
 5. Fruit obovoid-globose. Styles connate, not recurved. Stamines 5–7. Leaves glaucous beneath; petiole deeply sulcate on the adaxial side 3. *Q. nivea*.
 4. Cupule rounded or truncate at base. Leaves glabrous or densely brownish stiff-pubescent or sparsely stellate-tomentose, neither glaucous nor silvery beneath; margin remotely minutely serrate in the apical half.
 6. Cupule c. 2–2.5 cm in depth and in diameter; lamellae 6–8. Fruit ovoid-conical, c. 2–3 cm in length and c. 2 cm in diameter; base convex 4. *Q. gaharuensis*.
 6. Cupule c. 3–3.5 cm in depth and in diameter; lamellae c. 9–11. Fruit ovoid-globose or ovoid-cylindrical, c. 2.5–3.5 cm in length and c. 2–3 cm in diameter; base flat or convex 5. *Q. oidocarpa*.
 2. Cupule shallowly cup-shaped or saucer-shaped, covering c. $\frac{1}{4}$ part of the fruit, c. 0.5–1.2 cm in depth and c. (0.7)–1–1.8–(2.5) cm in diameter.
 7. Leaves elliptic-lanceolate or ovate-lanceolate, c. (3)–10–15–(24) by (1)–3–5–(9) cm; petiole c. 1–3 cm long.
 8. Leaves elliptic-lanceolate, chartaceous, base attenuate-acute.
 9. Cupule covering c. $\frac{1}{6}$ – $\frac{1}{5}$ part of the fruit, base of the fruit concave. Petiole terete or flattened on the adaxial side 6. *Q. sumatrana*.
 9. Cupule covering c. $\frac{1}{4}$ part of the fruit; base of the fruit convex. Petiole sulcate on the adaxial side 7. *Q. subsericea*.
 8. Leaves ovate-elliptic or ovate-lanceolate, thick-coriaceous; base rounded or cordate.
 10. Cupule covering c. $\frac{1}{4}$ part of the fruit; fruit ovoid-cylindrical. Leaves c. (3)–5–10–(14) by 2–5.5 cm, lower surface not glaucous; lateral nerves c. 5–8 pairs 8. *Q. lowii*.
 10. Cupule covering c. $\frac{1}{6}$ – $\frac{1}{5}$ part of the ovoid-globose fruit. Leaves c. (10)–15–18–(20) by 5.9 cm, glaucous beneath; lateral nerves c. 8–10 pairs 9. *Q. percoriacea*.
 7. Leaves obovate or elliptic-obovate, c. 1.5–5.5 by 0.7–3.5 cm; petiole c. 0.1–0.6 cm long.
 11. Leaves glabrous or with sparse pubescence beneath, upper surface shining, margin entire, apex rounded or truncate-emarginate; lateral nerves c. 4–5 pairs 10. *Q. chrysotricha*.
 11. Leaves with dense pubescence on both surfaces, upper surface dull, margin remotely serrulate in the apical half, apex bluntly acute; lateral nerves c. 5–8 pairs 11. *Q. merrillii*.

1. Rim of the cupule c. 0.5–4 mm in thickness, lamellae more or less connate at the rim; female inflorescence normally few-flowered.
12. Cupule c. 0.7–1.2 cm deep, c. 1–2 cm in diameter; lamellae c. 5–8. Fruit c. 1–2–(3) by 1.2–1.5 cm. Leaves with entire margin.
 13. Leaves elliptic-lanceolate, glabrous, glaucous beneath, base attenuate-acute 12. *Q. kerangasensis*.
 13. Leaves ovate-elliptic densely yellowish-brown pubescent, base rounded or acute 13. *Q. kinabaluensis*.
12. Cupule c. 1.5–2 cm deep and c. (1)–2–2.5 cm in diameter; lamellae c. (5)–8–10–(12). Fruit c. 2–5.5 by 1–2 cm. Leaves remotely serrulate in the apical half.
 14. Old leaves glabrous. Fruit c. 2–5.5 cm long.
 15. Leaves with strong and dense reticulation; lateral nerves c. 10–15 pairs. Stamens 5–9; styles connate at base; staminodes 0 14. *Q. valdinervosa*.
 15. Leaves with obscure and lax reticulation; lateral nerves c. 7–10 pairs. Stamens 3–6; styles free and recurved; staminodes 6–0 15. *Q. gemelliflora*.
 14. Old leaves with dense pubescence beneath. Fruit c. 1–3 cm long.
 16. Leaves with strong and dense reticulation.
 17. Cupule deeply cup-shaped, obconical, c. 1–1.2 cm in depth and c. 2–2.5 cm in diameter; lamellae 8–10. Fruit cylindrical-conical, c. 2–3 by 1–2 cm 16. *Q. lineata*.
 17. Cupule flattened cup-shaped or saucer-shaped, c. 0.7–1 cm in depth and c. 1.2–2.5 cm in diameter; lamellae 7–8. Fruit globose or ovoid, c. 1–2 cm in length and diameter 17. *Q. steenisii*.
 16. Leaves with obscure and lax reticulation.
 18. Cupule cup-shaped, base rounded, c. 1.5–2 cm deep and c. 1.5–2 cm in diameter; lamellae 10–12. Fruit with convex base. Leaves linear-lanceolate 18. *Q. treubiana*.
 18. Cupule saucer-shaped, base flat, c. 0.5–0.7 cm deep and c. 2–2.5 cm in diameter; lamellae 5–7. Fruit with flat base. Leaves elliptic-oblong 19. *Q. elmeri*.

KEY TO THE SPECIES, BASED ON STERILE SPECIMENS

1. Petiole c. (0.1)–0.3–0.5–(1) cm long. Leaves with rounded or bluntly acute apex.
 2. Leaves c. 6–17 by 3–6.5 cm, base rounded, subcordate or auriculate.
 3. Leaves elliptic-oblong or oblanceolate-oblong, c. 7–17 by 3–6.5 cm, margin entire; lower surface sparsely minutely pubescent; reticulation fine, dense, parallel 1. *Q. pseudo-verticillata*.
 3. Leaves ovate-elliptic or ovate-orbicular, c. 3–8 by 2–5 cm, margin remotely serrulate in the apical half, lower surface with dense layer of brownish woolly pubescence; reticulation distinct, prominent on the lower surface 17. *Q. steenisii*.
 2. Leaves c. 1.5–5 by 0.7–3.5 cm, base attenuate-acute or attenuate-rounded.
 4. Leaves glabrous on both surfaces, margin entire, apex rounded or truncate; lateral nerves c. 4–5 pairs 10. *Q. chrysotricha*.
 4. Leaves with dense pubescence on both surfaces, at least on the midrib and lateral nerves, margin remotely serrulate in the apical half, apex bluntly acute, rarely rounded; lateral nerves c. 5–8 pairs 11. *Q. merrillii*.

1. Petiole c. (1)–2–3–(4.5) cm long. Leaves with acute, acuminate or caudate apex.
5. Leaves elliptic-lanceolate, lanceolate-oblong or ovate-elliptic, c. (5)–10–17–(24) by (2)–3–5–(9) cm.
 6. Leaf margin entire, recurved, reticulation obscure on both surfaces.
 7. Lower surface of the leaf glaucous. Branchlets sparsely stellate-tomentose, shallowly fissured 3. *Q. nivea*.
 7. Lower surface of the leaf silvery. Branchlets glabrous densely and prominently lenticellate 2. *Q. argentata*.
6. Leaves remotely serrulate in the apical half, reticulation distinct, at least on the lower surface.
 8. Old leaf glabrous.
 9. Leaves elliptic-oblong, lateral nerves c. 10–15 pairs; reticulation strong and dense 14. *Q. valdinervosa*.
 9. Leaves elliptic-lanceolate, lateral nerves c. 7–10 pairs; reticulation obscure, lax 15. *Q. gemelliflora*.
 8. Old leaves not glabrous.
 10. Leaves ovate-elliptic, elliptic-oblong or oblong-lanceolate, c. (5)–10–20–(22) by (2.5)–5–7–(9) cm.
 11. Leaves ovate-elliptic, lower surface glaucous 9. *Q. percoriacea*.
 11. Leaves elliptic-oblong or oblong-lanceolate, lower surface not glaucous.
 12. Leaves densely brownish, stiff-pubescent beneath; petiole and midrib not sulcate on the adaxial side 4. *Q. gaharuensis*.
 12. Leaves sparsely stellate-tomentose; petiole and midrib deeply sulcate on the adaxial side 5. *Q. oidocarpa*.
 10. Leaves elliptic-lanceolate, c. (1.5)–5–13–(24) by 2.5–5 cm.
 13. Leaves glaucous beneath, reticulation fine, obscure 6. *Q. sumatrana*.
 13. Leaf not glaucous beneath; reticulation strong, distinct on the lower surface.
 14. Leaves with dense, simple, adpressed pubescence beneath; lateral nerves c. 10–20 pairs, dense; reticulation distinct beneath 16. *Q. lineata*.
 14. Leaves with dense woolly, rufous-pubescence beneath; lateral nerves c. 5–12 pairs, lax; reticulation obscure and lax 19. *Q. elmeri*.
5. Leaves linear-lanceolate or ovate-elliptic, c. 5–10 by 2–4 cm.
 15. Leaves linear-lanceolate, with dense pubescence beneath. 18. *Q. treubiana*.
 15. Leaves ovate-elliptic, with dense or sparse stellate-tomentum or completely glabrous beneath.
 16. Leaves with attenuate-acute or attenuate-rounded base, glabrous or sparsely stellate-tomentose beneath.
 17. Leaves glabrous, glaucous beneath; petiole c. 0.8–1.2 cm long; branchlets with dense warty lenticels 12. *Q. kerangensis*.
 17. Leaves sparsely stellate-tomentose beneath, not glaucous; petiole c. 1–2.5 cm long; branchlets sparsely minute-lenticellate 7. *Q. subsericea*.
 16. Leaves with rounded or cordate base, lower surface with dense stellate-tomentum or simple-pubescence.
 18. Leaf-margin remotely serrulate in the apical half; lower surface with dense stellate-tomentum or glabrous; reticulation more or less anastomosing 8. *Q. lowii*.
 18. Leaf-margin entire; lower surface with dense yellowish simple-pubescence; reticulation parallel 13. *Q. kinabaluensis*.

1. **Quercus pseudo-verticillata** Soepadmo, Pl. 1, Map III.

Q. pseudo-verticillata Soepadmo in Gard. Bull. Singapore 21, 3: 380, f. 1. 1966. — Type: Chew & Corner RSNB. 4434, Bem-bangan River, Mt. Kinabalu, Borneo, alt. c. 1650 m, Febr. fr. (Holotype: K; isotype L).

Tree c. 30 m tall, trunk c. 90 cm in diameter. *Buttresses* up to 2 m tall. *Bark* scaly, peeling off profusely into small, rectangular pieces. Branchlets glabrous, lenticellate. *Leaves* pseudo-whorled, thick-coriaceous, elliptic-lanceolate or oblanceolate-oblong, c. 7–17 by 3–6.5 cm; margin entire, base cordate to auriculate, apex rounded or bluntly acute; upper surface glabrous, lower surface with sparse minute simple-pubescent. *Midrib* and *lateral nerves* strongly prominent beneath, flattened to slightly impressed above, especially in the apical half. Lateral nerves c. 8–15 pairs, forming c. 30°–45° angle with the midrib, parallel, arcuating; reticulation obscure, parallel, dense. *Petiole* c. 0.5–1 cm long and 0.2 cm thick, tomentose, glabrescent, flattened on the adaxial side. Buds ovoid-globose, c. 0.2–0.3 cm in length and c. 0.2 cm in diameter. *Inflorescences* unknown. *Cupule* cup-shaped, obconical-globose, base pointed, covering c. $\frac{1}{3}$ – $\frac{1}{2}$ part of the fruit; c. 2–3.5 cm deep and 2.5–4 cm in diameter; outside brownish-sericeous, glabrescent; inside with dense brownish, stiff-pubescent; lamellae c. 10–12, thin, free at the rims, dentate, especially the lower ones. *Fruit* cylindrical-globose, c. 3–5 cm in length and 2–3 cm in diameter, sericeous, apex rounded or depressed, umbo conical, ringed, base convex or flat.

Ecology: in montane rain forest at c. 1650 m alt. Fruiting in October-February.

Distribution: so far only known from Mt. Kinabalu, in North Borneo.

2. **Quercus argentata** Korth., Fig. 6, Map IV.

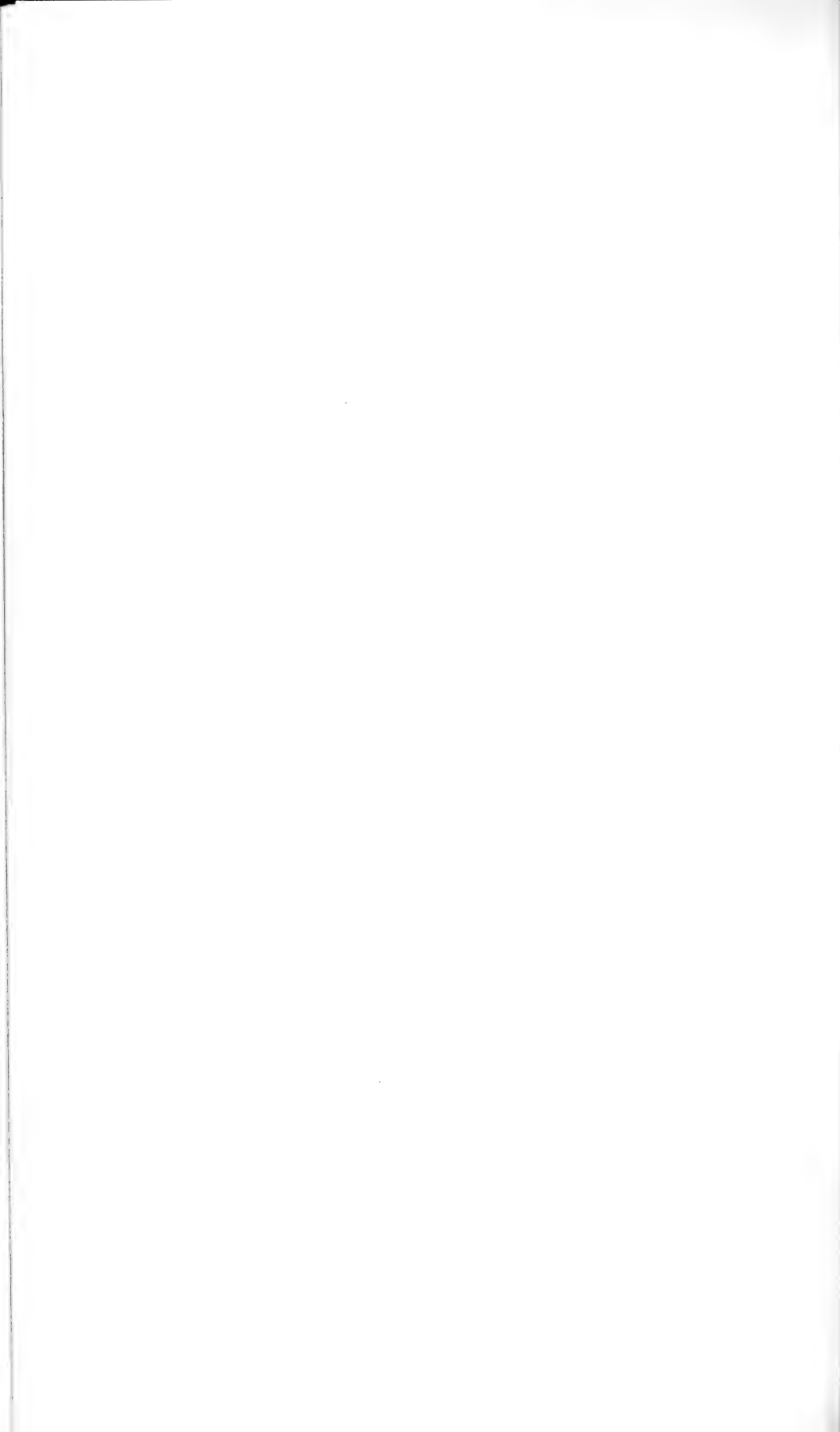
Q. argentata Korthals in Verh. Nat. Gesch. Bot.: 215, t. 47, f. 1–17, 1844; Blume, Mus. Bot. Lugd. Bat. 1: 299. 1850; Miquel, Fl. Ind. Bat. 1, 1: 858. 1856; in Ann. Mus. Bot. Lugd. Bat. 1: 115. 1863; A. DeCandolle, Prodr. 16, 2: 91. 1864; Scheffer in Nat. Tijdschr. Ned. Ind. 32: 417. 1872; Wenzig in Jahrb. Kön. bot. Gart. & Mus. Berlin 4: 230. 1886; King in Ann. Roy. Bot. Gard. Calc. 2: 30, t. 24 A. 1889; von Seemen in Bull. Dép. Agr. Ind. Néerl. 1: 3. 1906; Gamble in J. As. Soc. Bengal 75: 408. 1915, p.p.; Merrill in J. Str. Br. Roy. As. Soc., Sp. No.: 211. 1921; Ridley, Fl. Mal. Pen. 3: 373. 1924, p.p.; Moore in J. Bot. 63, Suppl.: 114. 1925; A. Camus, Les Chênes 1: 311. 1938; Atl. 1: t. 23, f. 1–9. 1934. — *Cyclobalanopsis argentata* (Korth.) Oersted in Vidensk. Medd. naturh. För. Kjöbn. 8: 79, t. I–II, f. 5–8. 1867; in Lieberman's Chênes Amér. Trop.: 20. 1889. — *Lithocarpus argentata* (Korth.) Merrill in Contr. Arn. Arb. 8: 42. 1934. — Type: Korthals s.n., in forest, Malintang, Sumatra, fruiting (Holotype: L).

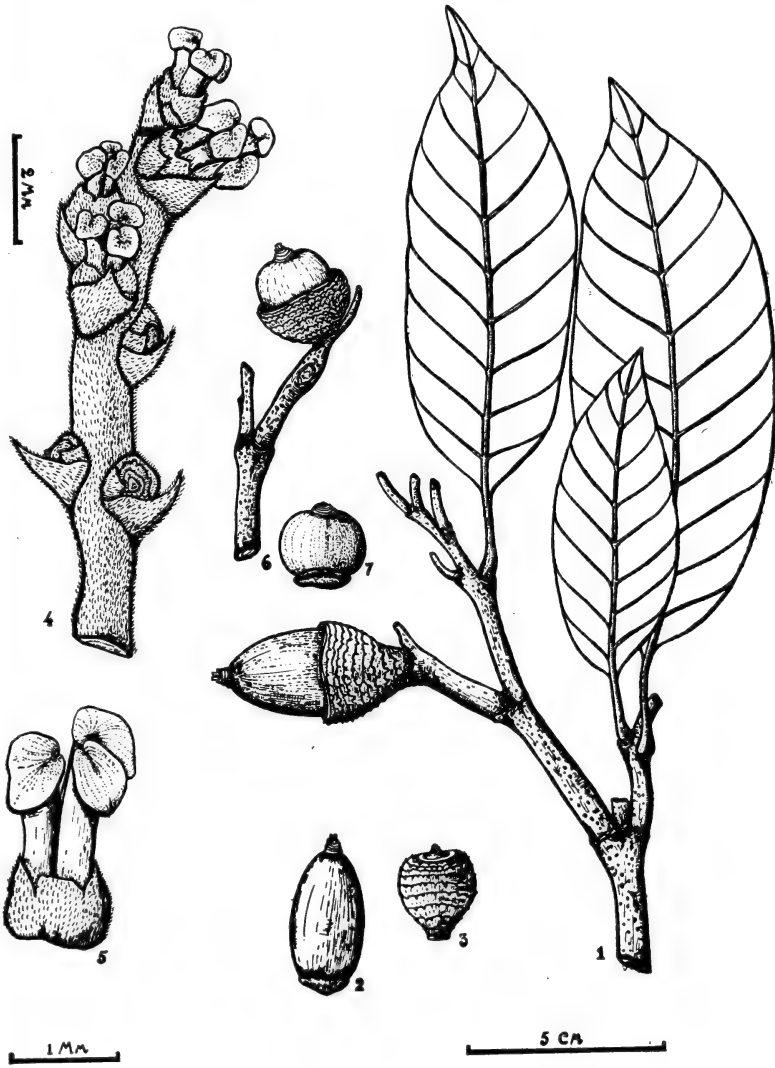
Q. pinanga Blume, Mus. Bot. Lugd. Bat. 1: 303. 1850. — Type: Blume s.n., Java, st., (L); syn. nov.



Plate 1: *Quercus pseudoverticillata*.

Natural habit, photographed
by Prof. E. J. H. Corner in
Mt. Kinabalu, North
Borneo.





Ex. 1964.

Fig. 6: *Quercus argentata*: 1, 2, 4, 5 after Smythies S. 12165; 3 after Korthals s.n. (Type); 6-7 after Jacobs 5114.

Q. wilhelminae von Seemen, 1.c.: 9–10, p.p., excl. fructu; Merrill in J. Str. Br. Roy. As. Soc., Sp. No.: 216. 1921. — Type: *Hallier* 2628, Amai Ambit, Sarawak, Borneo (Holotype: L); syn. nov.

Tree c. 7–37 m tall, trunk c. 20–100 cm in diameter. *Buttresses* up to 1.2 m tall. *Bark* smooth, lenticellate, pale grey, sometimes with horizontal cracks; inner bark c. 2 cm thick, pale brown, brittle. *Branchlets* glabrous, densely warty lenticellate, greyish-brown. Buds ovoid-globose, c. 2–3 by 2–2.5 mm, stellate- or simple-tomentose, glabrescent. *Stipules* linear-acute, with dense simple, stiff-pubescent, c. 3–5 by 1–1.5 mm, caducous. *Petiole* slender, glabrous flattened on the adaxial side, c. 1.5–3 cm long and c. 1–1.5 mm thick. *Leaves* coriaceous, elliptic- or lanceolate-oblong, c. 8–22 by 3–7 cm; lower surface with dense silvery stellate-tomentum, upper surface shining, glabrous; base attenuate-rounded or attenuate-acute, slightly asymmetrical, margin entire and slightly undulate, apex c. 0.5–1 cm acuminate. *Midrib* and *lateral nerves* strongly prominent beneath, impressed above, glabrous; lateral nerves c. 10–17 pairs, forming c. 60°–75° with the midrib, parallel, arcuating near the margin; reticulation fine, obscure. *Male inflorescence* in a paniculate cluster of 3 or 4 on a lateral new shoot, c. 5–10 cm long. Bract ovate-acute, with dense simple-tomentum, c. 1–1.5 by 0.5 cm, caducous. *Male flowers* in 3-flowered dichasial clusters or solitary along the rachis; perianth 4–6-lobed, the lobes connate at base; stamens normally 6, filament hairy at base, pistillode absent. *Female inflorescence* many-flowered, slender, c. 2–3 cm long, with dense simple-tomentum; perianth 4–6-lobed, densely tomentose outside; staminodes absent; styles 3–4, hairy at base, free and slightly recurved. Bracts linear-acute, c. 0.5–1 mm long. Immature cupule turbinate or ovoid-conical, flattened or rounded at the top, attenuate at base; lamellae c. 8–10, thin, dentate, with dense brownish tomentum, completely covering the fruit except for the umbo. *Mature cupule* cup-shaped, obconical or obovoid, c. 1.5–2 cm deep and c. 1–1.5 cm in diameter, with dense simple-pubescent outside; lamellae c. 8–10, free and denticulate at the rim. *Fruit* elongated conical or ovoid-globose, attenuating towards the acute apex and rounded base, c. 3–3.5 cm long and 1.5 cm in diameter.

Ecology: in lowland to montane forests at c. 0–2700 m alt. Flowering between July and September; fruiting between October and May.

Distribution: Malaya, Singapore, Sumatra, Bangka, Anambas Isl., Borneo, and Java.

Notes: The majority of the examined specimens come from Borneo and Sumatra.

3. *Quercus nivea* King, Fig. 7, Map III.

Quercus nivea King in Ann. Roy. Bot. Gard. Calc. 2: 31, Pl. 24B, 1889; Koidzumi in Bot. Mag. Tokyo 30: 201. 1916; Merrill in J. Str. Br. Roy. As. Soc., Spec. No.: 214. 1921; A. Camus, Les Chênes 1: 313. 1938; Atl. 1: t. 23, f. 10-16. 1934. — Lecto-type: *Beccari P.B. 2551*, fr., fl., Sarawak (FI).

Tree c 25 m tall, trunk c. 40 cm in diameter. *Buttresses* c. 2 m tall, 10-15 cm thick. *Bark* pale grey, rough; inner bark chocolate-brown, fibrous. *Branchlets* with dense brownish, stellate-tomentum, glabrescent; lenticels sparse, splitting longitudinally into shallow furrows. *Stipules* linear-acute, with stellate-tomentum outside, c. 2-3 by 0.5-1 mm, caducous. *Petiole* densely stellate-tomentose when young, soon becomes glabrous, c. 2-4.5 cm long, deeply sulcate on the adaxial side, especially near the leaf-base. *Leaves* thick-coriaceous, elliptic-oblong or lanceolate-oblong, c. 6-15 by 2.5-5.5 cm; upper surface shining, glabrous, lower surface glaucous, with dense stellate-tomentum; base rounded or abruptly acute, sometimes asymmetrical, margin entire, slightly undulate near the acuminate or caudate apex, acument c. 0.5-1 cm long. *Midrib and lateral nerves* prominent beneath, impressed or flattened above. Reticulation obscure on both surfaces. Lateral nerves c. 6-12 pairs, parallel, arcuating near the margin, forming c. 60°-70° angle with the midrib. *Male inflorescence* in a paniculate cluster on the lateral new shoot, c. 5 cm long, densely stellate-tomentose. *Male flowers* in 3-flowered dichasial clusters or solitary along the rachis; perianth 4-6-lobed, rather thick-coriaceous; stamens 4-6; filaments slender, hairy at base; pistillode absent. *Female inflorescence* solitary in the axil of a higher leaf; bracts ovate-acute, caducous. *Female flowers*: perianth 5-6-lobed, with dense stellate tomentum; staminodes developed considerably but remain not functional; style 3-4, short, connate at base. Young cupule obconical-turbinate, base attenuate, lamellae thin, with dense stellate-tomentum. *Mature cupule* cup-shaped, obconical, tapering towards the base, c. 1-1.7 cm deep and 1.5-2 cm in diameter; lamellae c. 7. *Fruit* obovoid-globose, c. 2 cm long and in diameter, apex depressed, base convex.

Ecology: in high heath forest, at c. 1000 m alt. Flowering in January.

Distribution: endemic in Sarawak (Mts. Gaharu and Pueh).

Notes: This species is closely allied to *Q. argentata*, but differs from the latter by its thick-coriaceous leaves which are glaucous and densely stellate-tomentose beneath, fewer lateral nerves, deeply sulcate petiole, and by its shallowly furrowed, not warty lenticellate branchlets. The lamellae in *Q. nivea* are more or less connate, whilst in *Q. argentata*, they are free and denticulate.



Ea. 1964.

Fig. 7: *Quercus nivea*

1, 3 after Beccari P.B. 2551 (Type); 2 after King, l.c. 1889.

4. *Quercus gaharuensis* Soepadmo, Map V.

Quercus gaharuensis Soepadmo in Gard. Bull. Singapore 21, 3: 384, f. 3. 1966. — Type: *Anderson et alia* S. 15534, Serian, lower slope of Mt. Gaharu, Sarawak, alt. c. 100 m, October fr. (Holotype: K*; isotypes: BO, L, SAN, SAR).

Quercus oidocarpa (non Korth.) Hooker f., Fl. Brit. Ind. 5: 603. 1888; King in Ann. Roy. Bot. Gard. Cal. 2: 28, pl. 21A, 1889, p.p., quoad specim. ex Mal. Pen.; Brandis, Ind. Trees, 3rd. ed.: 629. 1906, p.p., quoad specim. ex Mal. Pen.; Gamble in J. As. Soc. Bengal 75: 409. 1915, p.p., quoad specim. ex Mal. Pen.; Merrill in J. Str. Br. Roy. As. Soc., Spec. No.: 214. 1921, p.p., excl. *Beccari* 2919; in Contr. Arn. Arb. 8: 42. 1934, p.p.; A. Camus, Les Chênes 1: 213. 1938, p.p., excl. *Korthals* s.n.; Atl. 1, t. 7, f. 10–15. 1934.

Tree c. 10–30 m tall, trunk c. 30–100 cm in diameter. *Buttresses* short, spreading, up to 0.7 m tall. *Bark* smooth, mottled hooped, lenticels scattered in longitudinal rows. *Innovation* with dense stellate-tomentum. *Branchlets* glabrous, lenticellate. Buds ovoid-globose, c. 2 by 2 mm. *Stipules* linear-acute, c. 5 by 1 mm, caducous. *Petiole* slender, terete or flattened on the adaxial side, with dense stellate-tomentum, glabrescent, c. 1–3.5 cm long. *Leaves* elliptic-lanceolate or elliptic-oblong, c. 5–23 by 2–9 cm, thin coriaceous, base attenuate-acute or rounded, slightly asymmetrical, margin entire or remotely serrulate in the apical part, apex rounded or bluntly acute; upper surface glabrous, lower surface with dense stellate-pubescence, glabrescent. *Midrib* and *lateral nerves* prominent beneath, slightly so above; reticulation distinctly visible beneath; lateral nerves c. 8–15 pairs, parallel, arcuating towards the margin, forming c. 45°–60° angle with the midrib. *Male inflorescence* c. 1.5–3.5 cm long; bracts ovate-acute, c. 1–1.5 by 1 mm, caducous. *Male flowers* in 3-flowered dichasial clusters; perianth 4–6-lobed; stamens 4–6; filament hairy at base, c. 1–2 mm long; anthers c. 0.5 by 0.5 mm; pistillode reduced to a cluster of stiff hairs. *Female inflorescence* c. 1–1.5 cm long, carrying c. 2–5 solitary, sessile flowers; bracts ovate-linear, c. 1–2 by 0.5–1 mm. *Female flower*: perianth 5–6-lobed; staminodes absent; styles 3–4, slender, cylindrical, hairy at base, c. 1–2 mm long. Young cupule ovoid-globose, c. 1.5–2 cm in length and in diameter, covering the entire fruit; apex rounded or truncate, base attenuate-rounded, densely sericeous outside and densely brownish-stiff-pubescent inside. *Mature cupule* deeply cup-shaped, c. 2–2.5 cm in depth and in diameter; base rounded, enclosing c. $\frac{1}{2}$ – $\frac{2}{3}$ part of the fruit; lamellae c. 6–8, rim thin, slightly recurved and denticulate. Young fruit ovoid or depressed conical, c. 1–1.5 cm in length and in diameter, densely sericeous, glabrescent; apex rounded or abruptly truncate. *Ripe fruit* ovoid-conical, c. 2–3 cm long and 2 cm in diameter, apex acute or rounded, base convex.

Ecology: in lowland mixed Dipterocarps to submontane forests, at c. 100–1400 m alt. Fruiting in September–February.

Distribution: Malaya (Penang, Perak), Borneo (Sarawak), Sumatra (Karolands, Painan, Asahan Forest Reserve).

Recently Mr. Forman informed me that the holotype of this species was redeposited at Kew.

5. *Quercus oidocarpa* Korth., Fig. 8, Map VI.

Quercus oidocarpa Korthals in Verh. Nat. Gesch. Bot.: 216, t. 47, f. 18, 1844; Blume, Mus. Bot. Lugd. Bat. 1: 302. 1850; Miquel, Fl. Ind. Bat. 1, 1: 856, 1856; in Ann. Mus. Bot. Lugd. Bat. 1: 115. 1863; A. DeCandolle, Prodr. 16, 2: 99. 1864; Wenzig in Jahrb. Kön. bot. Gart. & Mus. Berlin 4: 233. 1886; King in Ann. Roy. Bot. Gard. Calc. 2: 28. 1889, p.p., quoad *Korthals* s.n.; A. Camus, Les Chênes 1: 213. 1938, p.p., quoad *Korthals* s.n. — *Cyclobalanopsis oidocarpa* (Korth.) Oersted in Vidensk. Medd. naturh. För. Kjöbn. 8: 78. 1867; Schottky in Bot. Jahrb. 47: 151. 1912. — Type: *Korthals* s.n., in forest, Malintang, Sumatra, fr. (Holotype: L).

Quercus brevistyla A. Camus in Bull. Soc. Bot. France 80: 353. 1933; Les Chênes 1: 276. 1938; Atl., t. 17. 1934. — Type: *Syed Alie Kep. 22574*, Fraser's Hill, Pahang, Malaya, Febr. fr. (Holotype: KEP; isotypes: P, SING); syn. nov.

Quercus semiserrata (non Roxb.) Koorders & Valeton, Bijdr. Booms. Java 10: 25. 1904, p.p., quoad *Koorders 1488 & 1533*; Koorders, Exk. Fl. Java 2: 16. 1912, p.p.

Tree c. 25–30 m tall, trunk c. 50 cm in diameter. *Bark* grey, scaly and peeling off profusely into-rectangular pieces. *Branchlets* with dense stiff-pubescent, glabrescent, lenticellate. Buds ovoid-globose, c. 3–5 by 2–3 mm. *Petiole* c. 1.5–3.5 cm long, shallowly furrowed on the adaxial side, especially near the leaf-base, glabrous. *Leaves* oblong-lanceolate or elliptic-oblong, c. 7–17 by 3–7 cm, base acute or rounded or subcordate, margin remotely serulate in the apical part, apex acute or 0.5–1.5 cm acuminate; upper surface glabrous, lower surface with sparse stellate-tomentum. *Midrib* and *lateral nerves* prominent beneath, impressed above; lateral nerves c. 9–13 pairs, parallel, forming c. 45° angle with the midrib; reticulation distinct beneath, parallel, dense. *Male inflorescence* on a new shoot in the axil of a higher leaf, c. 5–7 cm long, with dense stiff-pubescent; bracts ovate-acute, c. 1.5–2 by 1–1.5 mm, glabrous, caducous. *Male flowers* in 3–4-flowered dichasial clusters or solitary along the rachis; perianth membranaceous, glabrous, 4–6-lobed; stamens 4–7; filaments slender, glabrous, c. 2 mm long; anthers c. 0.7 mm long; pistillode absent. *Female inflorescence* c. 3–7 cm long, subglabrous, in the axil of a higher leaf, carrying c. 3–7 flowers; bracts ovate-acute. *Female flowers*: perianth 4–6-lobed; staminodes absent; styles 3–4, free, recurved, c. 2 mm long, hairy at base. *Cupule* deeply cup-shaped, c. 3–3.5 cm in depth and c. 3–3.5 cm in diameter; base attenuate-rounded; lamellae thin, c. 9–11, the lower ones denticulate, the other entire, yellowish-brown tomentose. *Fruit* ovoid-globose or ovoid-cylindrical, c. 2.5–3.5 cm in length and c. 2–3 cm in diameter, apex rounded or abruptly depressed, base rounded or flat.

Ecology: in lowland to submontane forests, at c. 700–1500 m alt. Flowering between March and April; fruiting between April–February.

Distribution: Malaya, Sumatra, and Java.

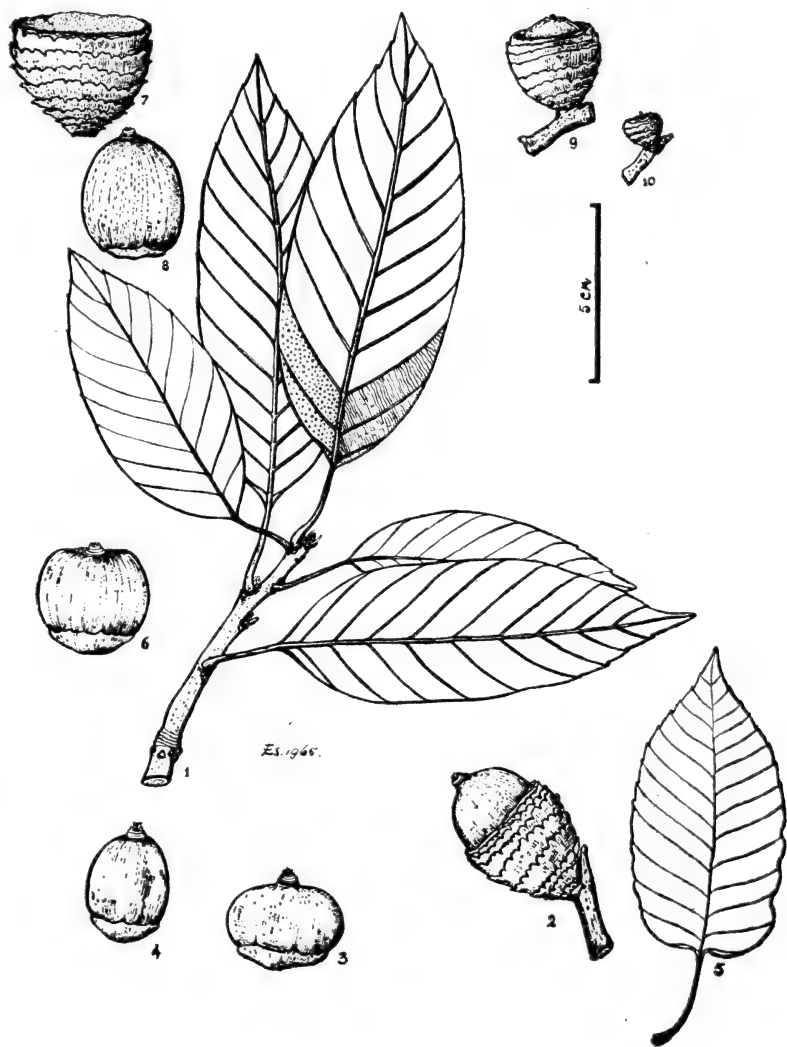


Fig. 8: *Quercus oidocarpa*

1-4 after Symington *Kep.* 31071; 5 after Poore 1315; 6 after Syed Ali *Kep.* 22574; 7-8 after Md. Nur s.n.; 9 after Poore 1348; 10 after Poore 1315.

6. *Quercus sumatrana* Soepadmo, Map VII.

Quercus sumatrana Soepadmo in Gard. Bull. Singapore 21, 3: 387, f. 4, 1966. — Type: *Achmad 1501*, Tapah, N. Sumatra, Nov. fr. (Holotype: BO; isotype: L).

Tree c. 35 m tall, trunk up to c. 130 cm in diameter. *Buttresses* c. 1–2.5 m tall. *Bark* rough, grey. *Young branchlets* smooth, with dense brownish, stiff-pubescent; older branchlets glabrous, lenticellate. Buds ovoid-globose, with dense pubescence, glabrescent, c. 2–3 by 1.5–2 mm. *Petiole* slender, c. 1–2.5 cm long, terete or flattened on the adaxial side, with sparse pubescence. *Leaves* thin-chartaceous, elliptic-lanceolate, c. 8–24 by 2–8 cm, base attenuate-acute, margin entire-undulate or remotely serrulate in the upper part; apex sharply 0.5–1.5 cm acuminate; lower surface with sparse stiff-simple-pubescent, glaucous, upper surface glabrous. *Midrib* and *lateral nerves* prominent beneath, slightly so above; lateral nerves c. 8–13 pairs, rarely opposite, forming c. 45°–60° angle with the midrib, parallel, arcuating near the margin; reticulation parallel, obscure on both surfaces. Inflorescences not known. Young cupule saucer-shaped, covering the whole fruit except for the protruding umbo which is topped by 3, recurved, c. 2 mm long styles; lamellae 3–5, thin, tomentose, rim recurved and denticulate. *Mature cupule* shallowly cup-shaped, c. 0.7–1 cm in depth and c. 2–2.5 cm in diameter, covering c. 1/6–1/5 part of the fruit, base attenuate-rounded, with dense tomentum on both surfaces; lamellae free at the rim. *Mature fruit* ovoid-conical, c. 1.8–2 cm in length and c. 1.5–2 cm in diameter, densely sericeous, apex acute, base concave.

Ecology: in lowland to submontane forests, at c. 10–1300 m alt. Fruiting between April and December.

Distribution: Sumatra, Borneo.

7. *Quercus subsericea* A. Camus Fig. 9, Map VIII.

Quercus subsericea A. Camus in Bull. Soc. Bot. France 80: 354. 1933; Les Chênes I: 366. 1938; Atl. I, t. 33, f. 21–26. 1934; Atl. 3, t. 347, f. 1–7. 1939. — *Quercus sericea* Scheffer in Nat. Tijdschr. Ned. Ind. 31: 361. 1870; 1.c. 32: 416. 1873; King in Ann. Roy. Bot. Gard. Calc. 2: 63, pl. 57 B. 1889; Merrill in J. Str. Br. Roy. As. Soc., Spec. No.: 215. 1921; non Willdenow (1805). — *Cyclobalanopsis sericea* (Scheff.) Schottky in Bot. Jahrb. 47: 656. 1912. — *Synaedrys sericea* (Scheff.) Koidzumi in Bot. Mag. Tokyo 30: 192. 1916. — Type: *Teijsmann HB. 21080*, Bangka, fr. (Holotype: BO; isotype: K).

Quercus lineata (non Bl.) S. Moore in J. Bot. 63, Suppl.: 114. 1925, p.p., quoad specim. ex *Forbes 572*.

Quercus oidocarpa (non Korth.) Merrill, 1.c.: 214. 1921, p.p., quoad specim. ex *Beccari 2919*.

Tree c. 6–15 cm tall, trunk c. 10–40 cm in diameter. *Bark* finely fissured or scaly, thin, greyish-brown; inner bark fibrous, brownish, c. 2.5 cm thick. *Innovations* with dense stiff-simple-pubescent or adpressed stellate-tomentum, glabrescent. *Older branchlets* sparsely

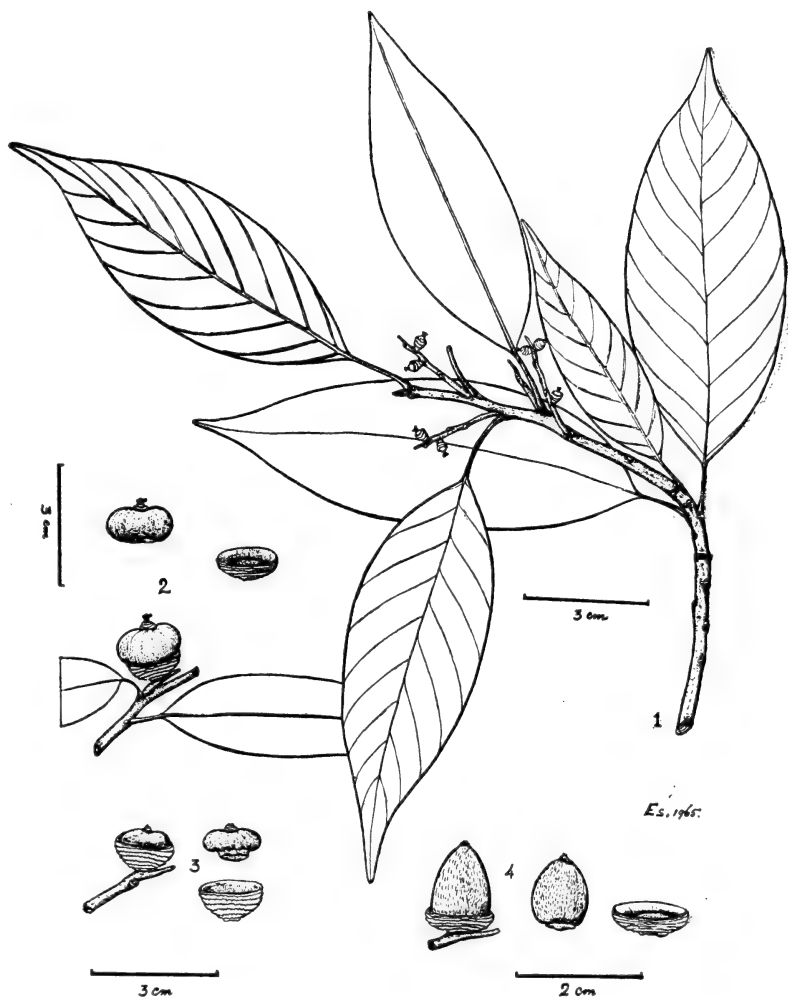


Fig 9: *Quercus subsericea*
1 after Teijsmann H.B. 7638; 2 after Symington Kep. 37644; 3 after SAN. 25119; 4 after SAN. 28276.

minute-lenticellate. *Stipules* linear-acute, with dense stiff-pubes-
cence, c. 0.5–0.7 by 0.1–0.2 cm, caducous. *Petiole* slender, c. 1–2.5
cm long, furrowed on the adaxial side. *Leaves* thin-coriaceous,
elliptic-lanceolate, rarely ovate, c. 5–16 by 1–5 cm, base acute or
roundish, margin entire or remotely serrulate near the sharply
acute or 0.5–1.5 cm acuminate apex; lower surface with sparse
stellate-tomentum, upper surface shining, glabrous. *Midrib* and
lateral nerves prominent beneath, impressed above; lateral nerves
c. 6–12 pairs, forming c. 45°–60° angle with the midrib, parallel,
arcuating towards the margin; reticulation obscure, especially on
the upper surface. *Male inflorescence* c. 2–5 cm long, solitary in
the axil of a lower leaf or in paniculate clusters on the lateral new
shoots, with dense stellate-tomentum. Bracts ovate-acute, tomen-
tose outside, c. 1–2 by 1 mm, caducous. *Male flowers* solitary along
the rachis or in 3-flowered dichasial clusters; perianth tomentose,
4–6-lobed; stamens 4–6; filaments slender, c. 1–2 mm long;
anthers c. 1 by 1 mm; pistillode absent. *Female inflorescence*
solitary in the axil of a higher leaf, c. 0.5–1.5 cm long, with dense
tomentum, carrying 2–5 flowers; bracts ovate-acute, c. 0.5–0.7 by
0.3–0.5 mm. *Female flowers*: ovary ovoid-cylindrical, c. 0.5 mm
long, rounded-triangular; perianth 5–6-lobed; staminodes 0; styles
3–4, c. 1 mm long, tomentose at base. Young cupule ovoid-
globose or obconical, lamellae 4–5, the 2–3 lower ones denticulate,
the other entire. *Mature cupule* cup-shaped, obconical, covering
c. $\frac{1}{4}$ – $\frac{1}{2}$ part of the fruit, c. 0.5–1.2 cm in depth and c. 0.7–1 cm in
diameter, base rounded or attenuate, lamellae with dense tomentum
outside. *Fruit* ovoid-conical or ovoid-globose, c. 1–2.5 cm in
length and c. 1–1.5 cm in diameter; densely sericeous, base obtuse
or convex, apex acute or abruptly depressed, umbonate.

Ecology: in lowland Dipterocarps to submontane forests, at
c. 500–1500 m alt. Fruiting in June–March.

Distribution: Malaya, Sumatra, Bangka, Borneo, Java.

8. *Quercus lowii* King, Fig. 10, Map IX.

Quercus lowii King in Ann. Roy. Bot. Gard. Calc. 2: 28, pl. 21B,
1889; Koidzumi in Bot. Mag. Tokyo 30: 201. 1916; Merrill in J.
Str. Br. Roy. As. Soc., Spec. No.: 214. 1921; A. Camus, Les
Chênes 1: 366. 1938; Atl. 1, t. 33, f. 27–19. 1934. — *Cyclobala-
nopsis lowii* (King) Schottky in Bot. Jahrb. 47: 653. 1912. — Type:
Low s.n., fr., Mt. Kinabalu, Borneo (CALC).

Tree c. 10–20 m tall, trunk c. 30–40 cm in diameter. *Branchlets*
dark-grey, shallowly fissured, with dense brownish, stellate-tomen-
tum; older branchlets lenticellate, glabrous. Buds ovoid- globose,
densely tomentose. *Stipules* linear-acute, c. 2–4 by 0.3–0.5 cm, with
dense tomentum, caducous. *Petiole* c. 1–2.5 cm long, sulcate on the
adaxial side, with dense simple- or stellate-tomentum. *Leaves* thick-
coriaceous, ovate-elliptic or ovate-lanceolate, c. (3)–5–10–(14) by
2–5.5 cm, base rounded or cordate, slightly asymmetrical, margin
entire or remotely serrulate in the apical half, apex sharply acute
or 0.5–2 cm acuminate; lower surface with dense, brownish stellate-
tomentum or almost glabrous, upper surface glabrous and shining



Fig. 10: *Quercus lowii*
1-2 after SAN. 28808; 3 after Clemens 40533; 4-7 after Chew & Corner RSNB. 4500.

or with sparse stellate-tomentum, especially on the midrib. *Midrib* and *lateral nerves* impressed above, prominent or flattened beneath; reticulation fine, more or less anastomosing, distinct beneath. *Lateral nerves* c. 5–8 pairs, forming c. 50°–60° angle with the midrib, parallel, arcuating towards the margin. *Male inflorescence* slender, c. 5–10 cm long, with dense stellate-tomentum, unbranched or rarely branched, solitary in the axil of a lower leaf; bracts ovate-acute, c. 1–2 by 0.5 mm, with dense stellate-tomentum outside, glabrescent, caducous. *Male flowers* solitary or in 3-flowered dichasial clusters along the rachis; perianth 4–6-lobed, with simple or stellate-tomentum, glabrescent; stamens 4–6; anthers c. 1 by 0.5–1 mm; filaments c. 1 mm long; pistillode reduced to a cluster of woolly simple hairs. *Female inflorescence* c. 1–2 cm long, with 2–5 solitary female flowers; solitary in the axil of a higher leaf; bracts ovate-acute, with dense simple or stellate-tomentum, c. 1 mm. *Female flowers*: perianth 4–7-lobed, with dense tomentum; staminode 0; styles 3–6, c. 1 mm long, recurved. Young cupule obconical, c. 0.8–1 cm deep and 0.7–1.2 cm in diameter; lamellae thin, c. 5–7, the lower ones denticulate, the others entire, with dense stellate-tomentum. *Mature cupule* cup-shaped, base rounded, c. 1.3–1.8 cm in diameter and 0.8–1 cm in depth, covering c. $\frac{1}{4}$ – $\frac{1}{3}$ part of the fruit. *Fruit* ovoid-cylindrical, apex rounded or acute, c. 1.5–2 cm in length and 1.3–1.5 cm in diameter, with dense stellate-tomentum, glabrescent; base convex.

Ecology: in lowland to montane forests, at c. 0–2500 m alt., more commonly between c. 1000–1500 m alt. Fruiting between July and March.

Distribution: endemic in Borneo; common in Mt. Kinabalu.

9. *Quercus percoriacea* Soepadmo, Map VI.

Quercus percoriacea Soepadmo in Gard. Bull. Singapore 21, 3: 382, f. 2. 1966. — Type: *Anderson S. 20226*, Sarawak, Bario, Ulu Baram, on path to Pa' Ukad, at alt. c. 1100 m, July fr. (Holotype: K; isotypes: L, SAN, SAR, SING).

Tree with trunk c. 50 cm in diameter. *Buttresses* up to 1 m tall. *Bark* smooth, grey, hoop-marked. *Branchlets* grey, glabrous, lenticellate. Buds ovoid-globose, c. 0.3 by 0.2 cm, with dense tomentum. *Petiole* c. 2–3.5 cm long, glabrous, terete or slightly grooved on the adaxial side. *Leaves* thick-coriaceous, ovate-elliptic, c. (10)–15–18–(20) by 5–9 cm, base rounded, margin incurved, remotely serrulate in the apical half; apex acute or 1–1.5 cm acuminate, lower surface with sparse stellate-tomentum, glaucous, upper surface shining, glabrous. *Midrib* and *lateral nerves* prominent beneath, impressed and obscure above. *Lateral nerves* c. 8–10 pairs, forming c. 45°–60° angle with the midrib, parallel, arcuating towards the margin; reticulation parallel, prominent beneath. *Male and female inflorescence* not known. Young infructescence c. 2–3 cm long, sericeous, glabrescent, lenticellate, with 1–4 solitary young fruits. Young cupule obovoid, sericeous, c. 0.7–1 cm deep,

0.8–1 cm in diameter; base attenuate; lamellae c. 4–8, the lower ones denticulate, the others entire. Young fruits ovoid-globose, attenuate towards the conical, ringed umbo, sericeous; styles 3, recurved, sericeous. *Mature cupule* flattened cup-shaped, c. 0.7–1 cm in depth and c. 2 cm in diameter, covering c. $\frac{1}{4}$ – $\frac{1}{2}$ part of the fruit, with dense tomentum, base rounded; lamellae c. 6–8, thin, more or less free at the rim. *Mature fruit* ovoid-globose, c. 2 cm in length and in diameter, with dense tomentum, apex rounded, umbonate, base convex.

Ecology: in primary heath forest on terrace sands, at alt. c. 1200 m. Fruiting in June–July.

Distribution: so far only known from Sarawak.

10. *Quercus chrysostricha* A. Camus, Fig. 11 — la-c, Map X.

Quercus chrysostricha A. Camus, Les Chênes 3, Expl. Pl.: 50; Atl. t. 347, f. 8–14. 1948; Text: 1212. 1954. — *Quercus arbutifolia* (non Hickel & A. Camus) Warburg in Kew Bull.: 19. 1936. — Type: *Richards 1885*, Sarawak, Mt. Dulit, alt. c. 1300 m, Sept. fr. (Holotype: K; isotype: L).

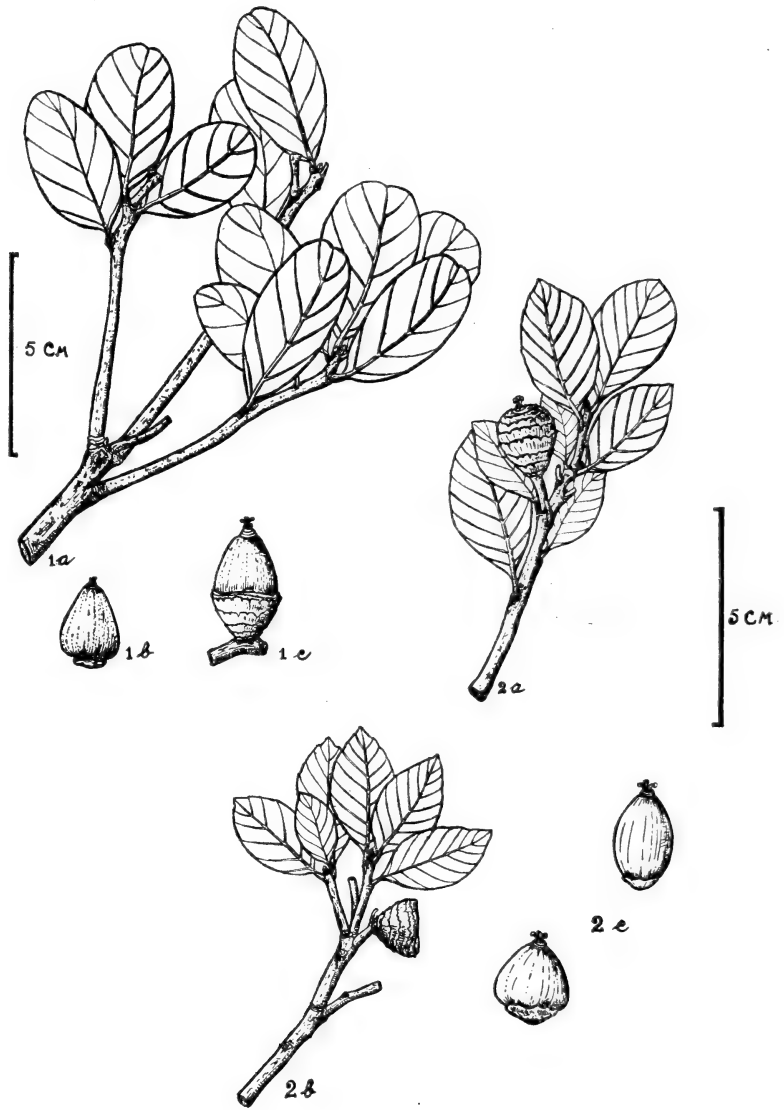
Tree c. 19 m tall, trunk c. 30 cm in diameter. *Bark* smooth or finely fissured. Young branchlets with dense, brownish, simple-pubescent; older branchlets glabrous, lenticellate. *Petiole* c. 1.0–0.5 cm long, flattened on the adaxial side, with dense pubescence, glabrescent. *Leaves* thin-coriaceous, obovate-elliptic, base attenuate-rounded or attenuate-acute, slightly asymmetrical, margin entire, apex rounded or truncate-emarginate; c. 1–5.5 by 1.5–3.5 cm; upper surface shining, glabrous, lower surface glabrous or with sparse pubescence. *Midrib* and *lateral nerves* slightly prominent beneath, flattened or slightly impressed above; reticulation obscure on both surfaces. *Lateral nerves* c. 4–5 pairs, forming c. 60°–70° angle with the midrib, parallel, arcuating towards the margin. *Cupule* cup-shaped, obconical, c. 1–1.5 cm in depth and in diameter, base attenuate-acute, covering c. $\frac{1}{4}$ – $\frac{1}{3}$ part of the fruit; lamellae thin, c. 6–7, with dense tomentum outside, denticulate. *Fruit* ovoid-conical, c. 1.5–2 cm in length and c. 1–1.5 cm in diameter, with dense tomentum, glabrescent; apex attenuate-acute, base convex.

Ecology: in submontane forests, at c. 1200–1300 m alt. Fruiting in September.

Distribution: endemic in Borneo (Mt. Dulit, Sarawak).

11. *Quercus merrillii* von Seemen, Fig. 11 — 2a-c, Map X.

Quercus merrillii von Seemen in Fedde's Rep. 5: 21. 1908; Merrill in Philip. J. Sc. Bot. 3: 329. 1908; Enum. Philip. Fl. Pl. 2: 28. 1923; Koidzumi in Bot. Mag. Tokyo 30: 201. 1916; A. Camus, Les Chênes 1: 210. 1938; Atl. 1, t. 7, f. 6–9. 1934. — *Cyclobalanopsis merrillii* (v. Seemen) Schottky in Bot. Jahrb. 47: 649. 1912. — Type: *Foxworthy 566*, Palawan Isl., fr. April 1906 (Holotype: K).



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Fig. 11. 1a-c = *Quercus chrysostricha*, after Richards 1885 (Type).
2a-c = *Quercus merrilli*, after Curran 3858.

Small tree. *Young branchlets* with dense brownish, stiff-pubescent; older branchlets glabrous, lenticellate. *Stipules* linear-acute, with dense pubescence outside, c. 0.5–1 by 0.1 cm. caducous. *Petiole* c. 0.3–0.6 cm long, flattened on the adaxial side, with dense pubescence, glabrescent. Leaves thin-coriaceous, obovate or elliptic-ovate, c. 1.5–5 by 0.7–2.5 cm, base attenuate-acute, margin remotely serrulate in the apical half, apex bluntly acute; with dense pubescence on both surfaces, glabrescent. *Midrib* and *lateral nerves* prominent beneath, flattened or impressed above; reticulation obscure on both surfaces. *Lateral nerves* c. 5–8 pairs, parallel, forming c. 50°–60° angle with the midrib, arcuating towards the margin. *Inflorescences* unknown. Young infructescence c. 1–2 cm long, with dense tomentum, glabrescent, lenticellate, with 1–2 solitary young fruits. Young cupule obovoid or obconical, c. 0.5 cm in depth and in diameter, with dense tomentum; styles 3, c. 1–2 mm long, with sparse tomentum at base. *Mature cupule* cup-shaped, obconical, covering c. $\frac{1}{4}$ – $\frac{1}{3}$ part of the fruit, c. 1 cm deep and 1–1.5 cm in diameter; lamellae c. 7–8, thin, denticulate, with dense tomentum outside. *Fruit* ovoid or ovoid-cylindrical, c. 2–2.5 cm long and 1–1.5 cm in diameter, shining, glabrous; apex acute, base convex.

Ecology: in lowland forest, at c. 100–500 m alt. Fruiting between April and August.

Distribution: Borneo and Palawan Isl.

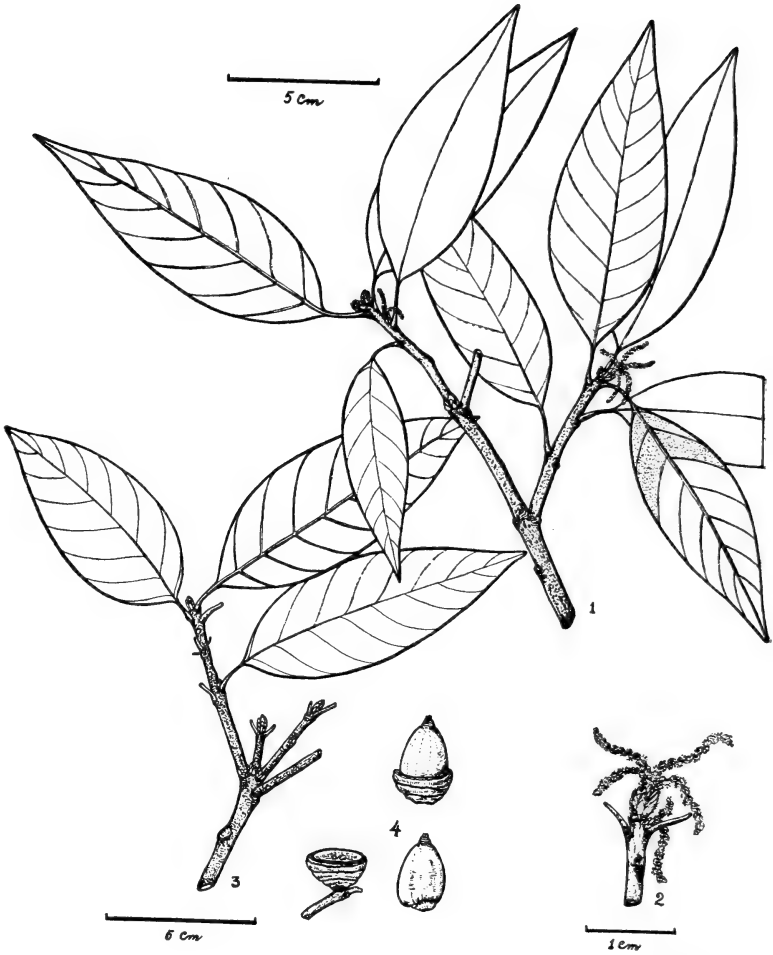
12. ***Quercus kerangasensis*** Soepadmo, spec. nov., Fig. 12, Map XI.

Arbor c. 20–30 m alta, trunco c. 25–50 cm lata; cortice laevi vel scabro, grisei-lenticellato. *Ramuli* laeves vel dense lenticellati annulati, griseo-brunnei, dense et rigide pubescentes, glabrescentes. *Alabastra* c. 2–4 × 3–4 mm, ovoideo-globosa, dense pubescens. *Stipulae* lineares acutae, c. 2–3 × 0.5–1 mm, dense pubescentes, glabrescentes. *Petiolus* gracilis, c. 8–12 × 0.5–1 mm, ad basim incrassatus, supra appplanatus vel subsulcatus. *Lamina* c. 4–11 × 2–4 cm, elliptico-lanceolata, coriacea, subtus glabra, glaucescens, supra nitida glabra; costa nervisque lateralibus subtus prominentibus, supra vix elevatis; nervis lateralibus c. 7–10, angulo 60°–70° exorientibus, ascendentibus, marginem versus arcuatis; nervis reticulatis invisibilibus.

Inflorescentia mascula c. 1–2 cm longa, axillaris semiterminalis, dense pallide brunneo-pubescent. Bractee c. 1 × 1 mm, ovatae acutae, dense et rigide brunneo-pubescentes; cymulis trifloris. Perianthium 5–6-lobatum, extus pubescens; stamina 5–6; filamentis c. 1–2 cm longis, glabris filiformibus; antheris c. 0.5 × 0.5 mm. *Inflorescentia feminea* ignota.

Cupula matura obconica cupuliformis, c. 0.8–1.2 cm alta, 1.5–2 cm lata, dense brunneo-sericea; lamellae c. 5–7, crasse, marginem crenato vel integro. *Nux* matura c. 2–3 cm longa, 1.2–1.5 cm lata, ovoideo-conica vel obovoideo-cylindrica, dense sericea, glabrescens; apice rotundato vel acuto, ad basim rotundato; hilum convexum.

Type: *Brunig S. 1065*, Badas Forest Reserve, Sarawak, alt. c. 10 m, September fr. (Holotype: K; isotypes: L, SAR).



E.S. 1965.

Fig. 12: *Quercus kerangasensis*

1-2 after Brunig 4661 (2 = male inflorescences); 3-4 after Brunig 1065 (Type).

Tree c. 20–30 m tall, trunk c. 25–50 cm in diameter. *Buttresses* small, fluted. *Bark* smooth or rough, lenticellate, grey. *Young branchlets* with dense stiff-pubescence, smooth or horizontally craked; older branchlets glabrous, greyish-brown, with dense warty lenticels. Buds ovoid-globose, with dense yellowish-brown pubescence, c. 3–6 by 3–4 mm. *Stipules* linear-acute, c. 2–3 by 0.5–1 mm, caducous. *Petioles* slender, c. 0.8–1.2 cm long and 0.5–1 mm thick, with dense pubescence, glabrescent, thickened at base, flattened or shallowly furrowed on the adaxial side. *Leaves* elliptic-lanceolate, coriaceous, c. 4–11 by 2–4 cm, upper surface shining, glabrous, lower surface pale glaucous, glabrous except the midrib; margin entire, base attenuate-acute, apex acute or 0.5–1 cm acuminate. *Midrib* and *lateral nerves* prominent beneath, slightly so above. *Lateral nerves* c. 7–10 pairs, ascendant, subparallel, arcuating towards the margin, forming c. 60°–70° angle with the midrib; reticulation obscure on both surfaces. *Male inflorescence* in panicle clusters on the lateral or subterminal new shoots, with dense yellowish-brown pubescence. c. 1–2 cm long. Bracts membranous, ovate-acute, with dense stiff-pubescence outside, c. 1 by 1 mm. *Male flowers* in 3-flowered dichasial clusters; perianth membranous, 5–6-lobed; stamens 5–6; filaments glabrous, filiform, c. 1–2 mm long; pistillode absent. *Female inflorescence* not known. *Mature cupule* cup-shaped, obconical, c. 0.8–1.2 cm in depth and 1.5–2 cm in diameter, base attenuate, rim c. 1–1.5 mm thick, with dense brownish tomentum on both surfaces; lamellae c. 5–7, margin entire or denticulate. *Mature fruit* ovoid-conical or ovoid-cylindrical, c. 2–3 cm long and 1.2–1.5 cm in diameter, densely sericeous, glabrescent, shining; apex rounded or acute, base convex.

Ecology: in primary heath forests, at c. 10–100 m alt. Flowering in June, fruiting in September.

Distribution: endemic in Borneo (Brunei, Sarawak).

Notes: This species is named after the local name of heath forest, viz. “kerangas” forest, from where the specimens were mainly collected. It may be recognized by its elliptic-lanceolate leaves with entire margin and pale glaucous lower surface, and by its small fruit and cupule.

13. ***Quercus kinabaluensis*** Soepadmo, spec. nov., Fig. 13, Map XI.

Arbor c. 10–40 m alta, trunco c. 20–30 cm lato; cortice laevi. *Ramuli* sparsim lenticellati, dense et rigide brunneolo-pubescentes, glabrescentes. *Alabastra*, c. 4–10 × 3–4 mm, ovoideo-globosa vel ovoideo-conica. *Stipulae* c. 5–10 × 0.5–1 mm, lineares acutae, dense et rigide pubescentes, caducae. *Petiolus* c. 1–1.5 cm longus, 1–1.5 mm crassus, dense brunneolo-pubescent, glabrescent, ad basim incrassatus, supra applanatus. *Lamina* c. 5–10 × 2–5 cm, ovato-elliptica, crasse coriacea, dense flavo-brunneolo-pubescent, glabrescent; margine integro, basi asymmetrico rotundato vel acuto; apice acuto acuminato, 0.5–1.5 cm longo; costa nervisque lateralibus subtus vix elevatis, supra applanatis vel subsulcatis; nervis lateralibus c. 6–8, ascendentibus, marginem versus arcuatis, angulo 45°–60° exorientibus; nervulis reticulatis invisibilibus.

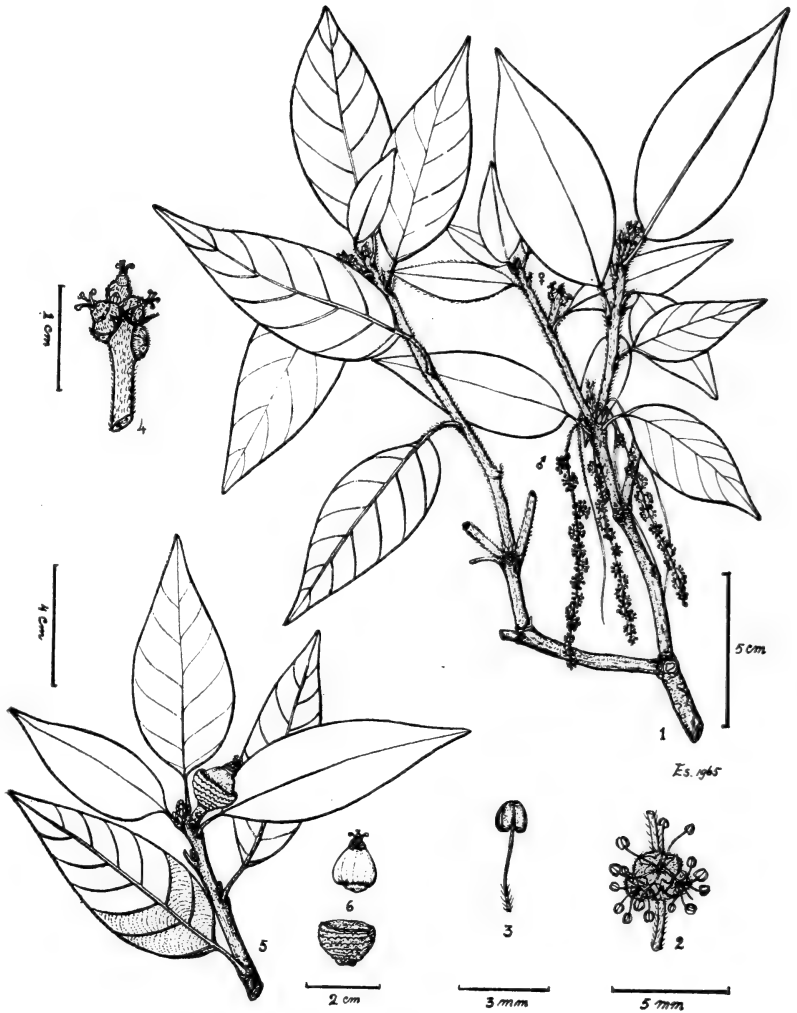


Fig. 13: *Quercus kinabaluensis*

1-4 after Chew & Corner RSNB. 4451; 5-6 after Chew & Corner RSNB. 7148 (2 = a 3-flowered male dichasium; 4 = female inflorescence).

Inflorescentia mascula gracilis flexuosa, c. 50–110 × 1 mm, dense brunneo-pubescentis; cymulis tri vel uni-floris. Bracteae c. 2–3 × 1–2 mm, ovatae acutae, tenue, extus dense pubescentes. Perianthium 4–7-lobatum, extus dense brunneo-pubescentis, glabrescentis; stamina 4–7; filamentia c. 2 mm, glabris; antheris c. 1 × 1 mm.

Inflorescentia feminea c. 10–30 × 2–3 mm, dense et rigide brunneo-pubescentis, 1–3-flores gerens. Flores femini solitarii. Bracteae c. 1–2 × 0.5–1 mm, dense pubescentes, glabrescentes. Perianthium 5–6-lobatum, crasse coriaceum, extus dense brunneo-pubescentis; staminodia nil; stili 3–5, recurvi, ad basim versus hirti, c. 2–3 × 0.5–1 mm.

Cupula immatura obconica cupuliformis, c. 0.7–1 cm alta, 1–1.5 cm lata, margine crassa, basi attenuati; lamellae 6–8, dense pubescentes, denticulo vel integro. *Nux* c. 1–1.2 cm alta, 0.8–1 cm lata, ovoideo-conica, dense brunneo-sericea, glabrescentis; apice rotundato vel attenuato, basi convexo.

Type: Chew & Corner RSNB. 7148, Mt. Kinabalu, Mentaki ridges, alt. c. 2600 m, March fr. (Holotype: K; isotypes: L).

Tree c. 10–40 m tall, trunk c. 20–30 cm in diameter. *Bark* smooth, brownish with white patches. *Innovations* with dense brownish, stiff-pubescent, glabrescent. *Branchlets* glabrous, with sparse lenticels. Buds ovoid-globose or ovoid-conical, c. 0.4–1 by 0.3–0.4 cm. *Stipules* linear-acute, c. 5–10 by 0.5–1 mm, caducous, *Petiole* c. 1–1.5 cm long and 1–1.5 mm thick, with dense brownish, stiff-pubescent, glabrescent, slightly thicken at base, flattened on the adaxial side. *Leaves* c. 5–10 by 2–5 cm, ovate-elliptic, thick-coriaceous, with dense yellowish-brown pubescence on both surfaces, glabrescent; margin entire, base asymmetrical, rounded or acute, apex acute or 0.5–1.5 cm acuminate. *Midrib* and *lateral nerves* slightly prominent beneath, flattened or impressed above. *Lateral nerves* c. 6–8 pairs, ascendant, arcuating towards the margin, forming a c. 45°–60° angle with the midrib; reticulation obscure on both surfaces. *Male inflorescence* in paniculate clusters on a lateral new shoots, with dense yellowish-brown, stiff-pubescent c. 5–11 cm long and 1 mm thick; bracts ovate-acute, membranous, with dense pubescence outside, c. 2–3 by 1–2 mm. *Male flowers* in 3-flowered dichasial clusters or solitary along the rachis perianth 4–7-lobed, with brownish-pubescent outside, glabrescent; stamens 4–7; filaments c. 2 mm long, glabrous; anthers c. 1 × 1 mm. *Female inflorescence* c. 1–3 cm long, 2–3 mm thick, with dense stiff-pubescent, carrying 1–3 flowers. *Female flower*: perianth thick-coriaceous, with dense brownish-pubescent outside, 5–6-lobed; staminodes 0; styles 3–5, hairy at base, recurved, c. 2–3 by 0.5–1 mm. *Immature cupule* cup-shaped, obconical, c. 0.7–1 cm deep and 1–1.5 cm in diameter, rim thick, base attenuate; lamellae c. 6–8, denticulate or entire, with brownish-pubescent on both surfaces. *Fruit* ovoid-conical, with dense brownish tomentum, glabrescent, c. 1–1.2 cm long and 0.8–1 cm in diameter; apex rounded or attenuate; base convex.

Ecology: in ridge or montane forests, at c. 500–2600 m alt. Fruiting between March and May.

Distribution: endemic in Mt. Kinabalu, Borneo.

Notes: In vegetative characters *Q. kinabaluensis* is closely allied to *lowii*, but differs from the latter by its thick-rimmed cupule and different type of pubescence.

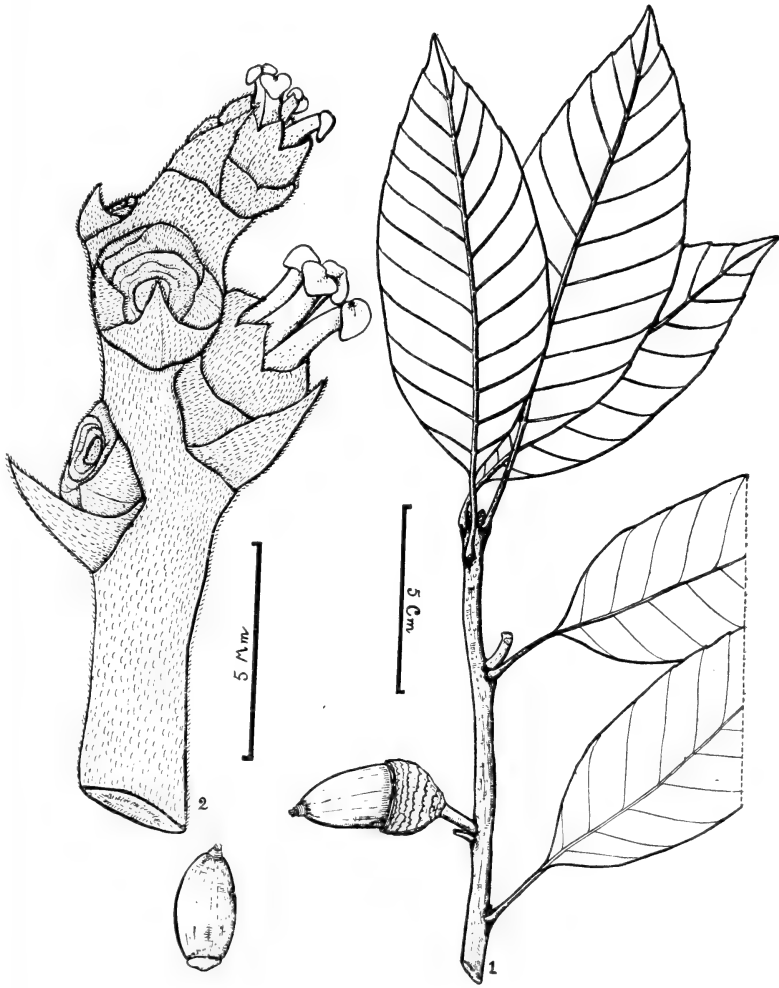
14. ***Quercus valdinervosa*** Soepadmo, spec. et stat. nov., Fig. 14, Map XII.

Quercus mespilifolia Wall. ex A.DC. var. *borneensis* Heine in Fedde's Rep. 54: 225. 1951. — Lectotype: *Clemens 31317*, Mt. Kinabalu, North Borneo, June fl. (Holotype: K; isotypes: A, B, K, L, SING, UC); paratype: *Anderson S. 4547*, Baram, path to the summit of Mt. Mulu, Sarawak, alt. c. 1900–2100 m, fr. 2-VII-1961 (A, K, L, SAR, SING).

Tree c. 20–35 m tall, trunk c. 30–60 cm in diameter. *Bark* smooth, grey. *Innovations* with dense brownish, stiff, simple- or stellate-pubescence. *Branchlets* glabrous, lenticellate. Buds ovoid-conical; scales arranged in four vertical rows. *Stipules* linear-acute, tomentose outside, c. 1–1.5 cm long, 1–2 mm wide, caducous. *Petiole* c. 1–2.5 cm long, glabrous, flattened on the adaxial side. *Leaves* elliptic or obovate-oblong, c. 8–15 by 3–6 cm, thick-coriaceous; upper surface glabrous, lower surface with dense simple pubescence, soon becomes completely glabrous; base acute or attenuate-rounded, margin remotely serrulate in the apical half, apex 0.5–1 cm acuminate. *Midrib* and *lateral nerves* prominent beneath, flattened or impressed above; reticulation dense, parallel, prominent beneath. *Lateral nerves* c. 10–15 pairs, dense, parallel and straight, arcuating near the margin, forming c. 60° angle with the midrib. *Male inflorescence* c. 5–10 cm; bracts lanceolate or linear-acute, membranous, c. 3–5 by 2–3 mm. *Male flowers* in 3-flowered dichasial clusters along the rachis; perianth 4–6-lobed, with dense tomentum outside; stamens 5–9; filaments c. 3–4 mm long, glabrous; anthers c. 1 × 1 mm; pistillode 0. *Female inflorescence* c. 1–1.5 cm long, with dense tomentum, carrying 4–6 female flowers; bracts ovate or linear, c. 2–3 by 1 mm. *Female flowers*: perianth 6-lobed, with dense tomentum outside; staminodes 0; styles 3–6, c. 1–2 mm long, tomentose at base. *Mature cupule* cup-shaped, obconical, base attenuate, c. 1.5–1.7 cm in depth and 1–2.5 cm in diameter, covering c. 1/3–1/6 part of the fruit; lamellae 7–8, rim crenate and thick, with dense tomentum outside. *Fruit* cylindrical-conical or ellipsoid, apex acute, base convex, c. 3–3.7 cm in length, 1.3–1.7 cm in diameter, tomentose.

Ecology: in submontane to montane forests, at c. 1300–2300 m alt. Fruiting between February and August.

Distribution: Borneo (Mt. Kinabalu, Brunei, Sarawak, W. Kutei).



Espl.

Fig. 14: *Quercus valdinervosa*
1 after Ashton Brun. 2378; after Meijer SAN. 29134.

15. *Quercus gemelliflora* Bl., Fig. 15, Map XIII.

Quercus gemelliflora Blume in Verh. Bat. Genootsch. 9: 223, t. 6. 1823, p.p., excl. fructu; Bijdr.: 523. 1825; Fl. Javae Cupul.: 30, t. 17. 1829; Mus. Bot. Lugd. Bat. 1: 295. 1850; Endlicher, Gen. Pl., Suppl. 4, 2: 28. 1847; Miquel, Fl. Ind. Bat. 1, 1: 854. 1856; Suppl. 1: 854. 1860; Ann. Mus. Lugd. Bat. 1: 111. 1863; A. DeCandolle, Prodr. 16, 2: 88. 1864; Wenzig in Jahrb. Kön. Bot. Gart. Berlin 4: 228. 1886; King in Ann. Roy. Bot. Gard. Calc. 2: 88. 1889; Koorders & Valeton, Bijdr. Booms. Java 10: 24. 1904; Koorders, Exk. 2: 61. 1912; Atl., t. 41. 1913; A. Camus, Les Chênes 1; 363. 1938; Atl. 2, t. 234. 1936; Backer & Bakhuizen van den Brink Jr., Fl. Java 2: 5. 1965. — *Cyclobalanopsis gemelliflora* (Bl.) Oersted in Vidensk. Medd. naturh. För. Kjöbn. 8: 77. 1867. — Type: *Blume s.n.*, Mt. Salak, Java, st. (Holotype: L).

Quercus turbinata Blume, Bijdr.: 523. 1825; Fl. Javae Cupul.: 31, pl. 18. 1829; Mus. Bot. Lugd. Bat. 1: 302. 1850; Miquel, Fl. Ind. Bat. 1, 1: 855. 1856; Ann. Mus. Bot. Lugd. Bat. 1: 114. 1863; Scheffer in Nat. Tijdschr. Ned. Ind. 31: 361. 1870; l.c. 32: 417. 1872; Koorders, l.c.: 60, f. 10. 1912; A. Camus, l.c.: 204. 1938; Atl. 1, t. 6, f. 6–16. 1934. — *Cyclobalanopsis turbinata* (Bl.) Schottky in Bot. Jahrb. 47: 648. 1912. — *Quercus merkusii* Endlicher, Gen. Pl., Suppl. 4, 2: 28. 1847; A. DeCandolle, l.c.: 98. 1864; — *Cyclobalanopsis merkusii* (Endl.) Oersted, l.c.: 79. 1867. — *Quercus lineata* Bl. var. *merkusii* Wenzig in Jahrb. Kön. Bot. Gart. Berlin 4: 232. 1886; King, l.c.: 32, pl. 26, f. 2. 1889. — Type: *Blume s.n.*, Mt. Salak, Java, yfr. (Holotype: L).

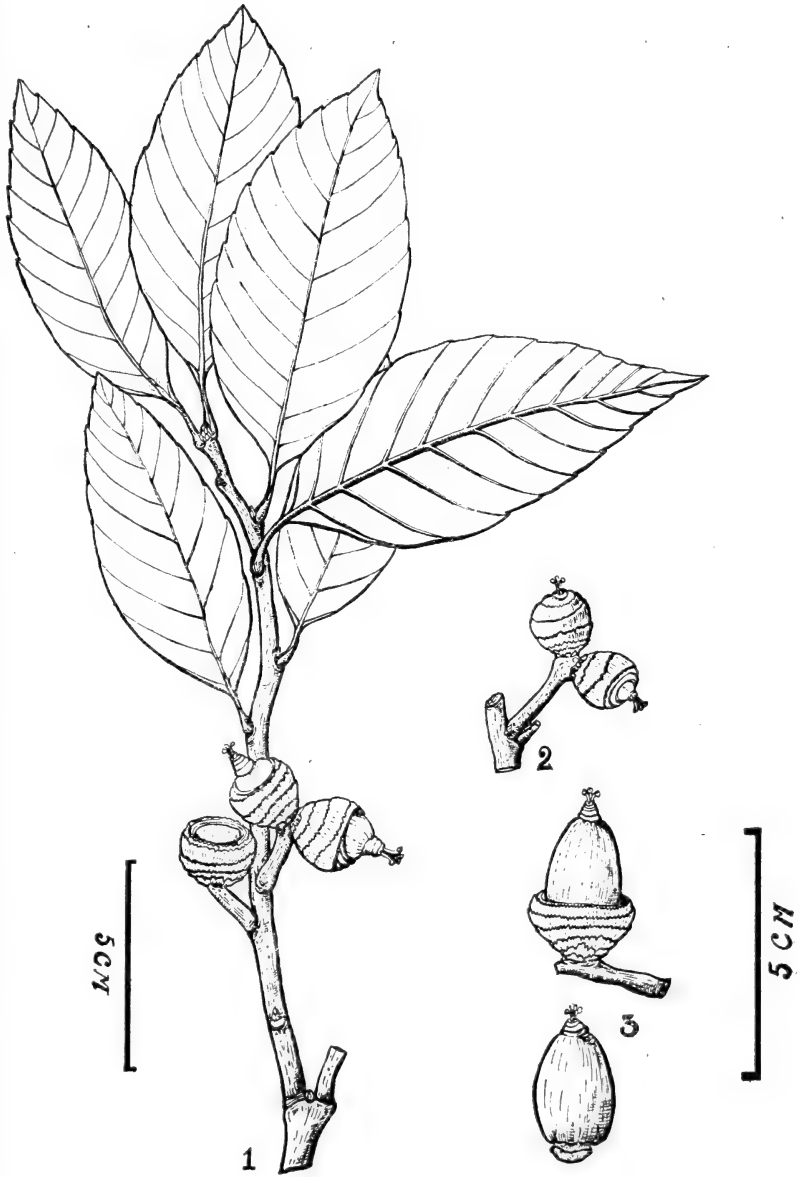
Quercus horsfieldii Miquel, l.c.: 856. 1856; Suppl.: 869. 1860; A. DeCandolle, l.c.: 99. 1864. — *Cyclobalanopsis horsfieldii* (Miq.) Oersted, l.c.: 78. 1867. — Type: *Horsfield 11*, Bangka, yfr. (Holotype: U; isotype: K); syn. nov.

Quercus horsfieldii Miq. var. *longifolia* Miquel, Fl. Ind. Bat. 1, 1: 869. 1856. — Type: *Diepenhorst 42*, Priaman, Sumatra, st. (Holotype: U); syn. nov.

Quercus semiserrata (non Roxb.) King, l.c.: 28. 1889, p.p., quoad specim. ex Bangka et Sumatra; Koorders & Valeton, l.c.: 25. 1904; Koorders, l.c.: 61. 1912; l.c. t. 55. 1913; A. Camus, l.c.: 186. 1938.

Quercus turbinata Bl. var. *crassilamellata* Gamble in J. As. Soc. Bengal 75: 410. 1915; Ridley, Fl. Mal. Pen. 3: 373. 1924. — *Quercus crassilamellata* (Gamble) A. Camus in Bull. Mus. Paris, Ser. II, 3: 689. 1931; Les Chênes 1; 226. 1938; Atl. 1, pl. 10, f. 1–7. 1934. — Type: *Wray 1532*, Kampong Ulu Batang Padang, Perak, Malaya, at c. 1600 m alt., fr. (Holotype: K; isotype: SING); syn. nov.

Tree c. 20–30 m tall, trunk c. 20–60 cm in diameter. *Buttresses* up to 1 m tall. *Bark* smooth or finely fissured, greyish-brown. *Young branchlets* and buds with dense tomentum; older branchlets glabrous, lenticellate. *Stipules* linear-acute, c. 0.5–1 by 0.1–0.2 cm, with dense tomentum outside, caducous. *Petiole* c. 1–3 cm long



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Fig. 15: *Quercus gemelliflora*
1 after Rastini s.n.; 2 after Bünnermeijer 1880; 3 after Teijsmann s.n..

and 0.1–0.2 cm thick, with dense tomentum, glabrescent. *Leaves*: thin-coriaceous, elliptic-lanceolate or elliptic-oblong, c. 5–15 by 2–5.5 cm; base attenuate-acute, asymmetrical, margin remotely serrulate in the apical half, apex shortly acuminate; upper surface glabrous, lower surface with dense pubescence, soon glabrescent. *Midrib* and *lateral nerves* prominent beneath, flattened or slightly raised above, especially the midrib; reticulation obscure on both surfaces. *Lateral nerves* c. 8–10 pairs, parallel, straight, arcuating towards the margin, forming c. 60° angle with the midrib. *Male inflorescence* c. 6 cm long, with dense brownish tomentum; outside, caducous. *Male flowers* solitary or in 3-flowered dichasial clusters along the rachis; perianth 3–6-lobed; stamens 3–6; filaments c. 2 mm, hairy at base; anthers c. 0.5–1 mm long; pistillode 0. *Female inflorescence* carrying c. 2–7 flowers, with dense brownish pubescence; bracts ovate-acute, c. 1–2 by 1 mm. *Female flowers*: perianth 4–6-lobed, with dense tomentum; staminodes 0–6; styles recurved, c. 1–2 mm long, tomentose at base. Young cupule turbinate-obconical or cylindrical-globose, covering the entire or the greater part of the fruit, base attenuate; lamellae c. 5–7, rim thick, entire or denticulate, with dense tomentum. *Mature cupule* cup-shaped, c. 1.5–2 cm deep and 1.5–2.5 cm in diameter, covering c. $\frac{1}{2}$ – $\frac{1}{3}$ part of the fruit, rim c. 2 mm thick; lamellae c. 7–8, with dense tomentum. *Ripe fruit* conical or cylindrical, c. 2–5.5 cm long and 1–2 cm in diameter, apex acute, base rounded, with dense tomentum, glabrescent.

Ecology: in lowland to submontane forests, at c. 100–1600 m alt. Flowering and fruiting the whole year round.

Distribution: Malaya (Kedah, Penang, Perak Pahang, Negri Sembilan, Malacca, Johore), Sumatra (Atjeh, Sibolangit, Tapanuli, Padang, Pajakumbuh, Mt. Sago, Indragiri, Pematang Siantar, Banjuasin-Palembang), Bangka, Borneo (Sandakan, Mt. Kinabalu, Sarawak, W. Kutei, Martapura and vicinity), Java.

16. *Quercus lineata* Bl., Fig. 16, Map XIV.

Quercus lineata Blume, Bijdr.: 523. 1825; Fl. Javae Cupul.: 32, pl. 19. 1829; Mus. Bot. Lugd. Bat. 1: 302. 1850; Miquel, Fl. Ind. Bat. 1, 1: 855. 1856; in Ann. Mus. Bot. Lugd. Bat. 1: 114. 1863; A. DeCandolle, Prodr. 16, 2: 98. 1864; Wenzig in Jahrb. Kön. Bot. Gart. Berlin 4: 232. 1886; Koorders & Valetton, Bijdr. Booms. Java 10: 20. 1904; Koorders, Exk. 2: 60. 1912; Atl. Baumart. Java 1: pl. 58. 1913; A. Camus, Les Chênes 1: 207. 1938; Atl. 1: t. 6, f. 1–5. 1934; Backer & Bakhuizen van den Brink Jr., Fl. Java 2: 5. 1965. — *Cyclobalanopsis lineata* (Bl.) Oersted in Vidensk. Medd. naturh. För. Kjöbn. 8: 78. 1867; in Libmann. Chênes Am. Trop. 1: 20. 1869. — *Quercus lineata* Bl. var. *typica* King in Ann. Roy. Bot. Gard. Calc. 2: 33, pl. 26, f. 1. 1889. — Type: Blume s.n., Java, fl. (Holotype: L; isotypes: A, BO).

Quercus polyneura Miquel, Pl. Jungh. 1: 11. 1851. — *Quercus lineata* Bl. var. *heterochroa* Miquel, l.c.: 855. 1856. — Type: Junghuhn 9, Priangan, Java, yfr. (Holotype: U).

Quercus oxyrhyncha Miquel, Fl. Ind. Bat., Suppl. 1: 347. 1860 — *Quercus lineata* Bl. var. *oxyrhyncha* (Miq.) von Seemen in Bull. Dép. Agr. Ind. Néerl. 1: 4. 1906. — Type: *Teijsmann H.B. 676*, Alahan Pandjang, Sumatra, st. (Holotype: U).

Quercus hendersoniana A. Camus in Bull. Mus. Paris, Sér. I., 4: 123. 1932; Les Chênes 1: 210. 1938; Atl. 1: t. 6, f. 6–8. 1934. — Type: *Henderson SFN. 18053*, Batu Brinchang, Pahang, Malaya, alt. c. 1600 m, Nov. fr. (Holotype: SING).

Tree c. 20–30 m tall, trunk c. 20–60 cm in diameter. *Bark* smooth grey; inner bark fibrous, reddish-brown. *Young branchlets* dark-grey with sparse lenticels, with dense stiff-pubescence, glabrescent; older branchlets glabrous, lenticellate. Buds globose or ovoid-conical, densely puberulous, glabrescent. *Stipules* linear-acute, c. 1–1.5 by 0.1–0.2 mm, with dense pubescence outside, caducous. *Petiole* c. 1–2 cm long, shallowly furrowed on the adaxial side, with dense pubescence, glabrescent. *Leaves* thin-coriaceous, ovate-elliptic or ovate-lanceolate, c. 5–16 by 2–6 cm, base attenuate-acute, sometimes asymmetrical, margin remotely serrulate in the apical half, apex acute, acuminate or c. 0.5–1.5 cm caudate; upper surface with sparse pubescence, especially on the midrib and lateral nerves, lower surface with dense, adpressed, simple-pubescence. *Midrib* and *lateral nerves* prominent beneath, slightly so above; reticulation prominent below, obscure above, dense, parallel. *Lateral nerves* c. 10–20 pairs, straight, parallel, dense, arcuating near the margin but not anastomosing; forming c. 45°–60° angle with the midrib. *Male inflorescence* c. 5–10 cm long, with dense pubescence; bracts ovate-acute, c. 2–3 by 2 mm, membranous, densely sericeous outside, glabrescent. *Male flowers* solitary or in 3-flowered dichasial clusters along the rachis; perianth 5–6-lobed, with dense tomentum outside; stamens normally 6; filaments c. 0.5–1 mm long, glabrous; anthers c. 0.5 by 0.5 mm; pistillode reduced to a cluster of stiff, simple-hairs. *Female inflorescence* c. 1.5–2 cm long, with dense pubescence, carrying c. 5–6 flowers. Bracts ovate-acute, c. 1–2 mm, with dense tomentum. *Female flowers*: perianth 5–6-lobed; staminodes 0; styles 3 recurved, c. 1–3 mm long. Young cupule ovoid-globose, densely sericeous, lamellae c. 3–4, thick, the 2 lower ones denticulate, the rest entire. *Mature cupule* cup-shaped, obconical, c. 1–1.2 cm deep, 2–2.5 cm in diameter, attenuating towards the base, with dense tomentum outside, rim thick; lamellae c. 8–10, free. *Mature fruit* conical-cylindrical, c. 2–3 cm in length, 1–2 cm in diameter, with dense tomentum; apex attenuate-rounded, base convex.

Ecology: in submontane to montane forests, at c. 1000–2000 alt. Fruiting between August and April.

Distribution: Malaya (Pahang), Sumatra (Lake Toba vicinity, Tapanuli, Alahan Pandjang), Borneo (Mt. Kinabalu), Java (Mt. Karang, Mt. Malabar, Mt. Salak, Mt. Tangkuban Prahua, Mt. Papandajan, Tjidatar, Tjigenteng, Mt. Telomojo, Madiun).

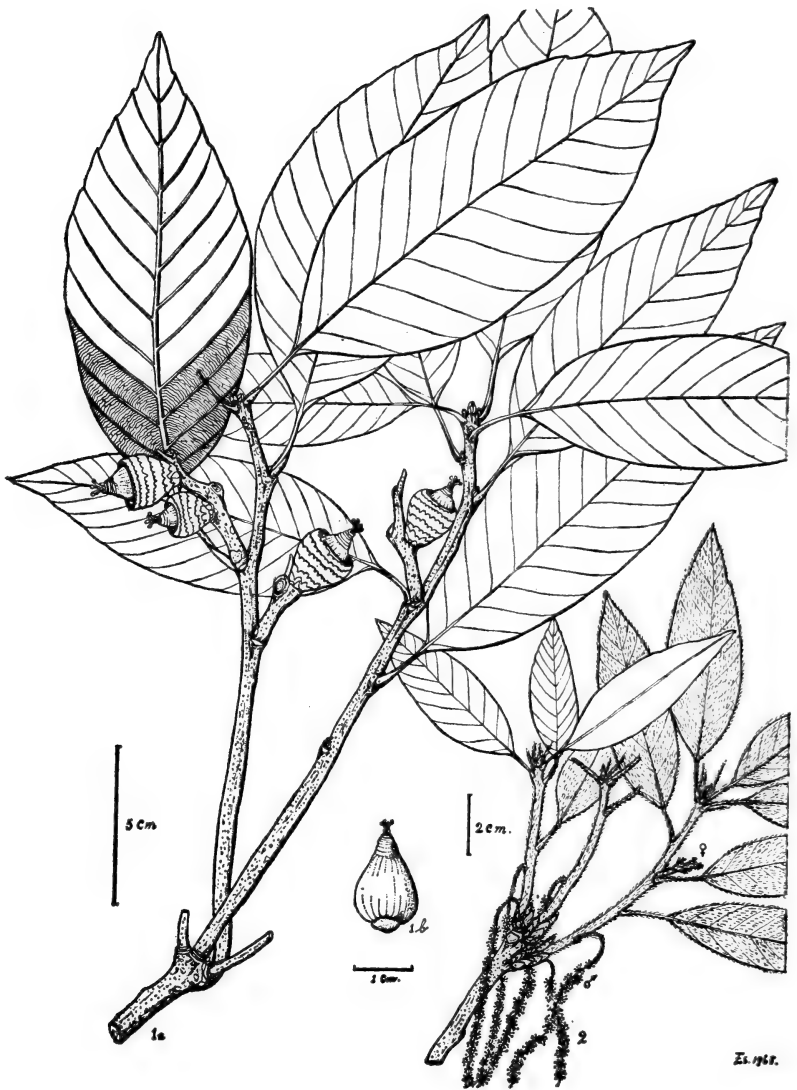


Fig. 16: *Quercus lineata*
 1a-b after Chew & Corner RSNB. 4561; after Chew & Corner RSNB. 4927.

17. *Quercus steenisii* Soepadmo, Map III.

Quercus steenisii Soepadmo in Gard. Bull. Singapore 21, 3: 389, f. 5. 1966. — Type: *van Steenis* 8607, Mt. Losir, Atjeh, N. Sumatra, alt. c. 3300–3460 m. Febr. fr. (Holotype: BO; isotypes: K, L, SING); paratype: *van Steenis* 8379, Putjuk Angasan, Atjeh, N. Sumatra, alt. c. 2000 m, Jan. fl. (BO, K, L, PNH, SING).

Tree c. 15 m tall, trunk c. 60 cm in diameter. *Young branchlets* with dense brownish-stiff-pubescent; older branchlets glabrous, lenticellate. Buds ovoid-ellipsoid, c. 1–1.5 by 0.5 cm. *Stipules* linear with blunt tip, c. 0.5–1 by 0.1–0.2 cm, with dense pubescence, caducous. *Petiole* c. 0.2–0.5 cm long, thickened at base, flattened on the adaxial side, with dense pubescence, glabrescent. *Leaves* thick-coriaceous, ovate-elliptic or ovate-orbicular, c. 3–8 by 2–5 cm, base rounded, obtuse, or cordate, margin entire or remotely serrulate in the apical half, apex rounded emarginate or bluntly acute; upper surface of the young leaf with dense brownish, stiff-simple-pubescent, glabrescent, lower surface with thick layer of brownish, woolly pubescence, glabrescent. *Midrib* and *lateral nerves* prominent beneath, keeled or flattened above; reticulation prominent beneath, parallel, dense. *Lateral nerves* c. 6–10 pairs, straight, parallel, arcuating towards the margin, forming c. 45°–60° angle with the midrib. *Male inflorescence* c. 5 cm long, with dense pubescence; bracts ovate-obtuse, c. 0.2 by 0.1 cm, densely pubescent. *Male flowers* in 3-flowered dichasial clusters; perianth 4–6-lobed; stamens 4–6; filaments glabrous, c. 1–1.3 mm long; anthers c. 1 by 0.5–1 mm; pistillode reduced to a cluster of stiff, simple-hairs. *Female inflorescence* not known. *Young infructescence* c. 1.5–3 cm long, with sparsely lenticels, with brownish, simple-pubescent; carrying 2–7 young fruits; bracts ovate-acute, caducous. Perianth of the female flowers (seen in the young fruit) thick-coriaceous, 5–6-lobed, with dense pubescence outside; staminodes 0–6, rudimentary; styles 3–4, recurved, c. 1–2 mm long. *Young cupule* ovoid-globose, with dense pubescence outside; lamellae thick, c. 3–4, the 2 lower ones denticulate, the others entire. *Mature cupule* cup-shaped, obconical, or patelliform, c. 0.7–1 cm in depth, 1.2–2.5 cm in diameter, enclosing c. $\frac{1}{3}$ – $\frac{1}{4}$ part of the fruit; lamellae c. 7–8, more or less recurved, with dense brownish pubescence. *Fruit* globose or ovoid, with dense brownish-tomentum, glabrescent, c. 1–2 cm in length and in diameter, apex rounded- or depressed-umbonate, base convex or flat.

Ecology: in montane forest, at c. 2500–3500 m alt. Flowering in January 28, 1937; fruiting in February 2, 1937.

Distribution: so far only known from Mt. Losir, Atjeh, N. Sumatra.

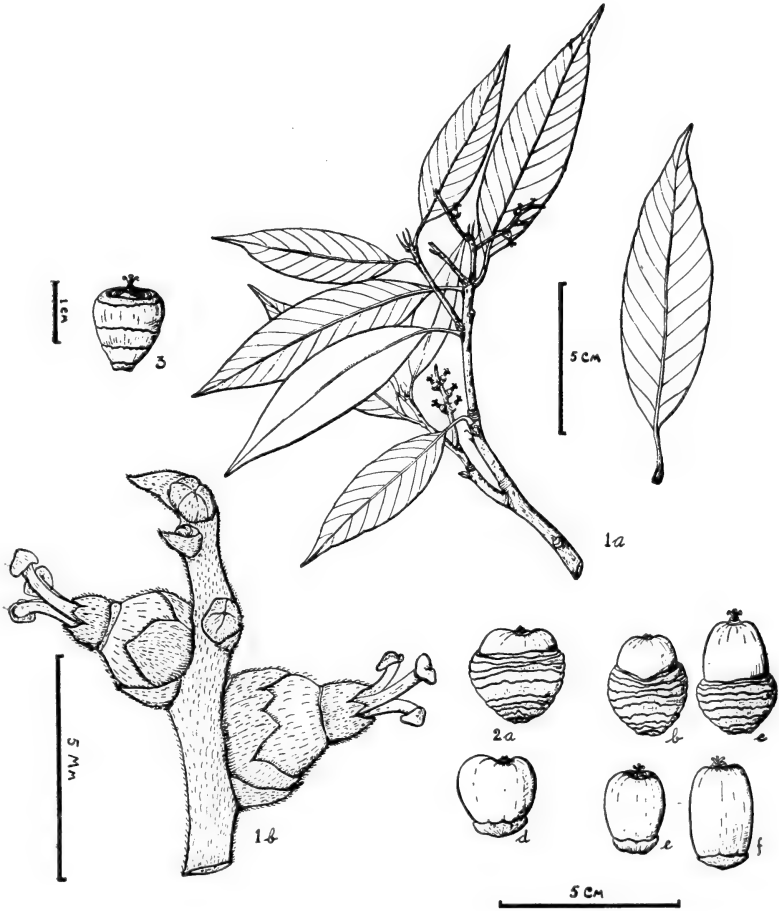
18. *Quercus treubiana* von Seemen, Fig. 17, Map XV.

Quercus treubiana von Seemen in Bull. Dép. Agr. Ind. Néerl. 1: 3. 1906; in Fedde's Rep. 3: 173. 1907; Merrill in J. Str. Br. Roy. As. Soc., Spec. No.: 216. 1921; A. Camus, Les Chênes 1: 368. 1938; Alt. 1: t. 33, f. 15-17. 1934. — *Cyclobalanopsis treubiana* (v. Seem.) Schottky in Bot. Jahrb. 47: 648. 1912. — Type: Hallier 2915, Mt. Liang Gagang, Borneo, fr. (Holotype: L; isotypes: K, SAR).

Tree c. 30 m tall, trunk c. 60 cm in diameter, bole irregular. *Buttresses* up to 1 m tall. *Bark* rough, peeling off profusely into rectangular pieces, rusty; inner bark c. 1.5 cm thick, ridged. *Innovations* with dense brownish-simple-pubescent. *Older branchlets* glabrous, lenticellate. *Buds* ovoid-ellipsoid; scales linear-acute. *Stipules* linear-acute, c. 5-10 mm long, caducous, densely pubescent outside. *Petiole* c. 0.5-1.5 cm long, flattened on the adaxial side, with dense pubescence, glabrescent. *Leaves* thin-chartaceous, linear-lanceolate or elliptic-lanceolate, c. 3-10 by 1-3 cm; base attenuate-acute, sometimes asymmetrical, margin remotely serrulate in the apical half, apex sharply acute or 0.5-1 cm acuminate; lower surface with dense simple-pubescent, glabrescent, upper surface glabrous, except for the midrib and lateral nerves. *Midrib* and *lateral nerves* more or less prominent on both surfaces; reticulation obscure on both surfaces. *Lateral nerves* c. 5-10 pairs, straight, parallel, arcuating towards the margin, forming c. 45°-60° angle with the midrib. *Male inflorescence* c. 3 cm long, rachis c. 0.1 cm thick, with dense pubescence; bracts and bracteoles linear-acute, densely sericeous outside, glabrescent. *Male flowers* solitary or in 3-flowered dichasial clusters along the rachis; perianth 5-6-lobed, the lobes densely sericeous outside; stamens 5-6; filament c. 2 mm long, puberulous at base; anthers c. 0.5-1 mm in length; pistillode reduced to a cluster of stiff-simple hairs. *Female inflorescence* not known. *Young infructescence* c. 1-2 cm long, rachis c. 1-2 mm thick, with dense woolly pubescence, glabrescent, carrying 2-5 young fruits; bracts ovate-acute, c. 1-1.5 by 0.5-1 mm, with dense tomentum outside. *Perianth* of the female flowers (seen on the young fruit) 5-6-lobed; styles 3, recurved, c. 2 mm long, with dense tomentum at base. *Young cupule* ovoid-globose or obconical, lamellae c. 6, with dense tomentum outside. *Mature cupule* cup-shaped, subglobose, base attenuate-rounded, c. 1.5-2 cm deep, 1-2 cm in diameter, covering c. $\frac{1}{3}$ - $\frac{1}{2}$ part of the fruit; lamellae 10-12, thick, densely sericeous outside. *Mature fruit* cylindrical-globose, c. 2-3 cm long and 1.5-2 cm in diameter; apex depressed-umbonate; base convex.

Ecology: in low ridges to montane forests at c. 600-2000 m alt. Fruiting in July-August.

Distribution: Sumatra (Palembang), Borneo (Mt. Kinabalu, Mt. Liang Gagang, Mt. Beratus, Mt. Palimasan).



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Fig. 17: *Quercus treubiana*
1a-b after Tikau SAN. 34643; 2a-f after Kostermans 7442; 3 after
Clemens 30465.

19. *Quercus elmeri* Merr., Fig. 18, Map XVI.

Quercus elmeri Merrill in Univ. Calif. Publ. Bot. 15: 43. 1925; A. Camus, Les Chênes, 1: 194. 1938; Atl. 1: t. 4, f. 9-12. 1934. — Type: *Elmer 21213*, Tawao, N. Borneo, fr. Oct. 1923 (Holotype: K; isotypes: A, L).

Tree c. 18-40 m tall, trunk c. 25-60 cm in diameter. *Bark* greyish-brown, cankered with longitudinal rows of lenticels or scaly; inner bark c. 0.5-1.5 cm thick, fibrous, reddish-brown. *Buttresses* narrow, up to 1.3-3 m tall. *Innovations* with dense rufous-tomentum. *Older branchlets* glabrous, lenticellate. *Stipules* linear-acute, c. 5-7 by 1 mm, with dense tomentum outside, glabrescent. Buds subglobose, c. 3-5 by 4-5 mm. *Petiole* c. 1-3 cm long, terete or flattened on the adaxial side. *Leaves* thin-coriaceous, elliptic-lanceolate or elliptic-oblong, c. 5-14 by 1-5 cm; upper surface glabrous, shining, lower surface with dense rufous-tomentum, glabrescent; base attenuate-acute, usually asymmetrical, margin remotely serrulate near the acute or sharply acuminate apex. *Midrib* and *lateral nerves* strongly prominent beneath, flattened or slightly raised above; reticulation fine, parallel, obscure on both surfaces. *Lateral nerves* c. 5-12 pairs, parallel, arcuating towards the margin, forming c. 60°-70° angle with the midrib. Inflorescence not known. Young infructescence c. 1-2 cm long, carrying c. 1-5 young fruits; bracts linear-acute, c. 1-2 mm long, with dense tomentum outside. Perianth of the female flower (seen in the young fruit) 6-9-lobed; staminodes 0; styles 3-5, c. 2-3 mm long, recurved. Young cupule ovoid-conical, lamellae c. 3-4. *Mature cupule* flattened cup-shaped, or patelliform, c. 0.5-0.7 cm deep, 2-2.5 cm in diameter, covering c. $\frac{1}{3}$ - $\frac{1}{4}$ part of the fruit; lamellae thick, c. 5-7; rim denticulate base truncate or rounded. *Mature fruit* ovoid-conical or conical-cylindrical, c. 2-3 cm in length and 1.5-2 cm in diameter, densely sericeous, glabrescent; base truncate or convex, apex rounded — or depressed-umbonate.

Ecology: in lowland to submontane forests, at c. 30-1300 m alt. Fruiting in September-April.

Distribution: Malaya (Pahang, Selangor), Sumatra (Agam, Pajakumbuh, Indragiri), Borneo (Bukit Kalong, Ranau; Mt. Kinabalu, Tawao, Sarawak, Samarinda vicinity).

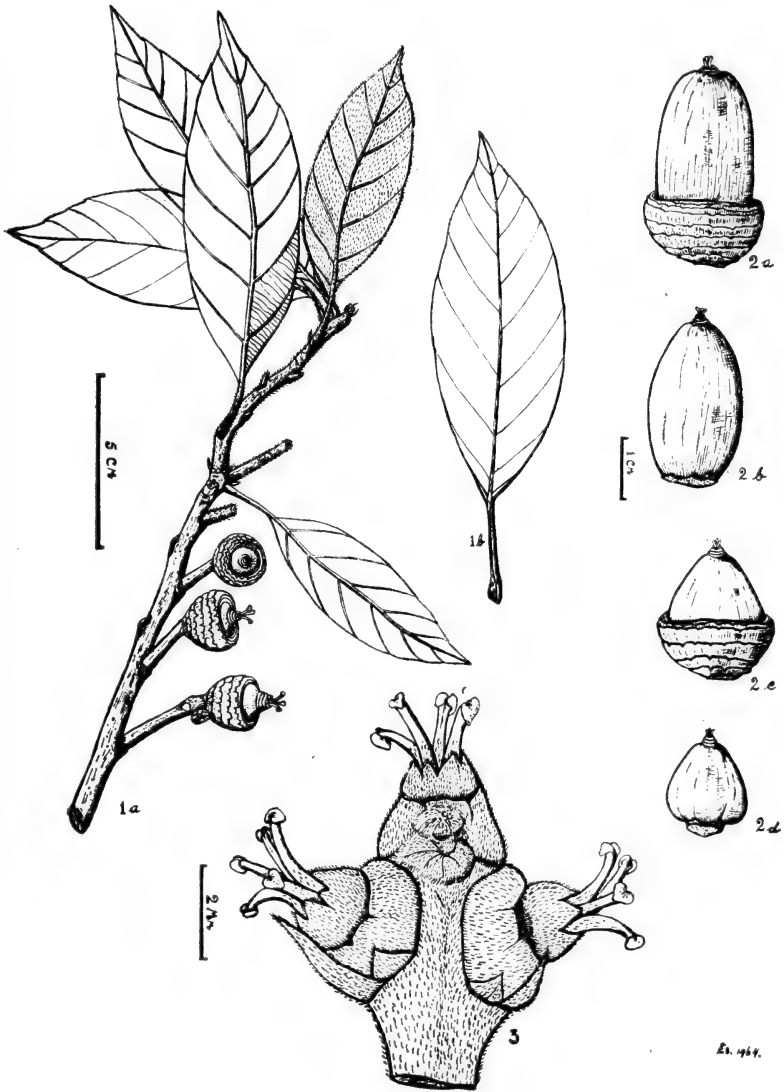


Fig. 18: *Quercus elmeri*
1a-b after Singh SAN. 28310; 2a-d after Elmer 21213; 3 after Anderson
et alia S. 15374.

List of identifications

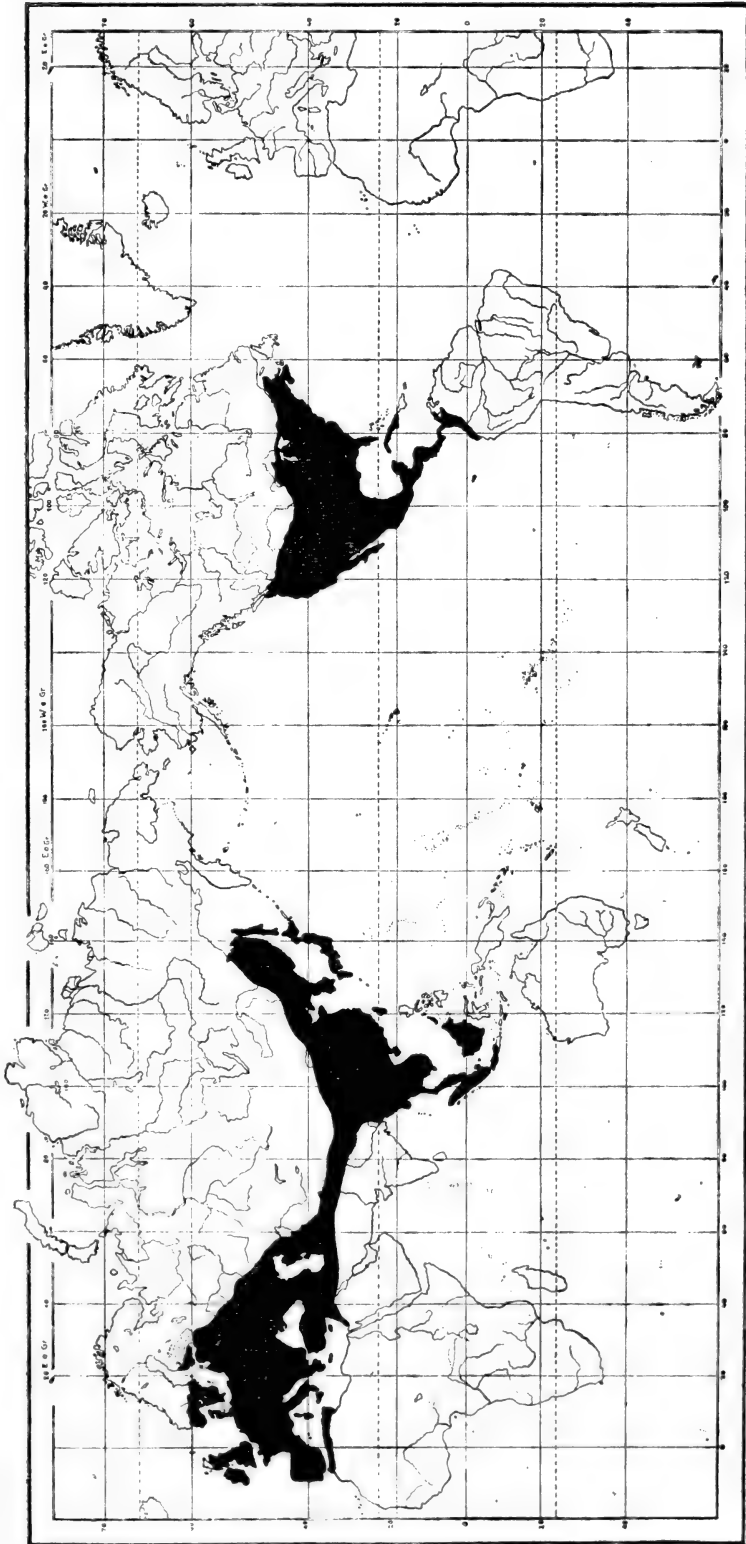
(The number following the colon corresponds to the number of species as treated in this paper).

Abbe et alia 9957: 13; *Achmat* 1094, 1199, 1501: 6; *Alvins* 1723, HS. 14675: 15; *Ashton Brun.* 2378: 14; *Backer* 25956: 5; *Bakhui-zen v.d. Brink* 4451, 6465: 15; *Bangham* 859: 4; *bb.* 2865: 2; 3102: 5; 3106: 4; 3126: 15; 3832: 16; 4177: 15; 4640: 16; 4784: 5; 5219: 2; 5326, 5471, 5624: 15; 5775, 5776: 5; 5778: 15; 5882: 19; 6521: 15; 6572: 19; 6739: 2; 10389: 15; 12708: 7; 14468: 16; 15952: 6; 16103: 7; 18994: 2; 20387: 15; 20389: 7; 20855: 2; 22382, 24758: 15; 29598, 30134: 7; 31703, 32190, 32254: 2; 33943: 15; 34224, 34346, 34392, 34439: 7; *bb. Ja.* 3029: 15; P.T.P. 740: 7; S.W.K. 1-41: 15; T. 937: 2; T.B. 211: 15; 604: 18; *Beccari P.B.* 1385: 11; 2243, 2551: 3; 2757, 2919: 7; *Berkhout* 1057: 7; *Bünnemeijer* 1880: 15; 2048: 2; *Borssum Waalkes* 1760: 15; *Burkill* 2858: 16; *Burkill & Holttum* 7753: 16; 8661: 19; *Clemens* 10963: 8; 11211: 2; 30465: 15; 30813: 14; 30948, 30964, 30967, 30976, 31097: 8; 31238: 14; 31264: 15; 31317, 31459: 14; 32364, 32448, 32933: 8; 34492: 12; 34493: 8; 34494: 16; 40231, 40390, 40533, 40534, 40536, 40637, 40699, 40951: 8; 50215: 14; 51254: 15; 51658: 2; *Curtis* 434: 4; 905: 15; *Docters van Leeuwen* 11673: 6; *Elbert* 56, 57, 58: 15; *Elmer* 13219: 11; 21213: 19; *Ender* 3215: 15; 3624: 14; 4511: 15; 4731: 2; *F.B.* 3858: 11; *Forbes* 572: 7; 585, 2719, 2753, 3834a: 2; *Fox* 14536: 2; *Foxworthy B.S.* 566: : 11; *Fuchs & Collenette* 21665: 1; *Grashoff* 142, 160, 230: 2; 800, 842: 7; 907, 1101: 15; *Hallier f.* 2628, 2864: 2; 2915: 18; 2950: 8; 3349: 2; *Hamid* 5445: 15; *Haniff* 231: 15; *Haviland* 1772: 12; *Herb. Sing.* 14534: 7; *Horsfield* 11: 15; *Hotta* 14732: 14; *Ichlas* 102: 15; *Jacobs* 5114: 2; *Junghuhn* 9, 63: 16; 70: 15; *Kadir* 63: 7; *Kalshoven* 10: 15; *KEP.* 22574, 29828, 31071: 5; 34029, 34031: 15; 38048: 7; 71649: 8; 99590: 2; *Koorders* 1407, 1408, 1410, 1418, 1435, 1439, 1440, 1468, 1472, 1475: 15; 1487, 1488: 5; 1503, 1526: 15; 1533: 5; 10940, 10941, 10946, 11729, 11928, 11931, 11932, 11933: 15; 12453: 16; 13859, 13955, 14051, 14118: 15; 14184: 5; 14930: 15; 15342: 5; 23863, 25716, 26562, 26670, 26784: 15; 27713: 16; 29204, 29247, 32762: 15; 33299: 5; 33415, 33737: 15; 33745: 16; 33762: 15; 37141, 37146: 16; 38144, 38145, 38151: 15; 38484: 5; 38624, 38689, 38695, 38698: 15; 38784: 5; 38801: 15; 39430: 5; 39608: 15; 40101: 16; *Korthals HB.* 7949: 2; *Kostermans S.* 92: 2; 4078, 4180; 7; 4433: 6; 4474, 6368: 7; 6530: 6; 7442: 18; 8963: 11; 10235, 12795: 7; 13030: 18; *Kostermans & Anta* 99: 15; 152: 7; 419, 463, 514, 801: 15; 1240, 1324, 1326: 7; *Krukoff* 4016: 15; *Kunstler* (King's collector) 3723, 8258: 4; *Labohm* 1130: 2; *Lands* 27204: 16; *Lörzing* 11449: 15; 15661: 16; *Meijer* 3253: 16; 5879: 15; 8687: 5; *Meijer & Amiruddin* 23: 19; *Monterie* 51: 16; *Nur*

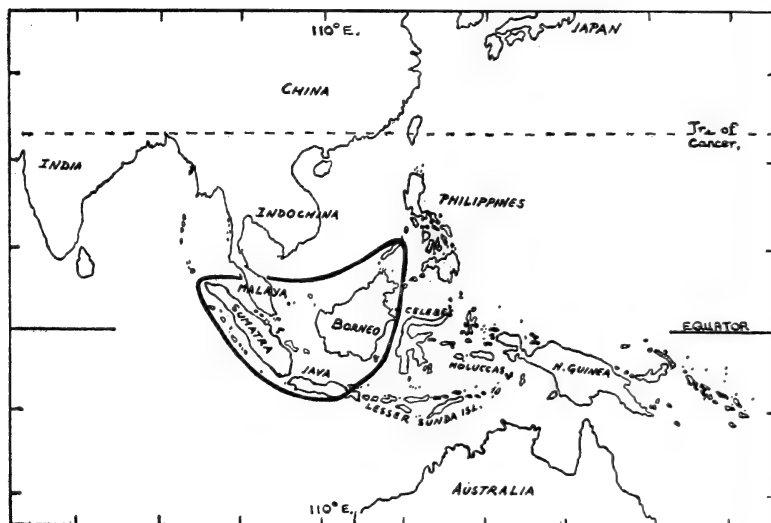
7378: 15; *Poore* HS. 14900: 16; *Poore* 855: 15; 1315: 5; 1321: 16; 1334: 15; 1348, 1378: 5; *Purseglove* 4263: 19; *Rajab* 482, 483: 5; 607: 16; *Richards* 1885: 10; *Ridley* 6443: 2; *RSNB*. 490: 2; 4248: 19; 4363: 8; 4427: 2; 4434: 1; 4451: 13; 4500: 8; 4533: 2; 4534, 4564: 16; 4792: 14; 4893, 4927: 16; 4976: 19; 7002: 14; 7096: 16; 7148: 13; 8411: 2; *SAN*. 3621a: 15; 16188, 16565: 6; 16683, 16811: 4; 19129: 15; 19868: 7; 20219: 2; 20731: 15; 20732: 2; 20973: 13; 21088: 8; 21342: 19; 24051: 18; 24106, 24121: 8; 24353: 15; 25119: 7; 25336: 13; 28276: 7; 28307: 15; 28310: 19; 28808: 8; 28919: 7; 28991: 16; 29060: 8; 29131: 14; 29134: 14; 30869: 16; 31936: 15; 32253: 11; 33131: 16; 33714: 2; 33949: 14; 34504: 8; 34643: 18; 34742: 7; 38069: 16; 38608, 39135: 8; 41832: 16; 42096, 44309, 44478: 8; 48115: 13; 49459, 49749: 15; 51434, 51438: 8; 53861: 15; *SAR*. 154: 4; 1065, 1070: 12; 2999: 10; 3919, 3946: 3; 4504, 4543, 4547: 14; 4580: 19; 4661: 12; 7553: 3; 12615: 2; 12622: 19; 12624, 13182, 13315: 2; 13562, 13565: 7; 15095: 14; 15374: 15534: 4; 16315: 2; 20011, 20021: 14; 20107: 2; 20115: 3; 20121: 9; 20135: 2; 20226: 9; 20801, 20802: 11; 22462: 6; 22650: 2; *Sauveur* 14, 70: 7; *SFN*. 10252: 3; 11798: 15; 18053: 16; 20191: 2; 23545, 23547: 16; 36268, 27668: 8; 27794: 15; 31253: 16; 31798: 5; 31973: 15; 35936: 19; 36275: 15; 36398: 2; *Soekaria* 107: 2; *Strugnell* 20308: 15; *Symington* 37664: 7; *Teijsmann* HB. 676: 16; 7595: 15; 7638, 7642, 7643: 7; 7649: 2; 3882, 21080: 7; *Toha* 2057: 2; *van Steenis* 904: 2; 8264: 16; 8379, 8607: 17; *Verhoef* 104: 2; *van de Vreeden* 93: 7; *Watson* 5817: 15; *Winckel* 970: 5; *Wind* 43: 16; *Wray* 1532: 15.

References

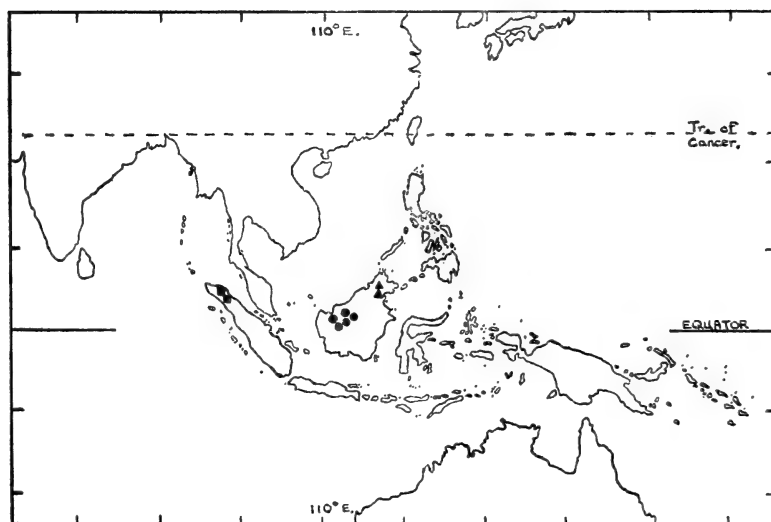
1. ARMSTRONG, J. M. & A. P. WYLIE in *Nature* 205: 1340-1341. 1965.
2. BAILLON, H. *Nat. Hist. Pl.* 6: 220. 1877.
3. BARNETT, E. C. in *Trans. & Proc. Bot. Soc. Edinburgh* 33, 3: 327-343. 1942; *I.c.* 34, 1: 159-204. 1944.
4. BERRIDGE, E. M. in *Ann. Bot.* 28: 509-526. 1914.
5. BRETT, D. W. in *New Phytol.* 63, 1: 96-118. 1964.
6. BURKILL, I. H. *Dict. econ. Prod. Mal. Pen.* 2: 1849-1859. 1935.
7. CELAKOVSKY, L. in *Bot. Centralbl.* 30, 1: 10-12. 1887; in *Jahrb. Wiss. Bot.* 21: 128-162. 1890; in *Oest. bot. Zeitschr.* 43: 272. 1893.
8. CORNER, E. J. H. in *Gard. Bull. S.S.* 10: 279-280. 1939; *Wayside Trees of Malaya I*: 290-305. 1940.
9. CUTLER, D. F. in *Kew Bull.* 17, 3: 401-409. 1964.
10. DALLA TORRE, C. G. & H. HARMS, *Gen. Siphon.* :117-119. 1907.
11. DUFFIELD, J. W. in *Am. J. Bot.* 27, 9: 787-788. 1940.
12. EICHLER, A. W. *Blüthendiagramme* 2: 20-30. 1878.
13. FORMAN, L. L. in *Kew Bull.* 17, 3: 381-396. 1964.
14. GHIMPŪ, V. in *Rev. Bot. Appl. & Agr. Trop.* 9: 176-179. 1929.
15. HANCE, H. F. in *J. Bot.* 12: 240-243. 1874.
16. HANDEL-MAZZETTI, H. *Symb. Sinicae* 7: 27-52. 1929.
17. HENDERSON, M. R. in *Gard. Bull. S.S.* 5: 76-78. 1930.
18. HJELMQVIST, H. in *Bot. Notis., Suppl.* 2, 1: 1-171. 1948.
19. HOSSEUS, C. C. in *Beih. Bot. Centralbl.* 28, 2: 284-385. 1911.
20. HUTCHINSON, J. *Fam. fl. Pl.* 1: 192-193. 1959.
21. JARETZKY, R. in *Planta* 10: 120-136. 1930.
22. JAYNES, R. A. in *Forest Sc.* 8, 4: 372-377. 1962.
23. LANGDON, L. M. in *Bot. Gaz.* 101: 301-327. 1939; 108 : 350-371. 1947.
24. LEMEE, A. *Dict. descr. syn. Gen. Pl. Phan.* 4: 127, 765. 1932; 5: 713-714. 1934; 7: 182-183. 1939.
25. LENDNER, A. in *Bull. Soc. Bot. Genève, Sér. II*, 8: 161-166. 1916.
26. MELCHIOR, H. in *Engler's Syll. Pfl.fam.* 2: 49-51. 1964.
27. MULLER, C. H. in *Miscel. Publ. U.S. Dept. Agr.* 477: 1-216. 1942; in *Chronica Bot.* 7: 12-14. 1942.
28. OHWI, J. *Fl. Jap.* : 377-378. 1965.
29. PALIBIN, J. in *Bull. Soc. Bot. Genève, Sér. II*, 1 : 359. 1909.
30. PRANTL, K. in *Bot. Jahrb.* 8: 321-336. 1887; in *Engler & Prantl, Nat. Pfl.fam.* 3, 1: 47-58. 1894.
31. REHDER, A. in *J. Arm. Arb.* 1: 122-136. 1919. *I.c.* 10: 132-139. 1929.
32. ————— & E. H. WILSON in *Sargent, Pl. Wils.* 3, 2: 190-237. 1916.
33. ROXBURGH, W. *Pl. Corom.* 3: 94. 1819; *Fl. Ind.* 3: 634, 639, 640. 1832.
34. SAX, H. J. in *J. Arn. Arb.* 11: 220-223. 1930.
35. SUGIRA, T. in *Bot. Mag. Tokyo* 45: 353-355. 1931.
36. TRELEASE, W. in *Mem. Nat. Acad. Sc.* 20: 1-255. 1924.
37. TROLL, W. in *Ber. Deutsch. Bot. Ges.* 44: 290-295. 1926.
38. YAMAZAKI, R. in *Jap. J. Genet.* 12: 101. 1936.



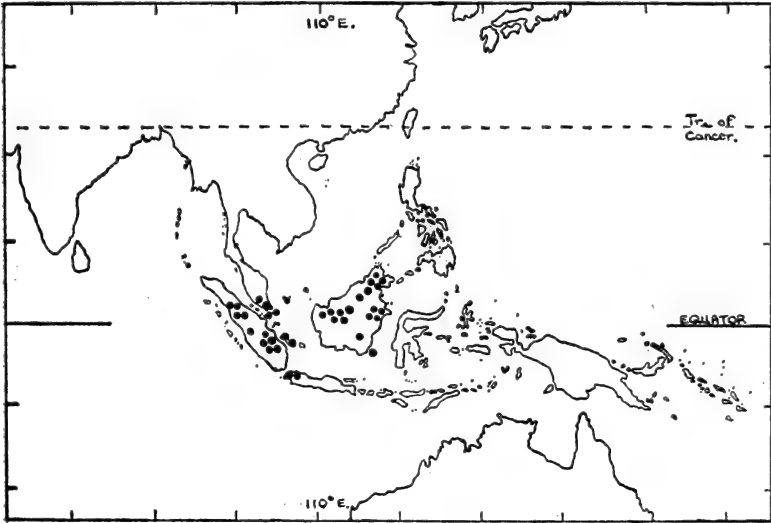
Map I: approximate range of distribution of the genus *Quercus* L.



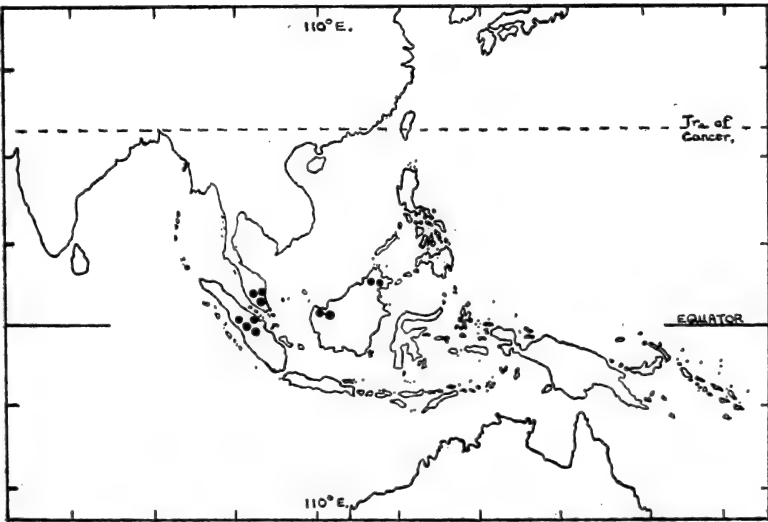
MAP I : DISTRIBUTION OF *QUERCUS* L. SUBGEN. *CYCLOBALANOPSIS* (OERSTED) SCHNEIDER IN MALASIA.



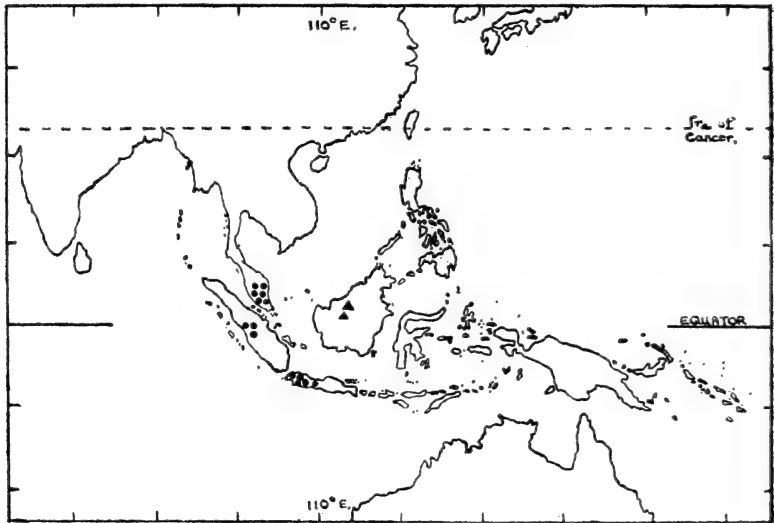
MAP II : DISTRIBUTION OF :
 ▲ = *QUERCUS PSEUDO-VERTICILLATA* E. SOEPADMO
 ● = ——— *NIVEA* KING
 ■ = ——— *STEENISH* E. SOEPADMO



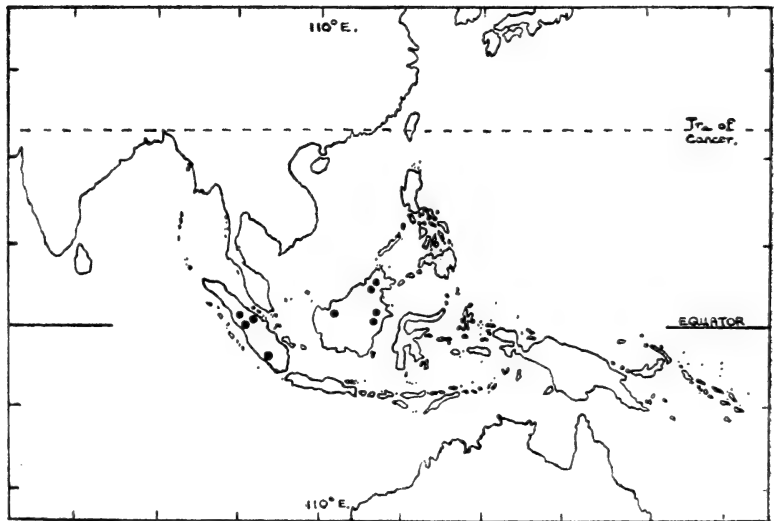
MAP II : DISTRIBUTION OF *Q. ARGENTATA* KORTH.



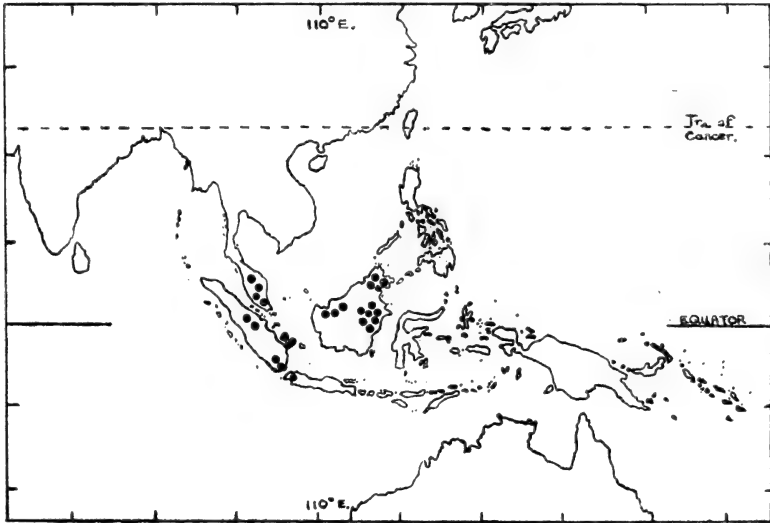
MAP III : DISTRIBUTION OF *Q. GANARUENSIS* E. SOEPADMO



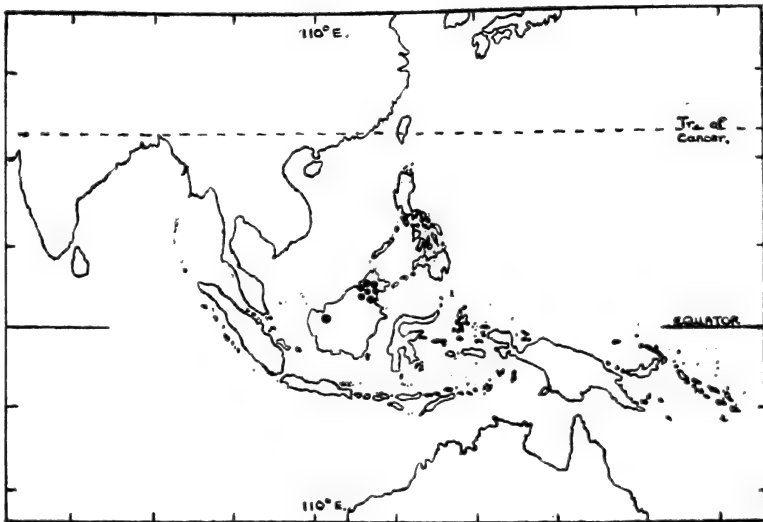
MAP V : DISTRIBUTION OF $\left\{ \begin{array}{l} \bullet = Q. DIDOCARPA \text{ KORTH.} \\ \blacktriangle = Q. PERCORIACEA \text{ E. SOEPADMO} \end{array} \right.$



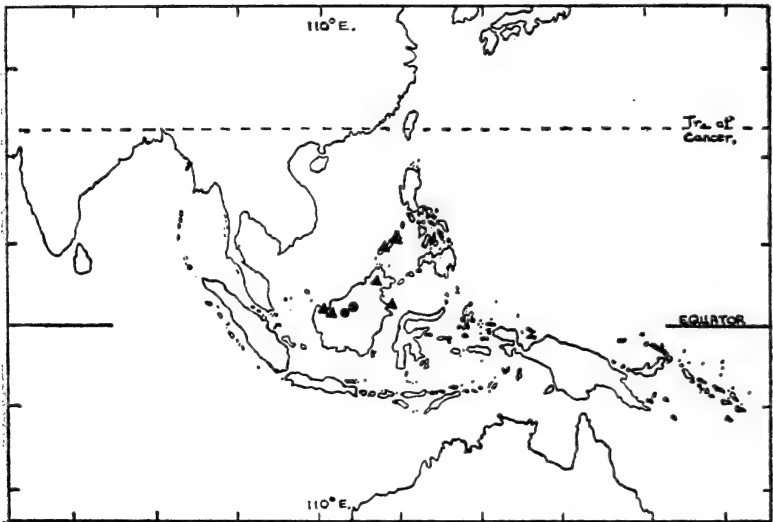
MAP VI : DISTRIBUTION OF *Q. SUYATRANA* E. SOEPADMO



MAP VII : DISTRIBUTION OF *Q. SUBSERICEA* A. CANUS

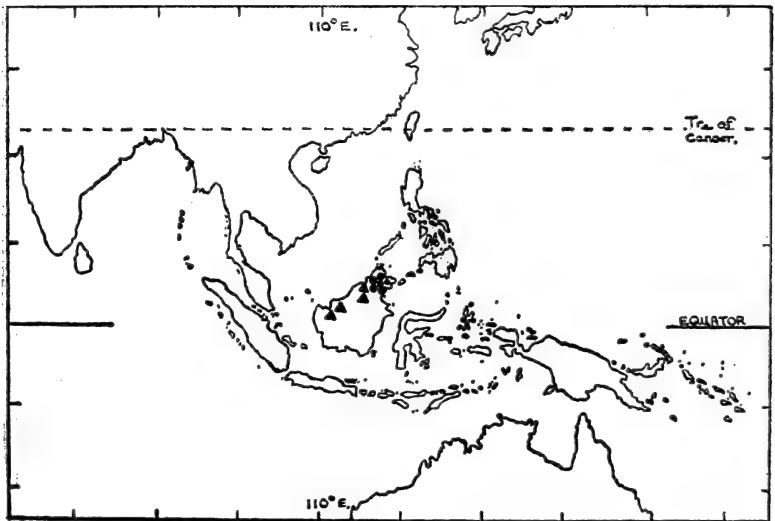


MAP IX : DISTRIBUTION OF *Q. LOWII* KING



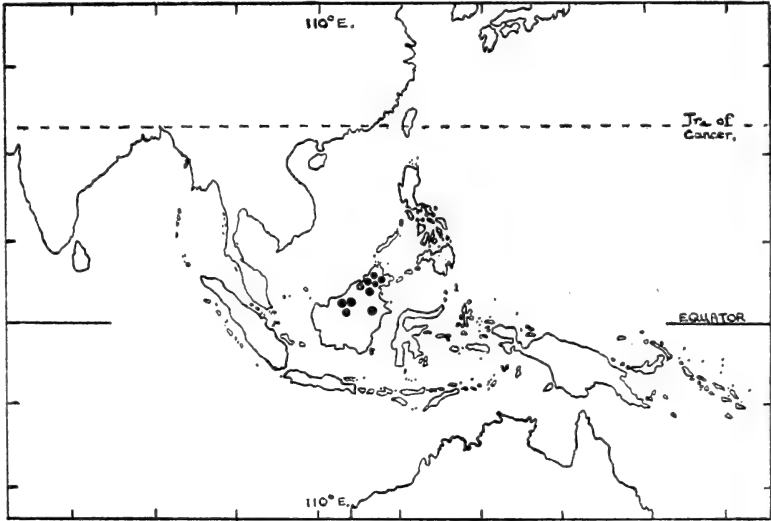
MAP IX: DISTRIBUTION OF

- = *Q. CHRYSOTRICHA* A. CAMUS
- ▲ = *Q. NERRILLII* V. SEEHEN

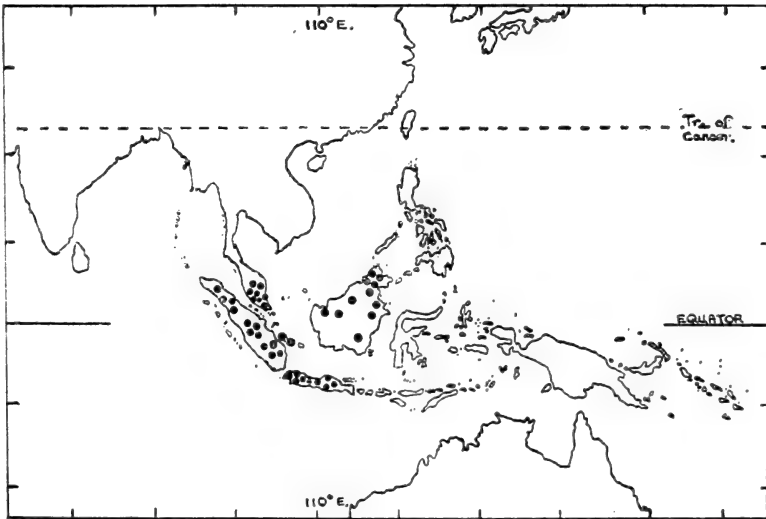


MAP X: DISTRIBUTION OF

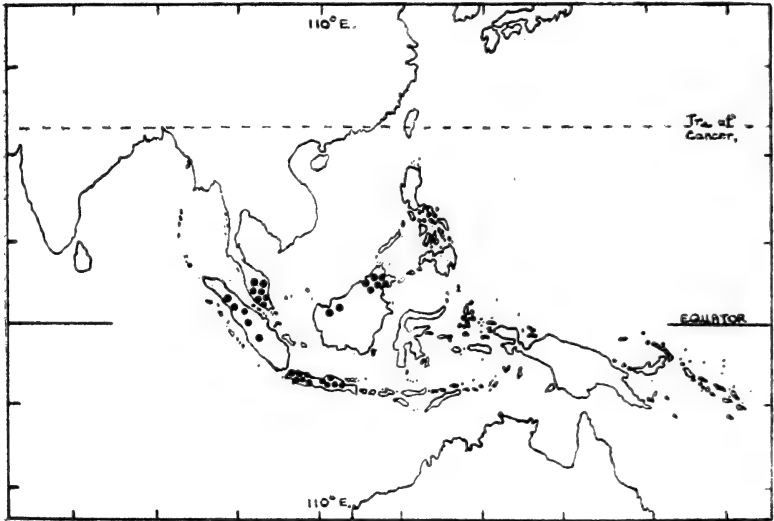
- ▲ = *Q. KERANGASENSIS* E. SOEPADMO
- = *Q. KINABALUENSIS* E. SOEPADMO



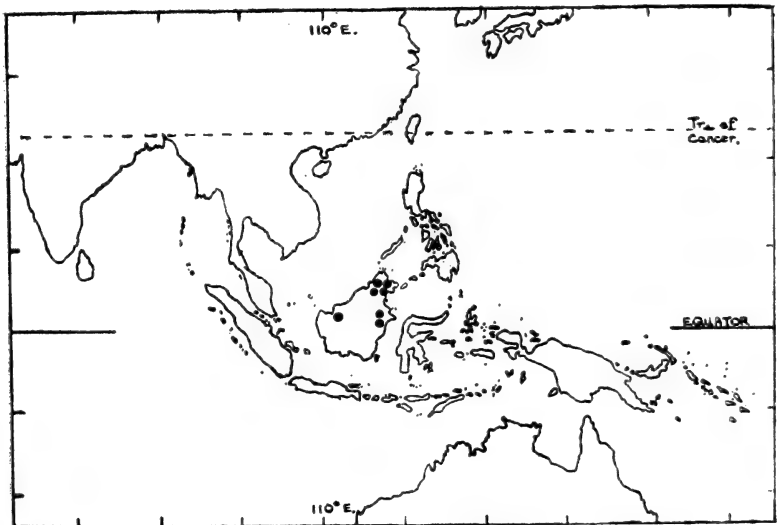
MAP II : DISTRIBUTION OF *Q. VALDINERVOSA* \neq SOEPADMO



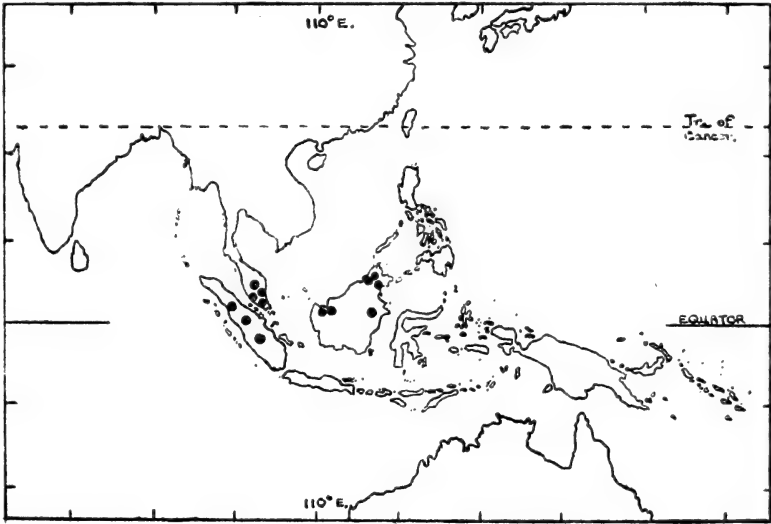
MAP III : DISTRIBUTION OF *Q. GENELLIFLORA* BL.



MAP XIV : DISTRIBUTION OF *Q. LINEATA* BL.



MAP XV : DISTRIBUTION OF *Q. TREUBIANA* V. SEEM



MAP XVI: DISTRIBUTION OF *Q. ELMERI* MERR.



Some Studies of Malayan Agarophytic and Alginophytic Seaweeds

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The social, as distinct from the industrial, uses of the Rhodophyceae in Malaya have been comprehensively listed by I. H. BURKILL (1935) and in Malesia by J. S. ZANEVELD (1959), but the actual agar content of Malayan agarophytic species has nowhere been reported. Similarly the same authors have recorded (loc. cit.) the social uses of the Phaeophyceae, and some of the traditional industrial uses such as sources of potash, soda and iodine. The alginic acid content of Malayan alginophytes has not been recorded. The object of this paper is to put on record some values for agarophytes in the first part, and for alginophytes in the second. The field work was undertaken by the first author: the analyses were done at the Tropical Products Institute, London.

Part I — Agarophytes

Japan has long been considered, and rightly so, the main agar-producing country of the world, though shortages of supply during World War II led the western nations to search for alternative domestic sources of supply. Of the agarophytes exploited in Japan, *Gelidium* spp. are the most important. This genus is represented in the Malayan algal flora but it has not been found in adequate abundance to make collecting practicable. The genus *Gracilaria* is well represented, and at many points around Singapore and the western coast of the Malay Peninsula there are beds of *G. lichenoides*, the source of Bengal isinglass. At certain times of the year this species is thrown up on the beaches as jetsam in quantity. This, and some collected in the shallow sublittoral, is used domestically for making *agar-agar* sweetmeats: some is collected for feeding to pigs and ducks (though its food value has not been investigated), but very little, if any, is collected for industrial use.

Besides, *Gracilaria*, there are *Eucheuma* spp. growing on the littoral and sublittoral fringe, which are used in a similar and small way, but never in quantity for commercial exploitation. This situation is in spite of the fact that Singapore handles a considerable entrepôt tonnage of agarophytic seaweeds (largely *Gracilaria* and *Eucheuma*) from neighbouring countries.

Samples of *Gracilaria* and *Eucheuma* from Singapore and the Johore River estuary have been collected for chemical analysis together with a sample from a commercial entrepot consignment from Indonesia for comparison.

Table I gives the results of these analyses. All three local samples of *Gracilaria lichenoides* had agar contents slightly superior to that of the Indonesian entrepôt sample. In respect of gel strength, both Singapore samples produced gels equal to the commercial sample, though that from the Johore River gave a somewhat softer gel. The 'Difco' agar against which these were compared is a standard, high quality, hard agar. The results from the local collections of *Gracilaria lichenoides* are considered to be highly satisfactory.

The Johore River station is a few miles up the tidal estuary from its mouth in the East Johore Straits. Pulau Tekong and Teluk Paku both stand to seaward of this point. The water at the Johore River station is of reduced salinity and differences of quality may be due to this.

Eucheuma muricatum yielded an agaroid, that is, an agar extract which would not gel. This quality is already known for *E. muricatum* which finds use in Japan as a diluent for high grade agars.

In extension of this information on Malayan agar resources, it seems appropriate to record here previously unpublished data (T.P.I. archives) on some 1940 analyses made by the Imperial Institute, London. These analyses were made in the general search for sources of agar other than from Japan at the beginning of World War II. Samples were submitted from Penang, Malacca, Pulau Besar and Pulau Upeh off the Malacca coast, and Singapore. Samples from Indonesia and South India were at the same time examined. All were labelled as *Gracilaria lichenoides* except that from Penang which was stated to be *Gracilaria* sp. The results are given in Table II.

The hot water soluble matter in these tests compared favourably with solubilities from different species used in Japan for the preparation of commercial agar, and they will be seen to be similar to those recorded in Table I.

Gelation tests, comparing these samples with commercial Japanese agar, showed the Indian sample to be superior. All the others except that from Pulau Upeh were good or fair and were deemed to be promising as sources of commercial agar.

TABLE I
ANALYSES OF SOME LOCAL AGAROPHYTES
Figures expressed as percent of dryweight (except Gel strength)

Species	Gracilaria lichenoides	Gracilaria lichenoides	Gracilaria lichenoides	Gracilaria lichenoides	Gracilaria lichenoides	Eucheuma muricatum	Gracilaria lichenoides
Locality	Teluk Paku Singapore	Pulau Tekong Singapore	Johore River	Pulau Hantu Singapore	commercial sample Indonesia		
Ash	37.8	21.7	14.5	41.4	48.6		
Cold water soluble extract	26.8	5.8	12.3	59.1	34.6		
Hot water soluble extract	68.6	43.9	51.5	88.1	70.9		
Agar content *	41.8	38.1	39.1	29.0	36.3		
Gel strength† as percent of control	21	21	16	Solid gel not formed	21		

* Hot water soluble extract less cold water soluble extract.

† Gel strength of 0.75 percent solution (dry matter basis) of extracted agar expressed as a percentage of a solution of 'Difco' agar of the same concentration used as a control.

TABLE II

Analyses of some local agarophytes

(Bull. Imp. Inst. 1941, 39, 16 and hitherto unpublished results).

Origin	Hot water soluble extract %	Soluble chlorides as NaCl %
Penang	67.1	4.9
Malacca, mainland	59.6	3.8
Malacca, P. Besar	64.1	3.8
Malacca, P. Upeh	51.4	3.9
Singapore	46.8	0.2
Indonesia	42.6	0.2
India	57.3	6.3

Penang sample = *Gracilaria* sp. All other samples = *Gracilaria lichenoides*.**Part 2 — Alginophytes**

The presence of algin is a feature of the larger brown seaweeds, but the most important genera which meet the world's demand for alginic acid are not represented in the Malayan algal flora: *Macrocystis*, *Laminaria*, *Ascophyllum*, *Eisenia*, *Ecklonia* and others occur in more temperate regions. Newton (1951) records the use of *Sargassum ringgoldianum* in Japan, and Hoppe and Schmidt (1962) refer to the presence of *Sargassum* species in the Singapore algal flora without mentioning any specifically. These authors quote alginic acid contents for *S. myriocystum*, 22 percent, *S. plagiophyllum*, 27 percent, and *S. wightii*, 25 percent, on the Ceylon and Indian coast. The genus *Sargassum* from the rather fragmentary collecting that has so far been done, is clearly well represented in Malayan waters (see Grunow, 1915-16). When further systematic collecting and taxonomic research has been undertaken, this vast genus will surely be found to be much richer here than is at present known. *Cystoseira* and *Turbinaria* of the family Sargassaceae also occur around Malaya.

The Sargassums at Raffles Light

Around Singapore, at least, and probably at many points along the western Malayan seaboard, the *Sargassum* beds are a conspicuous feature of the algal ecosystem of the littoral and immediate sublittoral coral reefs. For the present exercise, the beds at Raffles Light (Pulau Satumu) were chosen because of ease of access and because of facilities available in the marine laboratory of the University of Singapore Zoology Department situated there.

The island lies at the western limit of the Straits of Singapore at the southern end of the Straits of Malacca. It is of lateritic rock, barely one acre in extent. It has an intertidal littoral fringe of coral, rocks and small sandy pools covering about eight acres. The spring tide range is about 10 feet. The upper limit of the sargassum is about the midlittoral. The lower limit is at about two feet below low water spring tide level, which also marks the edge of the reef where it plunges steeply into deep water. Some studies of the littoral ecology of this island have been published by Purchon and Enoch (1954). They record only the occurrence of *Sargassum siliquosum* J. Ag. and *Turbinaria ornata* J. Ag. of the Sargassaceae, but there is plainly a greater representation than these two, especially of the genus *Sargassum*.

Observations recorded in this paper were made in 1960/61 on *Sargassum glaucescens*, *S. swartzii* and *S. assimile*, and in 1962/63 on *S. glaucescens*, *S. myriocystum* and *S. swartzii*. Vouchers for all the assays are laid in the Singapore Herbarium. These four species occupy marked niches on the coral shelf, the most obvious characteristic of their positions being the degree of tidal inundation and of exposure of the tidal flow. Tidal predictions (H.M.S.O. 1962) record peak water movement of over $3\frac{1}{2}$ knots. *S. swartzii* is predominant on those rocks most exposed to this movement, and hence it is mainly at the lowest littoral level though it does occur scattered here and there with *S. glaucescens* and *S. assimile*. These two latter species are freely intermixed with one another and cover the whole of the lower littoral coral shelf subject to tidal flow. *S. myriocystum* occurs only in sheltered water. It tends to be silt covered and is mainly at mid-tide level and is therefore inundated the least of the four species. *S. siliquosum*, referred to above was not sampled because of its inabundance relative to these other species. It occurs on the lower littoral in a small sheltered part.

Growth Cycle

The species are deciduous: *S. glaucescens*, *S. swartzii* and *S. assimile* completely shed their secondary branches towards the end of the northeast monsoon period which is approximately November to March. In 1961 and 1963, these species were entirely broken down to stubble — the holdfast and brief primary stem, a few basal leaves and a few incipient secondary branches — by March. In 1962 breakage was complete by February. *S. myriocystum* maintains some secondary branches the year round, though the old fertile branches are eventually shed. It appears that the secondary branches of this species, unlike the branches of the other three, may last longer than one annual cycle.

This timing is not necessarily the same elsewhere, and it must be considered to be a characteristic of the locality. For instance, *S. glaucescens* is common on the lower littoral of the Labrador

beach by the western entrance to Singapore docks, and some 10 miles distant. On this beach it is protected both from the northeast monsoon and also from extreme tidal flow. The mature growth of this species persists for much longer than it does at Raffles Light so that when it eventually does break off, the new secondary branches have grown appreciably and the rocks do not assume the same bare fallow appearance.

Regeneration at Raffles Light is slow at first and the reef is bare for some months except in those areas occupied by *S. myriocystem*. The sargassum of the lowest level grows first and most quickly, regeneration spreading upwards so that by July the reef is clothed again in its mantle. Mature stature is attained by August–September, and the plants become fertile soon after, there being some variation between species. Observation on these points are given in Table III.

TABLE III

Sargassum Growth Cycle at Raffles Light at approximately the mid-lower littoral level

(a) average length of plants in inches.

(b) state of fertility: s = sterile; f = slightly fertile; ff = moderately fertile; fff = very fertile.

Species	<i>S. glaucescens</i>		<i>S. myriocystem</i>		<i>S. swartzii</i>		<i>S. assimile</i>	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
20-3-60	..	..	..	..	3	s	..	..
27-6-60	..	..	..	..	6	s	..	..
6-9-60	15	s	..	..	..	..	24	ff
8-10-60	15	f	..	..	..	..	24	fff
5-11-60	18	ff	..	..	..	..	..	..
21-12-60	24	ff	..	..	..	..	36	fff
28-1-61	36	ff	..	f	24	f	60	fff
3-3-61	..*	..	12*	fff	15*	f	..*	..
			Persisting					
18-5-62	6	s	9	s	6	s	..	..
10-6-62	9	s	12	s	9	s	..	..
3-7-62	12	s	12	s	9	s	..	..
1-8-62	18	s	15	s	18	f	..	..
3-9-62	24	s	15	s	18	f	..	..
1-10-62	24	s	24	s	24	f	..	..
1-11-62	24	f	24	s	24	f	..	..
30-11-62	24	ff	24	f	24	f	..	..
28-12-62	24	fff	24	f	24	f	..	..
2-2-63	18*	fff	18*	fff	12*	f	..	..
25-2-63	..†	..	12*	fff	..†	..	..	..
			Persisting					

*End of season breakage occurring.

†End of season breakage completed.

In the areas dominated by *S. glaucescens* and *S. assimile* there is an underlayer of *Cystoseira prolifera* which is exposed when the sargassum shed its branches, and this too breaks up soon after.

Chemical analysis

Sampling of the material for chemical analysis was carried out during the growth cycles of 1960/61 and 1962/63, the secondary branches being cut from the primary stem, which with the holdfast remained *in situ*. The harvested material was rinsed in fresh water, oven-dried and despatched to the Tropical Products Institute, London, where the analyses were made.

The initial samplings of March to June 1960 were made on plants little more than stubble, and the species concerned were not separated, but they were mainly *S. glaucescens* and *S. assimile* mixed. Subsequent samplings were made on these species separately. The samplings of 1962/63 were carried out on *S. glaucescens*, *S. myriocystum* and *S. swartzii* separately.

Alginic acid and mineral ash contents on a percentage basis of dry matter are shown in histogram form in Figures I and II, and the annual results averaged out over species are at Table IV. Alginic acid contents observed rank favourably with the contents of other species from elsewhere which are exploited commercially.

TABLE IV
AVERAGE ALGINIC ACID AND ASH CONTENTS OF
SARGASSUM SPP.

Species	ALGINIC ACID AS PERCENT OF DRY WEIGHT		ASH AS PERCENT OF DRY WEIGHT	
	1960-61 Sept.—Jan.	1962-63 May—Feb.	1960-61 Sept.—Jan.	1962-63 May—Feb.
<i>S. glaucescens</i> ..	23.0	25.6	26.2	23.6
<i>S. myriocystum</i> ..	..	20.9	..	30.2
<i>S. swartzii</i> ..	..	24.6	..	21.5
<i>S. assimile</i> ..	23.7	..	26.6	..

Between species, in respect of alginic acid content *S. myriocystum* at 20.9 percent is markedly inferior to *S. glaucescens* at 25.6 percent and to *S. swartzii* at 24.6 percent. It is probably also inferior to *S. assimile* at 23.7 percent recorded, however, in a different, though probably a poorer alginic acid producing year. (See below.) There appears to be little difference in alginic acid content between *S. glaucescens*, *S. swartzii* and *S. assimile*.

Mineral ash contents follow a similar, but converse pattern. These are looked at in more detail below.

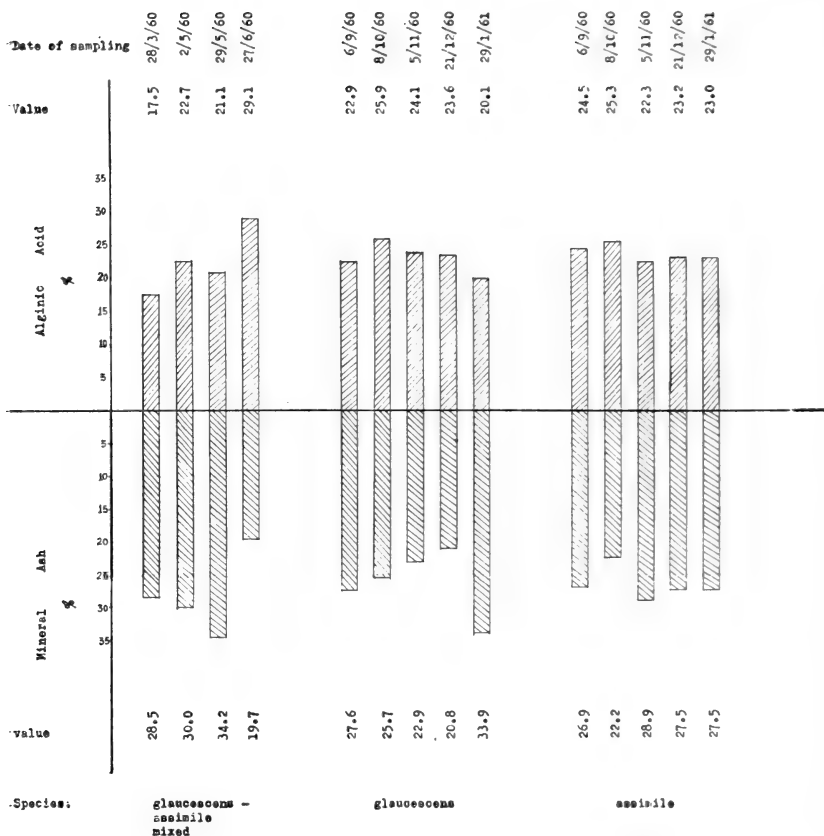


Fig. I. Alginic Acid and Mineral Ash contents of Sargassum species at Raffles Light, 1960/61 (as percentage of dry weight).

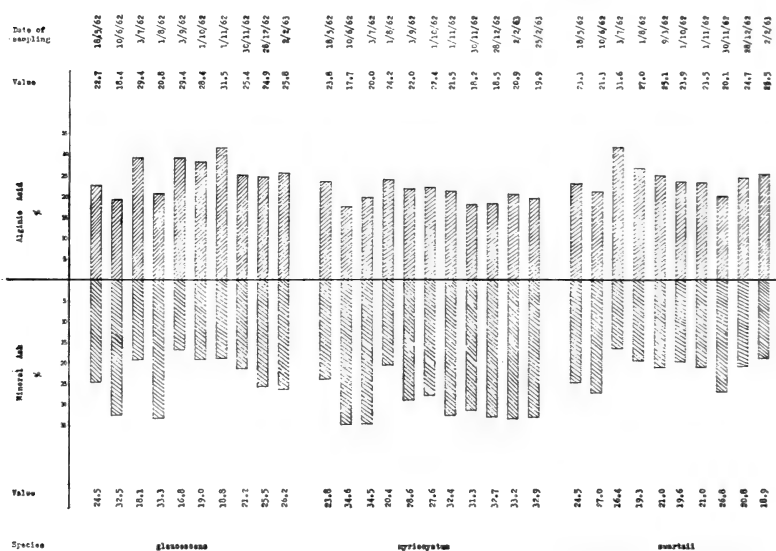
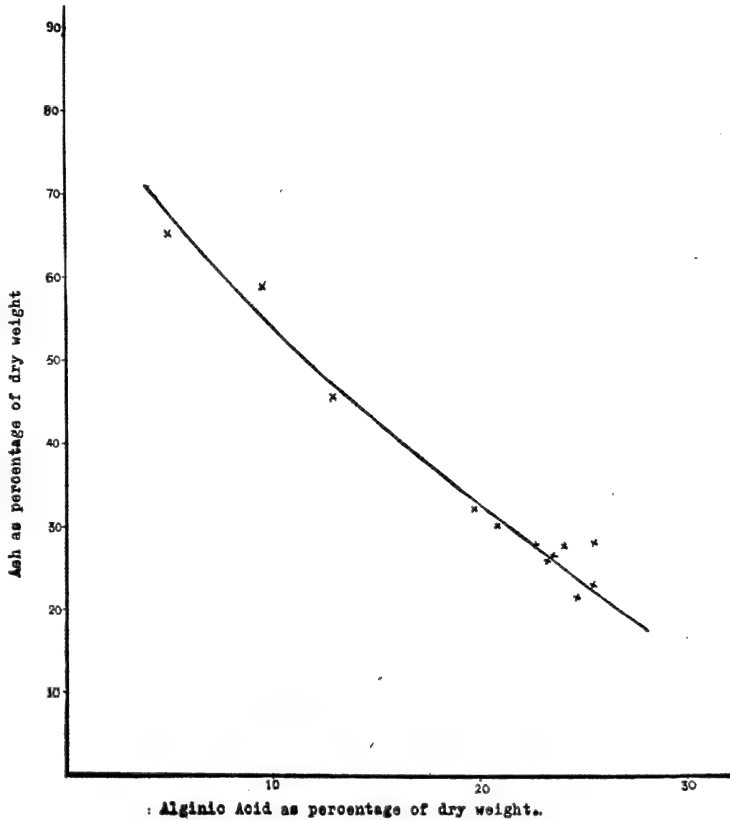


Fig. II. Alginic Acid and Mineral Ash contents of Sargassum species at Raffles Light, 1962/63 (as percentage of dry weight).

DATA.

Species	Locality	Year	Percentage dry weight	
			Ash	Alginic acid
Sargassum indet.	Raffles L.	1960	Av. 28.1	22.6
S. glaucescens	Raffles L.	1960/1	Av. 26.2	23.3
	-	1962/3	Av. 23.6	25.6
S. trybocystum	Raffles L.	1963/3	Av. 30.2	20.9
	P. Undan	1961	28.8	25.4
	P. Nangka	1961	32.3	19.7
S. swartzii	Raffles L.	1962/3	Av. 21.5	24.6
S. assimile	Raffles L.	1960/1	Av. 26.6	23.7
C. prolifera	P. Hantu	1959	59.0	9.5
	Raffles L.	1961	27.7	24.0
Turbinaria sp.	P. Hantu	1959	45.6	12.9
Fadina sp.	P. Hantu	1959	65.2	5.0

Fig. III. Relationship of Ash Content to Alginic acid content for species, localities and years



Variation between years in alginic acid content and ash content has been reported by Lunde (Chapman, 1950) in *Laminaria digitata*. Such variation is demonstrated here in respect of *S. glaucescens* which was recorded in both seasons, the 1962/3 season being better for alginic acid production, with a lower mineral ash content, than the 1960/61 season. Indeed, some annual variation in any harvested crop is a natural expectation.

Lunde for *L. digitata* and Black for *L. cloustonii* (Chapman *loc. cit.*) both recorded an annual period of peak for alginic acid content. Such a situation is not apparent in either of the two years over which the sargassum was examined. While there has been monthly variation, as is shown in Figures I and II, the variation has been irregular. Similar but converse irregularities are also shown for the mineral ash content. The causes of these abrupt changes are not understood, but that there is some relationship between the alginic acid and mineral ash contents is shown below. The irregularities however smooth out over the months and there is no apparent peak period.

TABLE V
ANALYSES OF OTHER MISCELLANEOUS COLLECTIONS

Species	Locality	Date	PERCENTAGE OF DRY WEIGHT	
			Ash	Alginic acid
Sargassum myriocystum	Pulau Undan Malacca	2-4-61	28.8	25.4
	Pulau Nangka Malacca	30-4-61	32.3	19.7
Sargassum swartzii ..	Raffles Light Singapore	28-1-61	32.8	22.9
Sargassum 'E' ..	Pulau Nangka Malacca	30-4-61	27.1	23.1
Cystoseira prolifera ..	Pulau Hantu Singapore	14-11-59	59.0	9.5
	Raffles Light Singapore	3-3-61	27.7	24.0
Padina sp. ..	Pulau Hantu Singapore	14-11-59	65.2	5.0
Turbinaria sp. ..	Pulau Hantu Singapore	14-11-59	45.6	12.9

A few other miscellaneous samples of various brown seaweeds have also been analysed, and these are recorded in Table V. The sargassum analyses are similar to those of the main part of this record. *S. myriocystum* at Pulau Undan, in the Straits of Malacca and 100 miles distant, ranks highest in alginic acid content of the observations for this species, though the record from Pulau Nangka, some four miles off from Pulau Undan, is only identical with the poorer ones from Raffles Light. Of particular interest is the record of *Cystoseira prolifera* taken at Raffles Light on 3rd March, 1961, which ranks equal in alginic acid with the best of the sargassums. This species is nowhere abundant enough to be a major element in the algal flora, and so would not contribute greatly in any exploitation, but the great disparity between the alginic acid content of this sample and of *C. prolifera* from Pulau Hantu, a Singapore inshore island, is one of many pointers to the effect of locality (perhaps salinity) that merits investigation. Black, Richardson and Walker (1959) record variation of Scottish samples of *Laminaria cloustonii* within a location and between locations of differing salinity, which is in line with our findings. Their observation on the variability between individuals is based on plants of large size, whereas our material being relatively small and slender did not lend itself to individual assessment. Variation is a reasonable expectation, but it is not possible to express an opinion whether our minimum sample of 20 plants (more often a sample contained about 30 plants) was adequate to smooth out sampling errors. Black, *et al.* required 120 plants of this very bulky material which varied in age between 4 and 10 years. Our material was all under one year old. It is a moot point how far we may draw comparisons and inferences of this sort on materials so differing in morphology, taxonomic status, and environment.

Weight of wet sargassum in relation to yield of alginic acid.

Yield per unit area has not been observed. It would anyhow vary between localities, between tide levels in the littoral and sublittoral, and between species harvested. The weight of wet sargassum to yield of alginic acid is however an important practical consideration in harvesting. Some observations on this were taken from the first one dozen samples of the 1960/61 season and are summarised in Table VI. The fresh samples were weighed wet but drip-free, i.e., when all the free surface water had drained off the sample spread on a wire mesh frame. Related material dry weights and alginic acid percentages on a dry weight basis gave data for a calculation of alginic acid on a wet weight basis.

The sargassum at harvesting contained between 8.4 and 11.6 per cent of dry matter and between 1.9 and 2.6 per cent of alginic acid. There is a suggestion that as the plant grows from 'stubble' to maturity there is a decline in dry weight percentage.

TABLE VI

YIELD OF DRY MATTER AND ALGINIC ACID IN RELATION TO SARGASSUM WET WEIGHTS AT SAMPLING

Sargassum Species	Date	Dry matter as % of wet weight	Alginic acid as % of wet weight
Mixed (mainly <i>S. glaucescens</i> and <i>S. assimile</i>)	28-3-60	11.2	2.0
	2-5-60	11.5	2.6
	29-5-60	10.3	2.2
	27-6-60	8.3	2.4
<i>S. glaucescens</i>	6-9-60	8.7	2.0
	8-10-60	10.1	2.6
	5-11-60	9.2	2.2
	21-12-60	8.8	2.1
<i>S. assimile</i>	6-9-60	10.6	2.6
	8-10-60	9.8	2.5
	5-11-60	9.3	2.1
	21-12-60	8.4	1.9

Relationship between alginic acid content and ash content

Our records very plainly show a strong negative correlation between alginic acid and ash contents: when the alginic acid content is high the ash content is low, and *vice versa*. Monthly variations also show this, but what is also noteworthy is that different genera fall into this pattern. If the values for alginic acid and ash content contained in Figures I and II and Tables IV and V are averaged for species and localities and the averages are plotted against one another, a near straight line regression is obtained, as is shown in Figure III, for ash contents between 20 and 65 per cent and for alginic acid contents between 5 and 27 per cent. We can offer no explanation for the significance of this fact, but it is one calling for further investigation. It may be that this is a mechanism, as Black, et al. (loc. cit.) suggest for a similar relationship between mannitol and ash in *L. cloustonii* for the maintenance of a constant osmotic pressure within the plant.

Possibilities of exploitation

Any plans for possible utilisation must be based on a sound policy of conservation which permits regeneration. Many aspects other than the taxonomic need to be studied, such as the ecology and autecology, and more especially the phenology of the species

to be harvested is all-important. The findings presented in this paper are but an introduction to a large field awaiting investigation before any exploitation is attempted. Inferences however may be drawn in respect of the species harvested at Raffles Light. The information in Table II indicates the need to limit harvesting of *S. glaucescens*, *S. swartzii* and *S. assimile* to between November and January when the plants attain a state of full maturity. Since the alginic acid content analyses give no apparent optimum over the growth cycle, this may be the only criterion. However since periodicity between localities varies, each locality will need a separate assessment. Any harvesting of *S. myriocystum* at Raffles Light would have to be deferred till February on account of later maturing.

Acknowledgements

We gratefully acknowledge the help of the following persons: Dr. George Papenfuss, University of California for determination of the four sargassa comprising the main part of the alginic acid investigation: Captain J. A. L. Pavitt, O.B.E., Master-Attendant, Singapore, for facilities at Raffles Lighthouse; succeeding Professors of Zoology, University of Singapore for the use of the marine laboratory at Raffles Lighthouse; Che Kadim bin Tassim, Plant Collector, Singapore Botanic Gardens, who undertook much of the sampling in 1962; and Mr. T. P. A. Mellon, Scientific Assistant, Tropical Products Institute, for help with the analyses. We also record receiving helpful comment from Mr. E. Booth of the Scottish Seaweed Institute on this paper while in preparation.

References

- BLACK, W. A. P., W. D. RICHARDSON & F. T. WALKER: 1959. Chemical and growth gradients of *Laminaria cloustonii* Edm. (*L. hyperborea* Fosl.). *Econ. Proc. Roy. Dublin Soc.* 4(8).
- BURKILL, I. H.: 1935. *A Dictionary of the Economic Products of the Malay Peninsula*. Oxford University Press.
- CHAPMAN, V. J.: 1950. *Seaweeds and their Uses*. Methuen & Co. Ltd. London.
- GRUNOW, A.: 1915-16. *Verhandl. Zool. Bot. Gesellschaft, Wien*, 65 and 66.
- HOPPE, H. A. and O. J. SCHMIDT: 1962. Meeresalgen als moderne Industrieprodukte *Botanica Marina* 3, Supplement.
- H. M. S. O.: 1962. *Tide Tables for Malaya, North Borneo and Sarawak*, 1963.
- NEWTON, L.: 1951. *Seaweed Utilisation*. Sampson Low, London.
- PURCHON, R.D. and I. ENOCH 1954. Zonation of the Marine Fauna and Flora on a rocky shore near Singapore. *Bull, Raffles Mus. Sing.* 25, 47-65.
- ZANEVELD, J. S.: 1959. The utilisation of marine algae in tropical S and SE Asia. *Econ. Bot.* 13, 89.

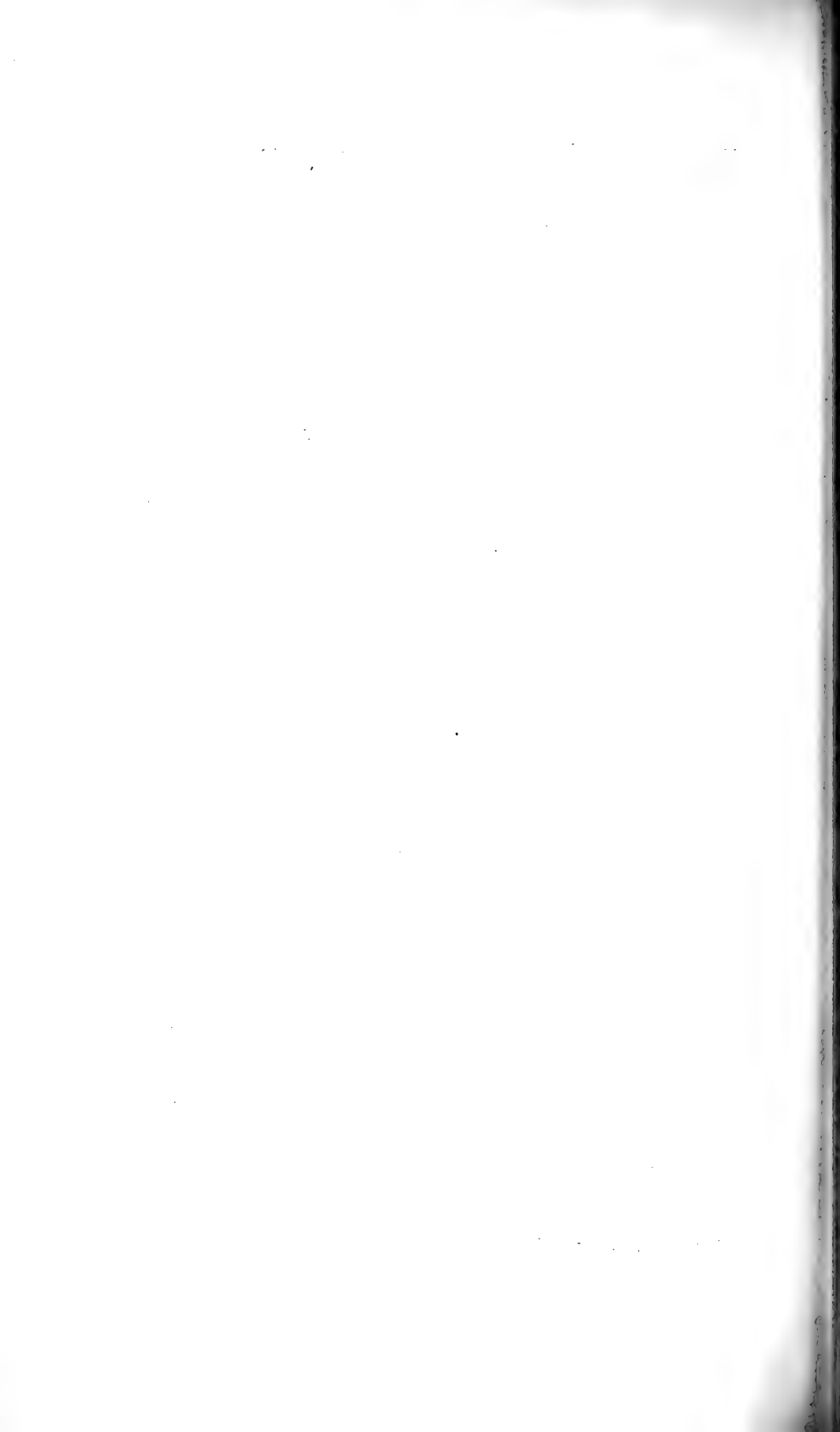




Plate I. Drift of *Gracilaria* spp. at Pasir Ris, Singapore, December 1964, on the East Johore Straits, and in close proximity to Teluk Paku, Pulau Tekong and Johore River — see Table I.

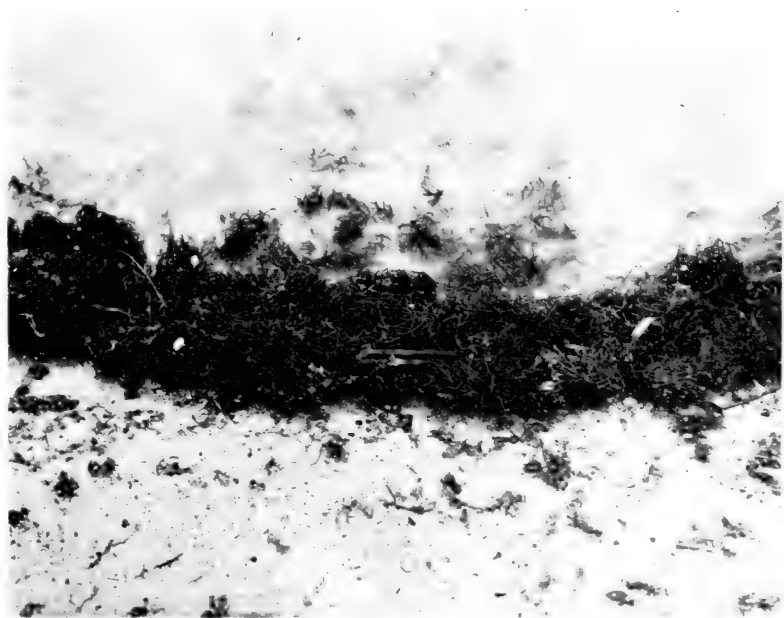


Plate II. Drift of *Gracilaria* spp. at Pasir Ris, December 1964.



Plate III. Sargassum stubble at Raffles Light, April 1963.



Plate IV. Sargassum in young growth at Raffles Light, June 1963. Reef at low water.



Plate V. Sargassum in young growth at Raffles Light, June 1963.



Plate VI. Sargassum at mature growth at Raffles Light, December 1960.

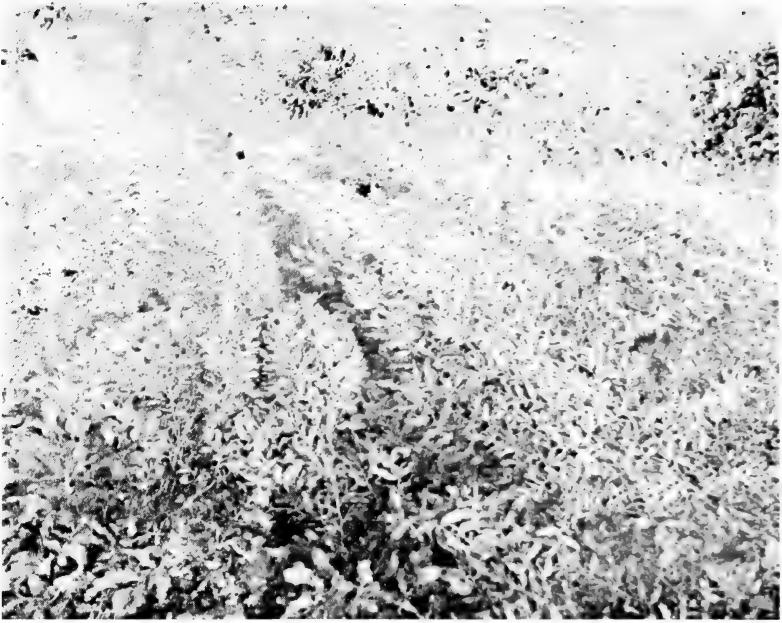


Plate VII. Mature growth of mixed *S. myricoystum* J.G. Ag. and *S. glauccscens* J.G. Ag. at Raffles Light, December 1960.

New Species of Dipterocarpaceae, Sterculiaceae and Monimiaceae, and a re-interpretation of *Tetranthera rumphii* Bl.

by

A. J. G. H. KOSTERMANS

Herbarium Bogoriense

DIPTEROCARPACEAE

Hopea celtidifolia Kosterm., spec. nov.

Arbor ramulis minutissime dense adpresse stellato pilosis, foliis chartaceis vel rigide chartaceis glabris ovato-ellipticis acuminatis basi in petiolem gracilem contractis supra nitida laevia nervo mediano prominulis costis vix prominulis subtus sublaevia nervo mediano prominentibus nervis lateralis inferiore parte erecto-patentibus superiore parte subito verticalibus totis nervum basalem costae parallelum quasi nervaturam palmatum aemulantibus nux elongato ovoideus acutis alae majoribus oblanceolatis obtusis basim versus sensim attenuatis glabris alae minoribus elongato ovatis acutis.

Typus: Versteegh BW 4854 (L).

Tree, up to 28 m high, free bole 24 m, diam. 43 cm; buttresses up to 2 m high, out 1 m; bark brown, not fissured, rather strongly peeling; living bark brown or lightbrown; sapwood yellow or yellowish brown; heartwood yellowish brown or yellow. Branches smooth, glabrous; branchlets slender, densely, minutely adpressed stellate pilose. Leaves chartaceous to thickly chartaceous, glabrous, ovate-elliptic, 2.5 × 6 — 4 × 10 cm, abruptly acuminate, acumen obtuse, up to 5 mm long, base contracted into the slender, up to 1 cm long, above slightly, narrowly canaliculate petiole; upper surface smooth, midrib prominulous, ribs faint, prominulous; lower surface rather smooth, midrib prominent, lateral nerves ca 5 pairs, slender, erect-patent, rather straight, at about halfway the margin abruptly perpendicular and anastomosing with the former and next one, forming two pseudo-basal nerves, that reach up to the leaf tip, at the outside some more arcuate, faint nerves; secondary nerves dense, parallel, faint. Inflorescence unknown. Nut glabrous, elongate-ovoid, acute, up to 1 cm long. The two longest wings oblanceolate, glabrous, obtuse, up to 4 cm long, the widest part 1 cm, 7-9 ribbed, reticulate, gradually narrowed at base; the short wings half, respectively $\frac{2}{3}$ the nut length, acute.

W. IRIAN: S.E. part, E. Digul, Iwur R., alt. 400 m, Agathis forest on clayey soil, ster., BW 8533 (L); along Digul R. near Wage, alt 15 m, Nov., fr., Versteegh BW 4854 (L); Muju Distr., Opka, 10 km N.E. of Ninati, alt. 50 m, BW 6441 (L); 5 km N. of Ninati, alt. 50 m, ster., BW 6430 (L).

STERCULIACEAE

Scaphium burkillfilii Kosterm., spec. nov.

Arbor magna ramulis crassis glabris lenticellatis foliis alternantibus glabris coriaceis ellipticis acuminatis basi rotundatis supra nitida laevia nerviis primariis gracilibus prominulis subtus opaca dense prominule reticulata nervo mediano prominentibus costis prominentibus basalibus 2 vel 4, majoribus strictis usque ad $\frac{2}{3}$ foliorum lamina adscendentibus, minoribus arcuatis submarginalis costis caeteribus utrinque 3-4 suberectis curvatis marginem versus arcuatim evanescentibus; petiolis perlongis glabris; infructescentiis magnis vix ramosis perdense minutissime stellato pilosis fructus coriaceis Scaphiformibus acutis extus laxe minutissime stellato pilosis, intus pernitidis griseis glabrescentibus semen globosum magnum.

Typus: Ilias Paie S 15575 (SING).

Large tree, 50 cm in diam.; branchlets cylindrical, stout, glabrous, glossy, grey, with tiny lenticels. Leaves spirally arranged, coriaceous, glabrous, elliptical, 11 × 24 — 12 × 37 cm, apex shortly acuminate, base rounded; upper surface glossy, smooth, main nerves filiformous, prominulous; lower surface dull, densely, prominulously reticulate, midrib prominent, basal nerves prominent, 2 pairs, the lower pair almost marginal, reaching $\frac{1}{5}$ the blade length, the inner ones straight, reaching $\frac{2}{3}$ of the leaf length; lateral nerves 3-4 pairs, towards margin running out arcuately. Petiole 16-21 cm long, glabrous, thickened at both ends, glabrous.

Infructescence hardly branched, up to 25 cm long, densely, minutely rusty stellate pilose; fruit boat-shaped, acute, up to 7 cm long and (opened) 2 cm wide, leathery; outside sparsely, minutely stellate hairy, inside glossy, grey, glabrescent; seed globose, 3 cm diam.; seedcoat 4 mm thick; peduncle thick, densely pilose, 5-7 mm l.

Outstanding by its leafshape, the thick, leathery capsules and the enormous thick-walled seed. As the tree was collected in a swampy area, one is tempted to ascribe the leathery fruit and the thick-walled seed to the conditions of water dispersal, as opposed to the other species of *Scaphium* where the paperthin capsules and light seed are wind dispersed.

The species is named after Mr. Humphrey M. Burkill, Director of the Botanic Garden, Singapore, under whose directorship the library and herbarium facilities have been greatly extended and improved and whose valuable cooperation to help the Herbarium Bogoriense in the difficult period of 1957 - 1967 is herewith gratefully acknowledged.

SARAWAK: Bintulu Distr., Segan For. Res., swamp forest; fruit chocolate coloured, Nov., fr., Ilias Paie S 15575 (SING) (also distributed to K, L, SAN).

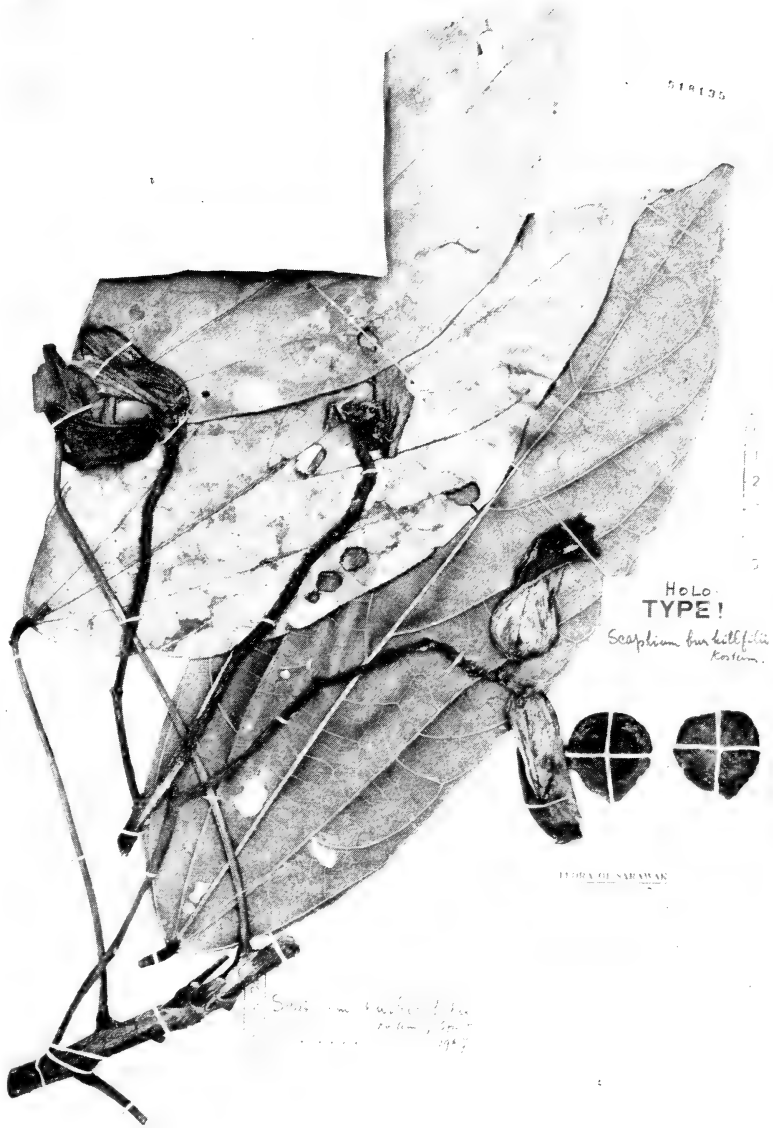
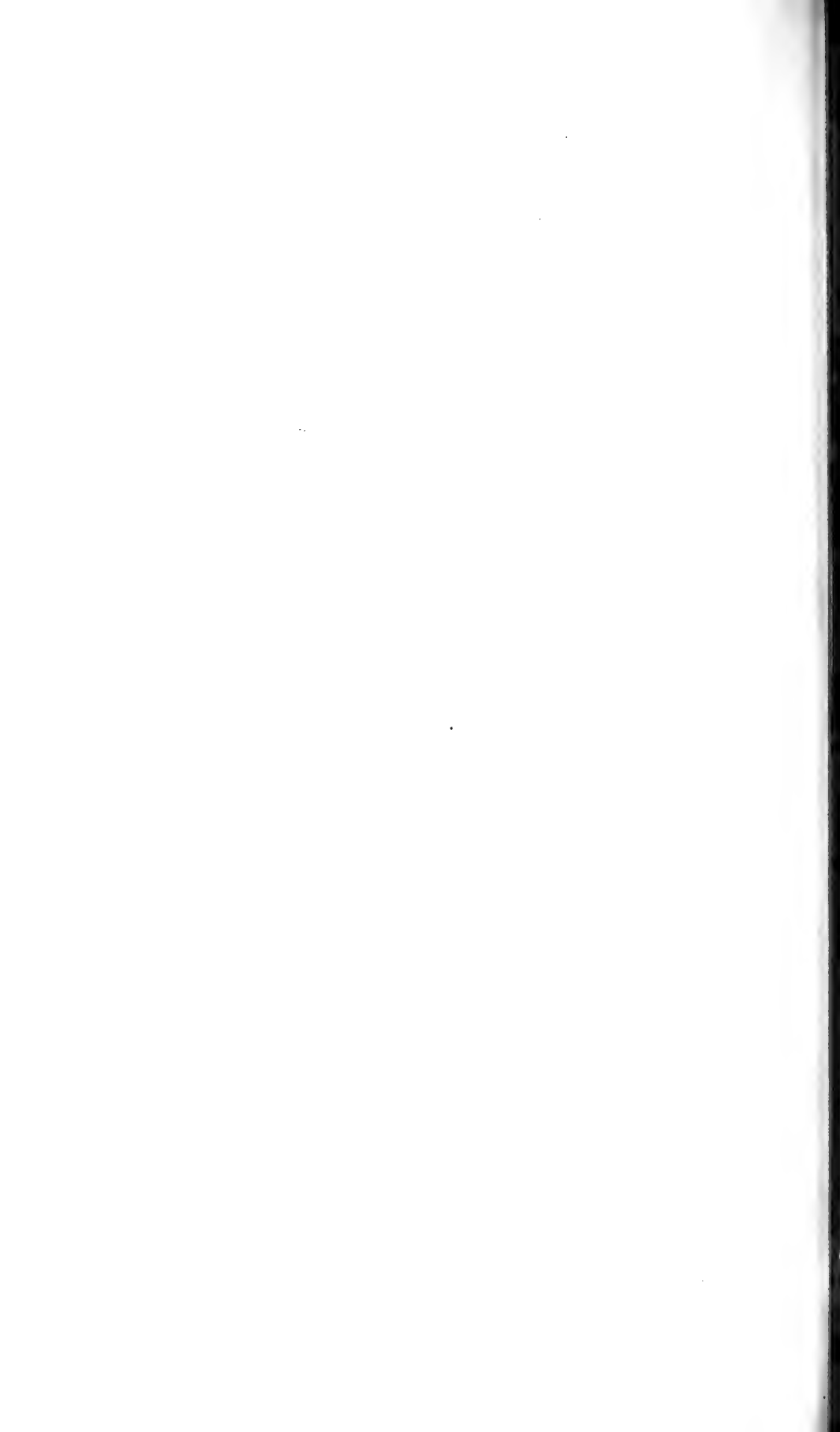


Plate I. Holo-type sheet of *Scaphium burkillfilii* Kosterm. deposited in the Singapore Herbarium, Accession No. 518135.



MONIMIACEAE

***Steganthera suberoso-alata* Kosterm., spec. nov.**

Arbor parva vel mediocris ramis suberoso-alatis griseo albis ramulis minutissime laxe adpresse pilosis vel sublanuginosis foliis chartaceis ellipticis vel ovato-ellipticis obscure longe acuminatis basi rotundatis supra glabra nervo mediano prominulo costis filiformibus subimpressis subtus pallidiora sparse minutissime (sub lente) sublanuginosa vel adpresso pilosis nervo mediano prominentibus costis utrinque 7–8 prominentibus arcuatis marginem versus arcuatim conjunctis rete laxe prominule petiolis incrassatis brevis dense minutissime adpresse pilosis vel sublanuginosis. Inflorescentiis rami vel caulifloris aggregatis dense minutissime griseo sublanuginosis alabastris semi-globosis adpresse pilosis pedicellis longis gracilis.

Typus: Hunt 2513 (K).

Tree or shrublike tree, 5–15 m high; branches with conspicuous grey-white corky wings. Branchlets minutely, rather sparsely (denser towards apex) sublanuginose or adpressed pilose. Leaves chartaceis, elliptical or ovate-elliptical, 4×18 — 8×27 cm, gradually acuminate, base rounded; upper surface glabrous, midrib prominulous, ribs and secondary veins slightly impressed, lower surface paler with sparse adpressed or subadpressed, tiny hairs (denser on nerves), midrib prominent, lateral nerves 7–8 pairs, prominent, arcuate, near the margin arcuately anastomosing; reticulation lax, prominulous. Petioles swollen, densely, minutely sublanuginose, up to 5 (– 8) mm long. Inflorescences on old wood on accrescences or on the branches, fasciculate, up to 6 cm long, minutely, grey sublanuginose; flower buds semiglobose, sparsely, minutely adpressed pilose.

The species is characterized by the corky wings. There is a slight discrepancy in the tomentum, the type specimen has bent hairs (sublanuginose), in the other specimens the hairs on the branchlets and leaves are straight and adpressed. Vernac. name: *U-uni-alakau*.

SOLOMON ISLANDS: Kolombangara, alt. 800 m, open rain-forest with much moss, Sept., buds, Hunt 2513 (K); Guadalcanal, E. slopes of Mt. Gallego, July, fr., Dennis 2142 (K), tree 10 m, carpel ellipsoid, smooth, 9×13 mm, stalk 3×3 mm. like the receptacle minutely, adpressed pilose; *ibid.*, Popomanasiu, Vunvulukama, alt. 1500 m, Oct., fr., Corner 151; fr. with yellow-ochre carpel stalks and receptacle; E. San Cristobal, 8–11 miles inland, alt. 500 m, Warahito R., July, fr., Whitmore 6229 (K), peduncles swollen, bright orange, receptacle 3 cm diam.; Santa Ysabel, Cockatoo Anchorage, forest on ultrabasic rock near sea, Sept., fl., Hunt 2617 (K).

MYRISTICACEAE

Myristica rumphii (Bl.) Kosterm., comb. nov.

Tetranthera rumphii Blume (basionym), Mus. bot. Lugd. bat. 1 (24): 382. 1851; cf. Kostermans, Bibl. Laur. 1424 no 203. 1964; typus: sine coll., Moluccas (L); syn.: *Litsea rumphii* (Bl.) Vill.; cf. Kostermans, l.c. 874 no 402.

The species is most likely conspecific with *Myristica hollrungii* Warb.

On some species of *Euglena* Ehr. from Singapore (De Species *Euglenae* Ehr. ex Singapore.)

by

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Botanical Institute of Sao Paulo, Brazil

Abstract

Six forms of *Euglena* Ehr., collected by the author in the Lake of the Botanic Gardens in 1962, are described. They are (1) *E. downiae* sp. nov., named in honour of Mrs. V. V. Down a British resident of Singapore and an old friend of the author's family, (2) *E. prowsei* sp. nov., named in honour of Dr. G. A. Prowse, Director of the Freshwater Fish Culture Research Institute, Malacca, (3) *E. proxima* Dang., var. *tropica*, var. nov., (4) *E. clara* Skuja var. *singaporensis* var. nov., and (5) *E. variabilis* Klebs.

On 25th July 1962 the author arrived in Singapore on a journey from China to Brazil, and, thanks to the kindness of Mrs. V.V. Down, he was enabled to visit the Singapore Botanic Gardens and her own private garden where material was collected for his future studies. Samples of water plants and pond mud were taken for cultivation of algae by addition of pepton at the Cryptogamic Laboratory of the Botanic Institute, Sao Paulo, Brazil. The culture was found to contain the material described below.

The holotype of *Euglena downiae*, *E. prowsei*, *E. proxima* var. *tropica*, and *E. clara* var. *singaporensis* are preserved at the Cryptogamic Laboratory of the Botanical Institute of Sao Paulo, Brazil (S.P.).

1. *Euglena downiae* sp. nov. Plate I, figs. 1-4.

Differt a *Euglena proxima* Dang. (vide Popova, 1955, p. 143, figs. 50, 1-3) periplasto non striato, granulis paramylaceis, non annulatis, ecoloratis, flagellis, fere $\frac{1}{2}$ - $\frac{2}{3}$ cellulae aequilongis.

Cellula fusiformis, metabolica, anteriore plus minusve attenuata oblique obtusa, posteriore recta vel obliqua, breviter acuta, 18-30-47-55-63 \times 12-15-25 μ . *Periplastus* non striatus. *Flagellum* breve $\frac{1}{2}$ cellulae usque aequilongum. *Stigma* rubrum oblongum. *Gula* elongata vel ovalis. *Nucleus* medianus, vel supra vel infra medium situs. *Chromatophora* disciforma numerosa vel nulla. *Granula* paramylacea ovalia vel bacilliformia, non annulata.

Habitat: Singapore, Horto Botanico, in lacu, legit B. Skvortzov, July 1962 — S.P.

Dedicavi in honorem Dominae V.V. Down, Singapore.

Cell fusiform, metabolic, 18-63 \times 12-25 μ ; anteriorly more or less narrowed, obliquely obtuse, posteriorly straight or oblique, shortly acute. *Periplast* non striate. *Flagellum* small up to half the

length of the cell. *Stigma* red, oblong. *Gullet* elongate or oval. *Nucleus* situated in the middle or above or below the middle. *Chromatophores* absent, or when present many, disc-shaped. *Granules* paramylaceous, oval or bacillus-shaped, not annulated.

Differs from *E. proxima* (vide Popova, 1955 p. 143, figs. 50, 1-3) in the periplast being non-striate, granules paramylaceous not coloured and not annulated, flagella nearly half or $\frac{2}{3}$ the length of the cell.

I have dedicated this species to Mrs. V. V. Down, Singapore.

2. *Euglena prowsei* sp. nov. Plate I, fig. 5.

Differt a *E. minuta* Prescott et *E. vivida* Playfair cellulis sine pyrenoidibus.

Cellula late fusiformis utrinque apiculatis, plus minusve attenuatis. *Flagellum* cellulae longius. *Stigma* oblongum, rubrum. *Chromatophorum* laminatum viride sine pyrenoidibus. *Granulis* paramylaceis numerosis ovoideis, utrinque chromatophoris. *Nucleus* magnus posterior.

Habitat: Singapore, Horto Botanico, in lacu cum plantis aquaticis, legit B. Skvortzov, August 1962 — S. P.

Dedicavi haec speciem ad Dom. Dr. G. A. Prowse, Director of Tropical Fish Culture Research Institute, Batu Berendam, Malacca.

Cells broadly fusiform, apiculate at both ends, more or less narrowed. *Flagellum* longer than the cell. *Stigma* red, oblong, anterior. *Chromatophore* laminated, green without pyrenoids. *Granules* paramylaceous, numerous, ovoid coloured on both sides. *Nucleus* large, posterior.

Differs from *E. minuta* and *E. vivida* in the absence of pyrenoids in the cells.

3. *Euglena proxima* Dang. var. *tropica* var. nov. Plate I, fig. 6.

Differt a *E. proxima* Dang. (vide Popova, 1955, p. 143, fig. 50, 1-3) granulis haematochrome in parte posteriore cellulae instructis.

Cellula late fusiformis, 25-35 × 20-22 μ . *Periplasto* non striato. *Stigma* ovale. *Chromatophorum* disciforme sine pyrenoidibus. *Granulis* paramylaceis, annulatis; eis haematochromis numerosis parte posteriore cellulae. *Nucleus* posterior. *Flagellum* cellula longius.

Habitat: Singapore, Horto Botanico, in lacu, legit B. Skvortzov, July 1962 — S.P.

Cells broadly fusiform, 25-35 × 20-22 μ . *Periplast* non striate. *Stigma* oval. *Chromatophores* disc-shaped, without any pyrenoids. *Granules* paramylaceous, annulated; haematochromes numerous in the posterior. *Nucleus* posterior. *Flagellum* longer than the cell.

Differs from *E. proxima* Dang. (Vide Popova, 1955, p. 143, figs. 50, 1-3) in the presence of haematochromic granules in the posterior of the cell.

4. ***Euglena clara*** Skuja in Popova (1955), Plate I, figs. 7–8.

Cells metabolic, fusiform, anteriorly shortly attenuate, obliquely rounded at apex, posteriorly gradually attenuate, acute or obtuse, 25–37–40 × 10–20 μ . *Chromatophores* in oblong plates with sheathed pyrenoids. Paramylaceous granules bacilliform. Haematochrome granules numerous in the middle of cell. *Flagellum* $\frac{2}{3}$ of the cell-length. *Eyespot* oblong, red. *Gullet* oblong, nucleus distinct.

Differs from the type form in having hyaline periplast and haematochromic granules.

Habitat: Singapore, Botanic Gardens, in a pond collected by B. Skvortzov, July 1962. Reported from Europe.

5. ***Euglena clara*** Skuja var. ***singaporensis*** var. nov. Plate I, fig. 9.

Differt a *E. clara* var. *clara* granulis paramylaceis majoribus, ellipsoides.

Cellula ca. 30 μ longa. *Granula* paramylacea eis var. *clarae* majora, ellipsoidea.

Cells about 30 μ long. Paramylaceous granules ellipsoidal, longer than those in the type form.

Habitat: Singapore, Botanic Gardens, in pond collected with the type form by B. Skvortzov, July 1962. Type in Herb. S.P.

6. ***Euglena variabilis*** Klebs in Popova, 1955. Plate I, fig. 10–12.

Cells ovoid or short ellipsoid, rarely fusiform, 25–35 × 7.20 μ . *Periplast* not seriated. *Flagellum* about cell length. *Eyespot* red, large, oblong. *Chromatophores* in large, roundish or oval plates without pyrenoids. Paramylaceous granules small, oval, numerous.

Habitat: Singapore, Botanic Gardens, in a pond, collected by B. Skvortzov, July 1962, together with *E. clara*. Reported from Europe, central and eastern parts of Asia.

Acknowledgements

The writer acknowledges the help of Mrs. V. V. Down and the Singapore Immigration authorities in granting a four-hour landing pass, and wishes to express his gratitude to the Director of the Botanical Institute of Sao Paulo, Brazil, the leaders of the Cryptogamic Section, Dr. Oswaldo Fidalgo, Dr. Joao Salvador Furtado and Dr. Carlos Eduardo de Mattos Bicula and the Secretary of the Institute Marlene Ocana Orlando for facilities for the conduct of this and the author's other algological research work. He also acknowledges the help of Dr. C. X. Furtado of the Botanic Gardens, Singapore in the preparation of the Latin diagnoses, and of the Director, Mr. H. M. Burkill, for publishing this note in *The Gardens' Bulletin, Singapore*.

References

- PRINGSHEIM, E. G.: Contribution towards a Monograph of the Genus *Euglena*, Leipzig. 1956.
 GOJDICS, M.: Genus *Euglena*. Madison. 1953.
 POPOVA, T. G.: Euglenophyta. Mosqua. 1955.
 HUBER-PESTALOZZI, G.: Euglenophyceen. Stuttgart. 1955.

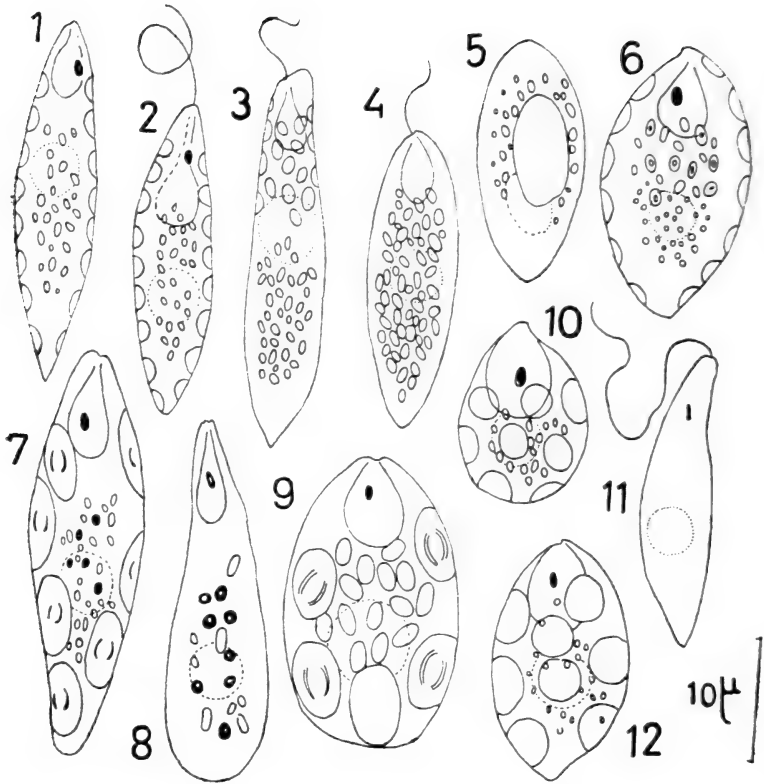


Plate I. Fig. 1-4, *E. downiae*; Fig. 5, *E. prowsei*; Fig. 6, *E. proxima* var. *tropica*; Fig. 7-8, *E. clara*; Fig. 9, *E. clara* var. *Singaporensis*; Fig. 10-12, *E. variabilis*.

On a new species of the genus *Collodictyon* Carter, a colourless flagellata new to the Hongkong flora.

(De specie et genere *Collodictyon* Carter nova ad
flora Hongkongensis.)

by

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Abstract

While the author was travelling from China to Brasil in 1962 via Hongkong, he visited The Peak, a mountain near the city, and collected samples of mosses. These were cultivated with the addition of pepton for flagellata at the Cryptogamic Laboratory of the Botanical Institute, Sao Paulo. Amongst the numerous aerial diatoms present in the culture a large colourless flagellate was found which was feeding on both the diatoms and green algae. This flagellate belongs to the genus *Collodictyon* proposed by Carter many years ago from India. During the past 20 years it has been found in many parts of Europe. The Hongkong specimens are here described as *Collodictyon hongkongense* sp. nov.

The genus *Collodictyon* was referred by A. Pascher and E. Lemmermann (1914) to the family Tetramitaceae, order Protomastiginae. Pascher in 1927 transferred it to the colourless Volvocales. In the latest revision, made by Russian algologists of Charkov University (Dedusenko-Shtegoleva, *et al.*, 1959), *Collodictyon* is placed near to the colourless genera *Polytomella* Aragao and *Cyromitus* Skuja of fam. Polystomellaceae (Aragao) Volvocales.

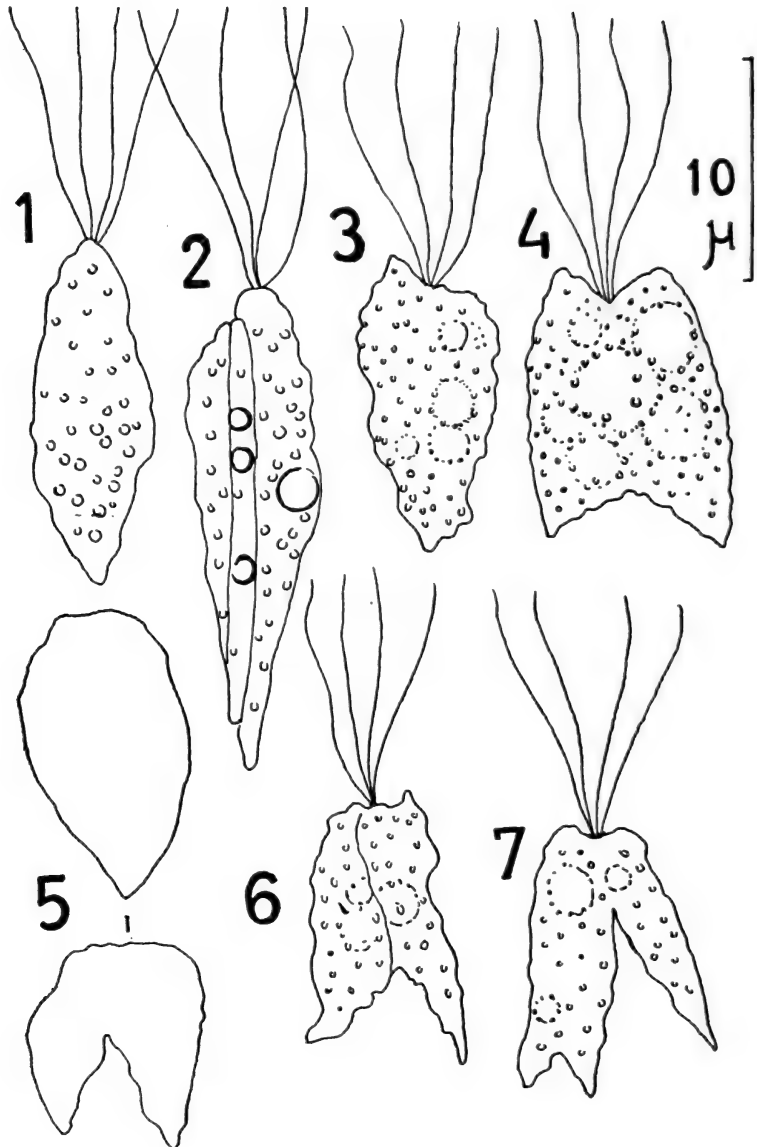
Studying the description of the genus *Collodictyon* in different books, the present author has come to the conclusion that the descriptions were made from different species which seem to be from different genera. For instance, in the description of 1914 (Pascher & Lemmermann) the cells of *Collodictyon* are stated to be strongly metabolic; in the revision of 1959 (Dedusenko-Shtegoleva *et al.*), it is written that the cells have a distinct periplast.

The Hongkong specimens are not similar to *Collodictyon triciliatum* Carter as given by Pascher and Lemmermann.

Collodictyon hongkongense sp. nov. Figs. 1-7.

Differt a *C. triciliato* membranis non metabolicis, vacuolis contractilibus nullis vel indistinctis, nucleo indistincto, forma monadis diversa, posteriore acuta vel bifurcata.

Cellula solitaria, libere natans, vix vel non metabolica, holozoice nutrita, applanata, ambitu variabilis ovata, oblonga vel fere fusiformis, aut triangularis, 10-15-18-26, 37-40 μ longa; anteriore acuta, truncato-rotundata, plerumque depressa, cum nucleo indistincto, supra medium sito posteriore utrinsecus angustata, apice



Collodictyon hongkongense.

acuta or caudata, oblique truncata vel bilobata; ventre carinis 2 paulo altis longitudinaliter praedita; dorso fere applanata. *Periplastus* nullus vel tenuissimus, superficie rugosus, nunquam laevis; cytoplasma hyalinum, vacuolis multis cum granulis olei leicosinique copiosis instructa; vacuolis contractilibus non visis. *Pseudopodia* posteriora tantum visa, vix metabolica, simplicia, extensibilia. *Flagella* 4, tenuissima, vix visibilia, aequalia, monade aequilonga vel eo paulo longiora. *Proles* divisione cellulae motae longitudinali aucta.

Habitat: Hongkong, in monte "The Peak" dicto, inter muscos rupestres, legit Skvortzov. 15-VIII-1962; holotypus ex speciminibus in Lab. Crypt., Sancto Paulo, Brazil, cultis, et ibidem asservatus est.

Differs from *C. triciliato* in the cells being of different shape and non-metabolic and contractile vacuoles being absent or indistinct, indistinct nucleus and acute or bifurcate posterior end.

Cells solitary, free swimming, hardly or non-metabolic, holozoi-cally nourished, flattened, varying in shape from ovate, oblong or almost fusiform or triangular, 10-40 μ long; *anteriorly* acute, truncately rounded, often depressed, with an indistinct nucleus seated above the middle, contractile vacuoles not seen; *posteriorly* narrowed on both sides, acute or caudate at apex or obliquely truncate or bilobed; ventrally provided with little raised ridges; dorsally more or less flattened. *Periplast* absent or very slender with its surface rugose, never smooth; plasma transparent, having many vacuoles abounding in oil and leicosin granules; contractile vacuoles not seen. *Pseudopodia* seen only in the posterior, hardly metabolic, simple, extensible (?). *Flagella* 4, very slender, hardly visible, equal, as long as the cell or slightly longer. *Offspring* produced by longitudinal division of free moving cells. *Locomotion* is by creeping or rotation, and is not rapid. *Feeding* holozoic, diatom fustules, or more rarely cells of Chlorophyta adhering to the periplast are covered over.

Habitat: The Peak, Hongkong, in mosses growing in rocks, collected by B. Skvortzov, 15 August 1962; holotype cultivated from this material at the Cryptogamic Laboratory of the Instituto de Botanica, Sao Paulo, Brasil and deposited there.

Acknowledgements

The author expresses his gratitude to the Director of the Botanical Institute, Sao Paulo, Dr. Alcides Ribeiro Teixeira and to the leaders of the Cryptogamic Section, Dr. Oswaldo Fidalgo, Dr. Joao Salvador Furtado, and Dr. Carlos Eduardo de Mattos Bicudo, and to the secretary Marlene Ocana Orlando for facilities for the conduct of this and his other algological research work, and for the assistance of Dr. C. X. Furtado of the Botanic Gardens, Singapore, in the preparation of the Latin diagnosis.

Literature

- FRITSCH, F. E.: The structure and reproduction of the algae, Vol. I. Cambridge. 1935.
- DEDUSENKO-SHTEGOLEVA, N. T., MATVIENKO, A. M. and SCHKORBATEV, L. A.: Chlorophyta; Volvocineae. Mosqua, 1959.
- PASCHER, A. und LEMMERMANN, E.: Flagellata I in Die Susswasserflora Deut., Oster. und der Schwiez. Heft. 1914. Jena.
- PASCHER, A.: Volvocales-Phytomonadinae. Flagellatae IV. Chlorophyceae I. Heft 4. 1927. Jena.

New genera of primitive green flagellata from Hongkong and Sao Paulo, Brazil.

by

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Abstract

Three new genera of primitive green flagellata are described: **Protochroomonas**, **Angulomonas** and **Protoaceromonas**, belonging to Fam. Pyramydomonadaceae Pascher, Ord. Polyblepharidales and Class Volvocineae. One new species of the first named genus, two new species of the second and three new species of the last-named genus are described and illustrated together with a key to the genera.

Materials

The collecting localities (and the abbreviations used in this paper) of the material studied and the dates of collection were:

Habitat I (Hab. I): São Paulo, Brazil, Parque do Estado, in temperate swamp; col. B. Skvortzov. 20 May 1966.

Habitat II (Hab. II): *Ibid*, on surface of the soil with a growth of *Oscillatoria*; col. B. Skvortzov. 2 May 1966.

Habitat III (Hab. III): *Ibid*, on surface of soil with polluted spring water; col. B. Skvortzov. 17 May 1966.

Habitat IV (Hab. IV): Aberdeen, Hongkong, in a rivulet; col. S.T. Chan, 16 March 1966.

Key to genera

- I. Cell naked, with a spinulose or rugose periplast; flagella 2, connate; cells of varying shapes

Genus 1: **Protoaceromonas**

- I. Cell naked, periplast with spines or wrinkles 2a. Flagella 2, connate; cells triangular or ellipsoid in front view but much depressed, short lanceolate, trapezoid or reniform in lateral view.

Genus 2: **Angulomonas**

- 2b. Flagella 2, very remote from one another never connate.

Genus 3: **Protochroomonas**

Description of genera and species

- I. **Protoaceromonas** gen. nov.

Monades solitariae, libere natantes, vix vel paulo applanatae, metabolicae. Periplastus tenuissimus vel nullus, rugosus vel minute spinosus, luteolus vel hyalinus, stigma vel vacuolam contractilem includens. Flagella 2, connata, fere $1\frac{1}{2}$ cellulis longiora, similia natantia; chromatophora parietalia ut videtur, viridia, insignia cum pyrenoidibus nudis; motu rotanti, rapidissimo.

Differt ab *Angulomonas* gen. nov. periplasto rugose vel spinuloso et a *Protochroomonas* gen. nov. flagellis connatis.

Typus generis: *Protoaceromonas spinosa* sp. nov.

Cells solitary, freely swimming, hardly or little flattened, metabolic. Periplast slender or none, rugose or minutely spinose, yellowish or hyaline. Flagella 2, connate, almost $1\frac{1}{2}$ longer than the cell, similar, swimming. Eye-spot or contractile vacuole present. Chromatophores apparently parietal, green, large, with naked pyrenoids; movement rapid, rotational.

Differs from *Angulomonas* gen. nov. by its rugose or spinulose periplast and from *Protochroomonas* gen. nov. by its connate flagella.

Species 3. Distribution: Hongkong, Brazil.

Specific Key

1. Cell suborbicular in outline, angled, anteriorly depressed, 5–6–7 μ long; periplast slender, rugose or spinulose; eye-spot or contractile vacuole present.

1. **P. spinosa** Hab. I

2. Cell suboval, 12–13 \times 7–8 μ ; periplast rugose; eye-spot not present.

2. **P. rugosa** Hab. III

3. Cell orbicular, naked, rugose or denticulate, 9–10 μ in diam.; contractile vacuole not seen.

3. **P. orbicularis** Hab. IV

1. **Protoaceromonas spinosa** sp. nov. Figs. 1 and 2.

Cellula ambitu suborbicularis, angulata, anteriore depressa, periplasto tenuissimo rugoso vel minute spinoso, 5–6–7 μ longa cum stigmatibus vel vacuola contractilibus: Hab. I. Legit B. V. Skvortzov. Holotypus — S. P.

2. **Protoaceromonas rugosa** sp. nov. Fig. 3.

Cellula subovalis, periplasto rugoso; stigmatibus nullo; 12–13 \times 7–8 μ : Hab. II. Legit B. V. Skvortzov. Holotypus — S. P.

3. **Protoaceromonas orbicularis** sp. nov. Fig. 4.

Cellula orbicularis, nuda, rugosa vel minute dentata, 9–10 μ in diam.; vacuola contractilis non visa: Hab. IV. Legit B. V. Skvortzov. Holotypus — S. P.

II. *Angulomonas* gen. nov.

Monades solitariae, libere natantes, non metabolicae, ambitu fere triangulares, ventraliter applanatae; periplastus distinctus cum vacuola contractilis; chromatophorum pallide viride, parietale, perforatum granulosum; pyrenoides praesens vel nulla; stigma nullum; nucleus centralis; flagella 2, natantia.

Differt a *Phyllocardium* Korsch. cellulis ambitu triangularibus a *Protoaceromonas* gen. nov. cellulis ventraliter applanatis.

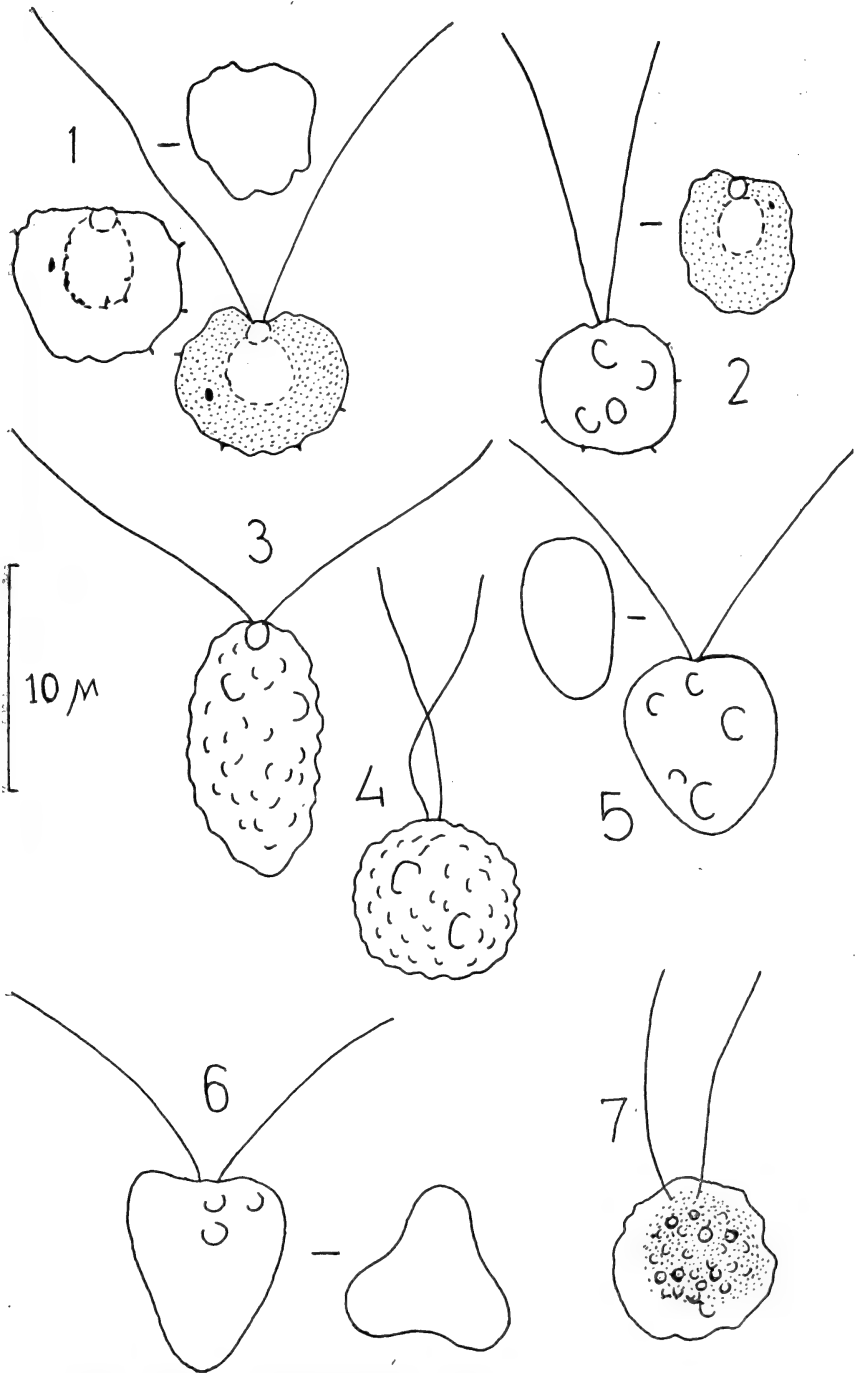


Fig. 1 and 2. *Protoaceromonas spinosa* gen. et sp. nov.
 3. *Protoaceromonas rugosa* sp. nov.
 4. *Protoaceromonas orbicularis* sp. nov.
 5. *Angulomonas triquetra* gen. et sp. nov.
 6. *Angulomonas stagnalis* sp. nov.
 7. *Protochroomonas granulata* gen. et sp. nov.

Typus generis: *Angulomonas triquetra* sp. nov.

Cells solitary, freely swimming, not metabolic, almost triangular in outline, flattened on the ventral side; periplast distinct; chromatophore pale green, parietal perforated, granulose; pyrenoids none or present; contractile vacuole present; eye-spot none, nucleus central; flagella 2, swimming.

Differs from *Phyllocardium* Korsch. in its triangular cells, and from *Protoaceromonas* gen. nov. in its cells being ventrally flattened.

Species 2. Distribution: Brazil. Hab. II.

Key to the species

1. Cells triquetrous in outline, ellipsoid in transverse (?) section, more or less acute at both ends, 5–6 μ long; pyrenoids present.
 1. **A. triquetra**
2. Cells triquetrous, in transverse section almost three angled, 9–10 μ long; pyrenoids indistinct.
 2. **A. stagnalis**

Description of the Species

1. *Angulomonas triquetra* sp. nov. Fig. 5.

Cellula ambitu triquetra, in sectione transversali ellipsoidea, apice utrinque plus minus acutis, 5–6 μ longa: Hab. II. Legit B. V. Skvortzov. Holotypus — S. P.

2. *Angulomonas stagnalis* sp. nov. Fig. 6.

Cellula triquetra, in sectione transversali fere triangulata, 9–10 μ longa, pyrenoidibus indistinctis: Hab. II. Legit B. V. Skvortzov. Holotypus — S. P.

III. *Protochroomonas* gen. nov.

Monades solitariae, libere natantes, non applanatae, cum vacuola contractili; periplasto nullo vel tenuissimo, minute rugoso; chromatophorum parietale, granulosum pallide viride, granulatum, granulis amylaceis; pyrenoides et stigma nulla; nucleus centralis; flagella 2, natantia, similia, $1\frac{1}{2}$ monade longiora, inter se remote sita.

Differt a *Mesostigma* Lauter. cellulis non applanatis, periplasto tenuissimo vel nullo et a *Caecomonas* gen. nov. Fam. *Heteromastigiaceae* Korsch. Class *Volvocineae* (vide manuscriptum authorum 1955) flagellis similibus.

Typus generis: *Protochroomonas granulata* sp. nov.

Cells solitary, free swimming, not flattened; periplast none or slender and minutely rugose; chromatophore parietal, pale green, with paramylaceous granules; pyrenoids and eye-spot absent; vacuoles contractile present, nucleus central; flagella 2, swimming, similar, remotely seated from each other, $1\frac{1}{2}$ times longer than the cell.

Differs from *Mesostigma* Lauter. in non-flattened cells, periplast being thin or absent, and from *Caecomonas* gen. nov. ms. in flagella being similar.

Species 1. Distribution: Brazil. Hab. I.

1. *Protochromonas granulata* sp. nov. Fig. 7.

Cellula 8–9–10 μ in diam.; flagella 2, remote sita, natantia. Hab. I. Legit B. V. Skvortzov. Holotypus — S. P.

Cell 8–9–10 μ in diam., flagella 2, very remote from one another, swimming.

Acknowledgements

This study was made in the Cryptogamic Section of the Botanical Institute, Sao Paulo, Brazil. The author expresses his gratitude to the Director of the Institute, Dr. Alcides Ribeiro Teixeira, and to the leaders of the Cryptogamic Section, Dr. Oswaldo Fidalgo, Dr. Joao Salvador Furtado, Dr. Carlos Eduardo de Mattos Bicudo, and the Secretary Marlene Ocana Orlando for facilities in carrying out this work. The material from Hongkong was received in 1966 for cultivation and study through the kindness of Dr. R. C. Stephens and Dr. T. Widdowson of the Department of Botany, University of Hongkong. The author thanks Mr. H. M. Burkill and Dr. C. X. Furtado of the Singapore Botanic Gardens for help in editing this paper.

Literature

- FRITSCH, F. E.: The structure and reproduction of the algae. Vol. I. Cambridge. 1935.
- PASCHER, A.: Volvocales-Phytomonadinae. Jena. 1927.
- DEDUSENKO-SHTEGOLEVA, N. T., MATVIENKO, A. M., SCHKORBATOV, L. A. CHLOROPHYTA: Volvocineae. Mosqua. 1959.

Foliar sclereids in some species of *Raphidophora* and *Scindapsus*

by

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The taxonomic value of the foliar sclereids has been emphasised by many early workers and this character has often been utilised to distinguish between suborders of a family, a species within the genus and also to assess the taxonomic position of varieties. Engler (1908, 1920) in the family Araceae, distinguished the subfamily Pothoideae from the Monsteroideae in that sclereids were present in the stems, leaves and roots of only the members of the Monsteroideae. Again he further distinguished the tribe Monstereae from the Spathiphyllae in that numerous sclereids were present in the leaves and petioles of members of the Monstereae when compared with those of Spathiphyllae. Very few studies have been made in Monocots either to identify or to delimit the species of different taxa. Recently, Nicolson (1960) and Rao (1964) have studied sclereids in some species of *Raphidophora* and *Scindapsus*. The present paper records the observations of a continued study on other Malesian species of the two above mentioned genera.

Materials and Methods

Materials for the present investigation were derived entirely from herbarium specimens, except for *Scindapsus hederaceus* where fresh material was used from the specimen growing in the Botanic Gardens.

The following specimens were used in the study:

1. *R. acuminata* Merr. Ramos M. & Edano G. 75472 at Philippines. Sept. 1928. SING.
2. *R. batoensis* Engl. Boden-Kloss C, 14713 at Sipora, Sumatra. Oct. 1924. SING.
3. *R. beccarii* Engl. Furtado C. X., No. D at Perak, Malaya. June 1937. SING.
4. *R. cornerii* Furtado. Corner E. J. 30441 at Ulu Kajang, Malaya. Nov. 1935. SING.
5. *R. falcata* Ridl. ? Haniff at ? Penang, Malaya 192 SING.
6. *R. foraminifera* Engl. Burkill I. H. and Haniff 12331 at Perak, Malaya. June 1924. SING.
7. *R. hollrungii* Carr C. E. 13237 at Papua. July 1935. SING.
8. *R. korthalsii* Schott. Ridley H. N. at Malang, Borneo. 1893. SING.
9. *R. kunstleri* Hook. Burkill I. H. 6267 at Ipoh, Malaya. Sept. 1920. SING.
10. *R. lobbi* Schott. Hardial 2 at Pahang, Malaya. June 1964. SING.
11. *R. megasperma* Engl. — at Buitenzorg.
12. *R. minor* Hook. Gordon H. S. 33280 at Perak, Malaya. Sept. 1937. SING.

13. *R. montana* (Bl.) Schott. Purseglove J. W. 4473 at Bau, Sarawak. Sept. 1955. SING.
 14. *R. octovulata* v.A.v.R. — at Buitenzorg. 1927. SING.
 15. *R. palladivenia* v.A.v.R. — at Buitenzorg. 1922. SING.
 16. *R. pilosula* v.A.v.R. — at Buitenzorg. 1920. SING.
 17. *R. sylvestris* (Bl.) Engl. Nur Md. at Kuala Selangor, Malaya. Oct. 1937. SING.
1. *S. beccarii* Engl. Sinclair J. & Kiah 40804 at Trengganu, Malaya. Sept. 1955. SING.
 2. *S. curranii* Engl. & Krause J. & M. S. Clemens 219617 at Tenompok. B. N. Borneo. May 1932. SING.
 3. *S. havilandii* Ridl. Haviland 20019 at Saribos, Borneo. July 1892. SING.
 4. *S. treubii* Engl. Burkill I. H. 9031 at Bukit Mertajam, Malaya. Oct. 1922. SING.
 5. *S. hederaceus* Schott. Growing in the Botanic Gardens — Singapore.

The procedures outlined previously by Foster (1955) and Arnott (1959) were followed to obtain the leaf clearings and macerations. Cleared leaf material was used to study the density and mode of distribution of the sclereids while macerated material was helpful for study of the form and size of the individual sclereids. All cleared and macerated material was stained with Safranin. Transverse and paradermal sections of leaves were cut to study the structure of the leaf and the positional relationship of the sclereids, and these were stained with Safranin and Fast Green.

To obtain the length of the sclereid, the two distant points of the arms of the sclereid oriented in opposite directions were measured, while for the width, the widest portion of the central axis was measured. In a single species, though a certain form of sclereid predominated, there were also a few others which did not exhibit this typical form but were a variation of this. Measurements were only taken of those sclereids exhibiting the basic shape typical of that species. The number of sclereids present in a given microscope field were counted from the leaf clearings of different species to assess their density of distribution. The figures recorded in all cases are an average of ten measurements or counts.

Observations

Of the twenty-two species investigated, sclereids are present in the mesophyll tissues of all the species except in *R. beccarii*, *R. corneri*, *R. korthalsii* and *R. minor*. Sclereids found in each of the various species are basically either of the LINEAR or the H-SHAPED type, though relatively few sclereids not exhibiting this typical form were also present but these were mere variations of either the linear or the H-shaped condition.

1. LINEAR sclereids were seen to be predominant in eight of the twenty-two species investigated, namely *R. falcata*, *R. lobbii*, *R. octovulata*, *R. palladivenia*, *S. beccarii* (Figs. 23–24), *S. curranii*, *S. treubii* and *S. hederaceus*.

In six of the above mentioned species, the linear sclereids within each species did not vary obviously in their size. However in *R. falcata* and *S. hederaceus* (Fig. 30) two distinct sizes of linear sclereids were seen, one type being about half the length and width of the larger sclereids. (See Table I). The variations of the linear sclereid were that in some, a notch was seen to arise around the middle portions of the sclereids, (Figs. 23–24), and in some others this protruberance was much longer resulting in almost a 'Y'-shaped sclereid (Fig. 25). In *R. lobbii*, *R. octovulata*, *S. beccarii*, *S. treubii*, and *S. hederaceus*, the linear sclereid predominated but an H-shaped sclereid was also found to be present but its occurrence was extremely rare and accounted for about 1 percent of the sclereids present.

2. H-SHAPED sclereids are predominant in ten of the species investigated namely *R. acuminata* (Figs. 1–2), *R. batoensis*, *R. foraminifera* (Figs. 5–6), *R. hollrungii*, *R. kunstleri* (Figs. 8–9), *R. megasperma* (Figs. 14–15), *R. montana*, *R. pilosula* (Fig. 16), *R. sylvestris* (Figs. 19–20) and *S. havilandii*. Besides the ideal H-shaped condition, tremendous variation of the H-shaped sclereid was seen, even in one and the same species. Figures 8–13 show the range of sclereid forms seen in *R. kunstleri*. Linear and Y-shaped sclereids were also seen to be present in species in which the H-shaped sclereid condition predominated but their occurrence was extremely rare and accounted only for about 1–2 percent of the total sclereids present. In *R. hollrungii* and *R. kunstleri*, the linear and 'Y'-shaped sclereids accounted for about 25 percent of the total sclereids present. Such sclereids were seen in *R. acuminata* (Figs. 3–4), *R. foraminifera* (Fig. 7), *R. kunstleri* (Figs. 11–13), and *R. sylvestris* (Figs. 21–22).

In most of the species, the sclereids were rather sparsely distributed and only in *R. acuminata*, *R. hollrungii*, *R. lobbii*, *R. montana*, *R. octovulata*, *R. pilosula* and *R. sylvestris* were they densely distributed. All species of *Scindapsus* had sparsely distributed sclereids. The sclereids were, in all the species investigated, orientated in the tangential plane to the leaf surface and were again diffuse in the distribution.

A very striking feature noticed was the presence of druses within the mesophyll cells of all the species investigated. These were best seen in the paradermal sections.

Discussion and Summary

The presence of H-shaped and linear sclereids in species of both the genera, namely *Raphidophora* and *Scindapsus* shows their close relationship and thus justifies Engler's placing both these genera in the tribe Monstereae of the subfamily Monsteroideae.

Considering the linear sclereid as the basic form, one can suggest a possible evolutionary trend resulting in the 'Y' and 'H'-shaped sclereids, all these three forms and their intermediates being found at times in one and the same species: (Figs. 31-40).

Foliar sclereids are seen present in eighteen of the twenty-two species investigated presently. Sclereids found in the various species were either of the two basic forms, linear or H-shaped, though variations of these basic forms were also seen to be present but in extremely small numbers.

Linear sclereids were predominant in eight of the species while the other ten had the H-shaped sclereids predominant. All the species of *Scindapsus* investigated had sparsely distributed sclereids and only seven of the seventeen species of *Raphidophora* exhibited a dense distribution of sclereids.

Druses are commonly present in the mesophyll cells of all the species investigated.

Literature cited

1. ENGLER, A., 1908: Das Pflanzenreich. Heft 37. w. Engelmann. Leipzig.
2. ENGLER, A., 1920: Das Pflanzenreich. Heft 74. w. Engelmann. Leipzig.
3. NICOLSON, D., 1960: Amer. J. Bot., 47, 598.
4. RAO, T. A. 1964: Proc. Ind. Acad. Sci. Lx, 66.

TABLE I

Species	Leaf thickness	SCLEREID			
		Length	Width	Density Av. No./field	Predominant Type
1. <i>Raphidophora acuminata</i> ..	185	1,105	49	Dense-16	H-shaped
2. <i>R. batoensis</i> ..	85	589	54	Few - 6	H-shaped
3. <i>R. beccarii</i> ..	114	..	..	—
4. <i>R. corneri</i> ..	284	..	..	—
5. <i>R. falcata</i> ..	200	1,278	32	Few - 6	Linear
		781	16		
6. <i>R. foraminifera</i> ..	71	525	45	Few - 3	H-shaped
7. <i>R. hollrungii</i> ..	128	909	60	Few - 9	H-shaped
8. <i>R. korthalsii</i> ..	128	..	..	—
9. <i>R. kunstleri</i> ..	170	553	57	Few - 2	H-shaped
10. <i>R. lobbii</i> ..	114	1,266	13	Dense-22	Linear
11. <i>R. megasperma</i> ..	170	477	40	Few - 7	H-shaped
12. <i>R. minor</i> ..	85	..	..	—
13. <i>R. montana</i> ..	355	312	22	Dense-36	H-shaped
14. <i>R. octovulata</i> ..	128	2,800	24	Dense-28	Linear
15. <i>R. palladivenia</i> ..	71	1,355	20	Few - 2	Linear
16. <i>R. pilosula</i> ..	184	630	61	Few - 9	H-shaped
17. <i>R. sylvestris</i> ..	213	540	50	Dense-32	H-shaped
18. <i>Scindapsus beccarii</i>	170	852	16	Few - 8	Linear
19. <i>S. curranii</i> ..	142	1,662	57	Few - 2	Linear
20. <i>S. havilandii</i> ..	128	568	60	Few - 1	H-shaped
21. <i>S. treubii</i> ..	170	2,130	67	Few - 5	Linear
22. <i>S. hederaceus</i> ..	284	1,846	64	Few - 3	Linear
		1,136	32		

* All measurements are in microns and each figure represents an average of ten measurements.

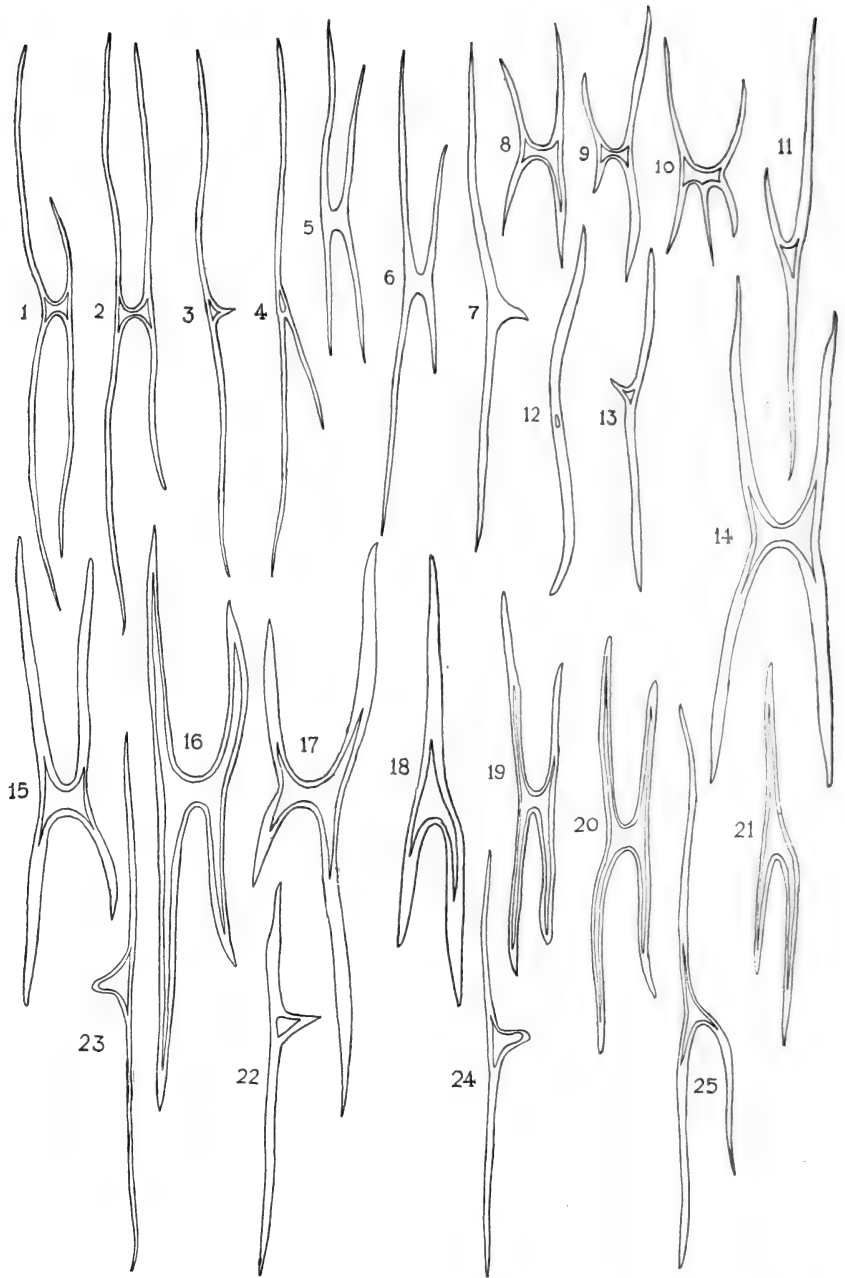


Plate I. Sclereids forms: Figs. 1-4 — *R. acuminata*, Figs. 5-7 — *R. foraminifera*, Figs. 8-13 — *R. kunstleri*, Figs. 14-15 — *R. megasperma*, Figs. 16-18 — *R. pilosula*, Figs. 19-22 — *R. sylvestris*, Figs. 23-25, *S. beccarii*. Camera lucida drawings x 60.

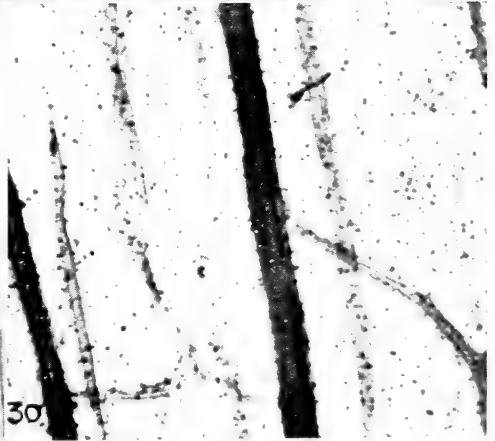
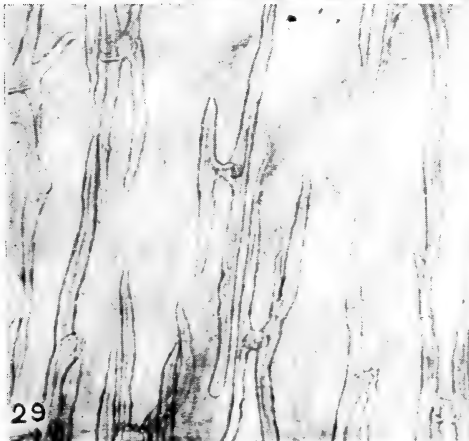
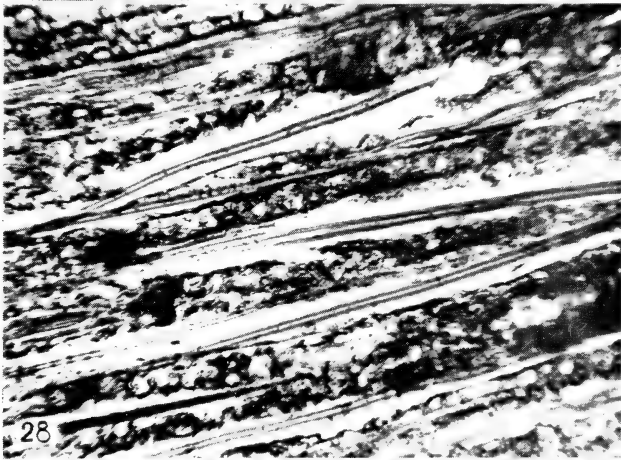
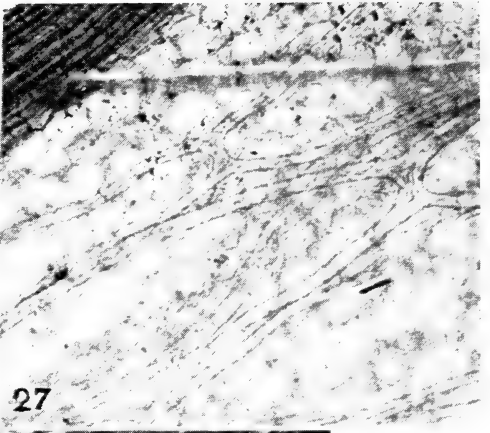
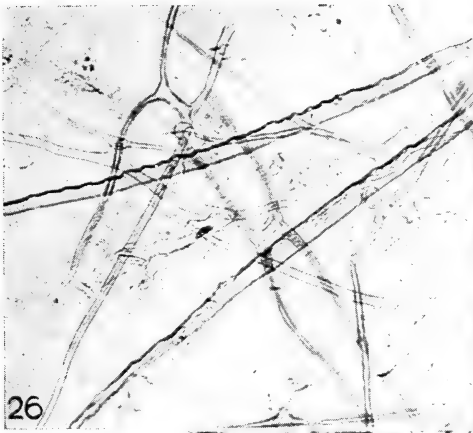


Plate II. Sclereid forms: Fig. 26 — *R. acuminata* x 100, Fig. 27 — *R. hollrungii* x 100, Fig. 28 — *R. lobbii* x 100, Fig. 29 — *R. sylvestris* x 100, Fig. 30 — *S. hederaceus* x 33.

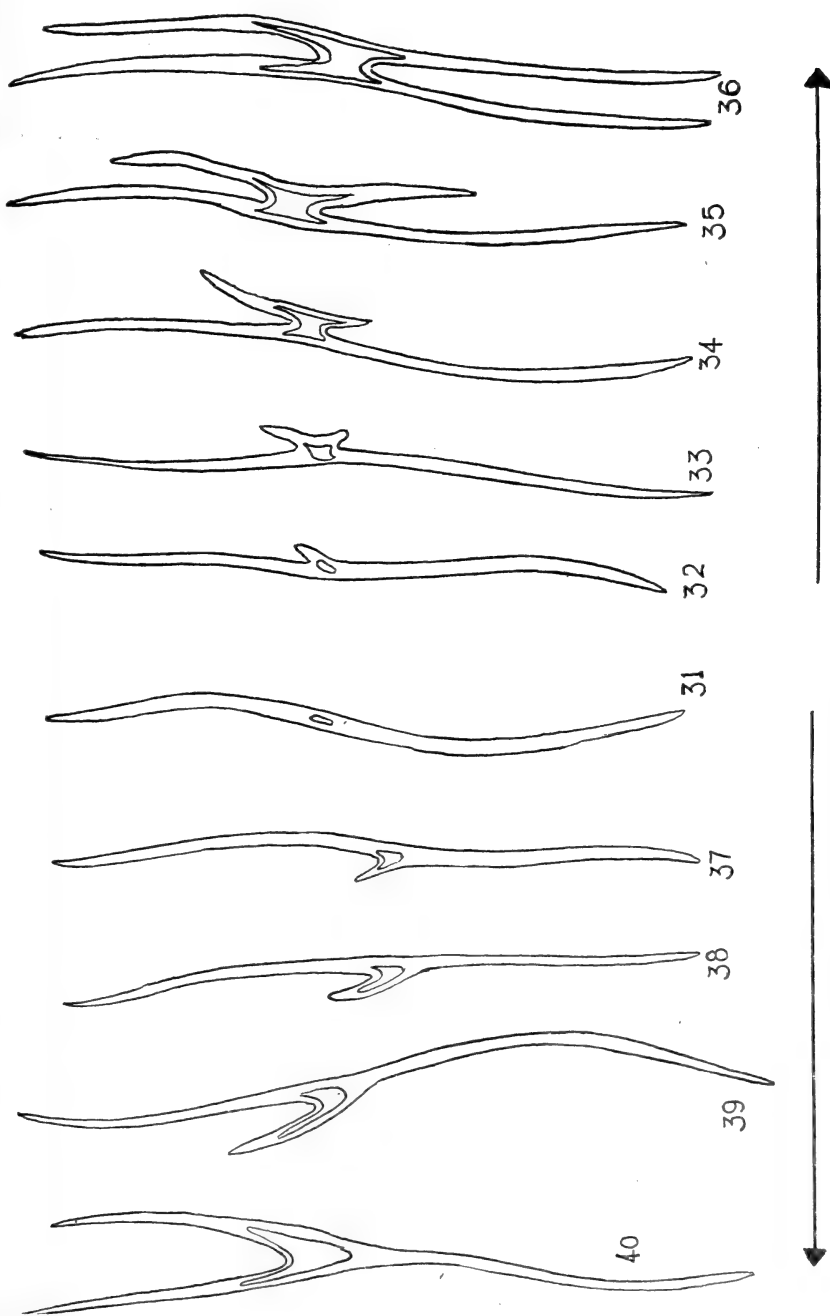


Plate III. A possible evolutionary trend from the 'basic' linear sclereid. Figs. 31-40 (Diagrammatic).

Book Review

by

THOMAS, A.: *Gardening in Hot Countries*

Faber & Faber, London, £1/10/—.

In writing a book on the subject of gardening in hot countries it is not possible to cover fully those aspects of horticulture which are peculiar or typical of each and every country. Even within the tropics there is a tremendous range in the climates and soils which to a great extent determine the types of gardening methods practised. In Singapore for instance where the soil is predominantly clay the traditional Chinese method of growing pot plants in burnt clay supplemented with dried cow dung and rotted soya bean cake is very typical of Malaysia and obviously the best form of pot plant culture in the region. One can also quote other examples which are typical of gardening of a particular country.

Nevertheless the publication is an excellent and painstaking effort on the part of the author to cover as much ground as one possibly can on the various forms of gardening as practised in the hot countries particularly in the African region.

The author has presented very vividly the difficulties and problems the gardener has to face in the tropics and many of his suggestions and ideas as a result of long experience of gardening in the tropics are very practical and would apply equally to the hot countries, be they in Africa, Asia, Australia or America.

A great deal of the book is spent on the precise descriptions of the many tropical plants. This is most useful, as the gardener must know his plants before he can grow them. Photographs to illustrate some of the plants are well taken but some of the captions need looking into. For example *Plumieria obtusifolia* should read as *Plumeria obtusifolia* and *Renanthera coccinea* is in fact *Arachnis maingayi*.

I am sure this book will prove of immense value to both the gardening enthusiasts and horticulturists alike.

A. G. ALPHONSO

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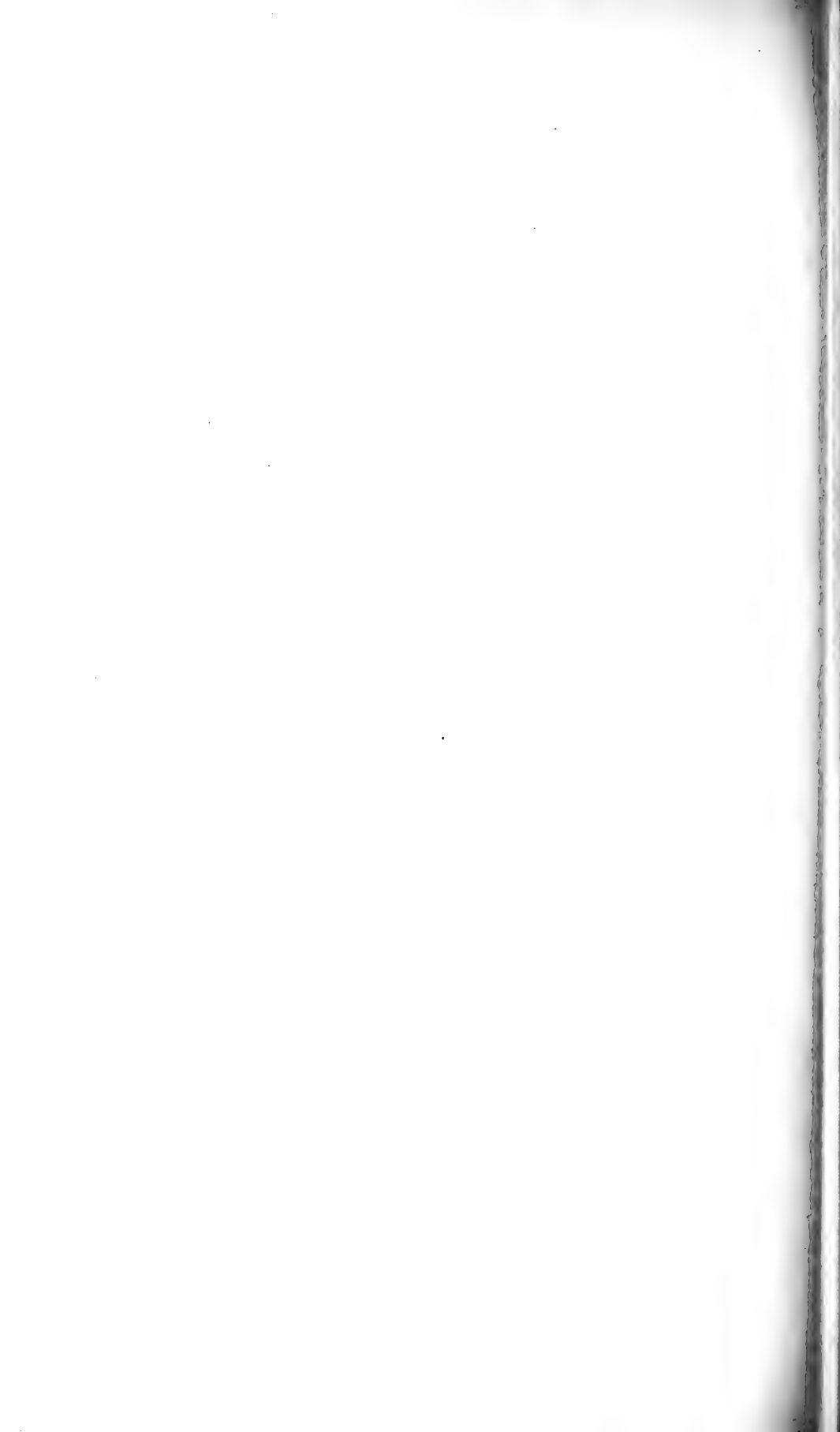
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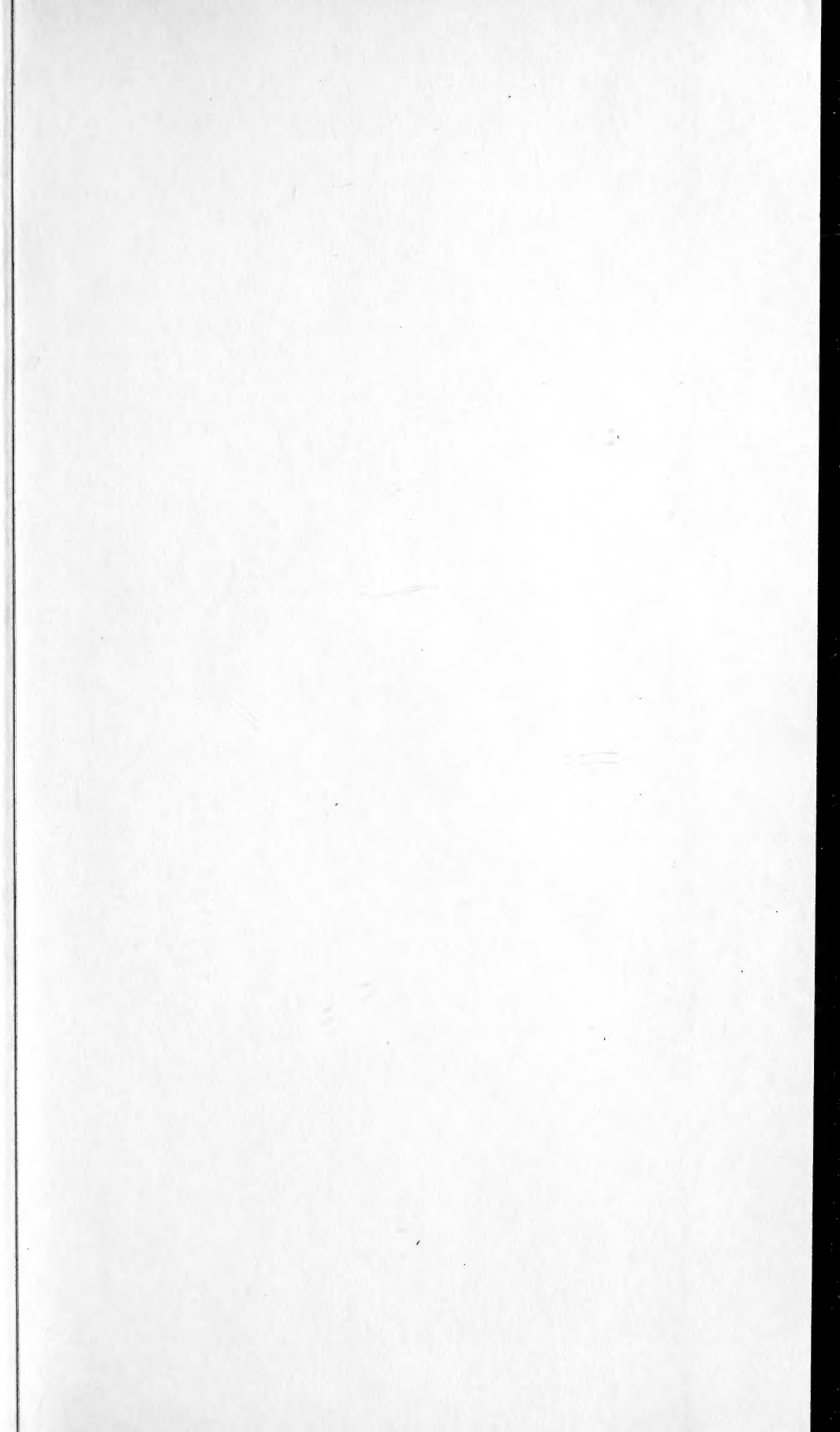
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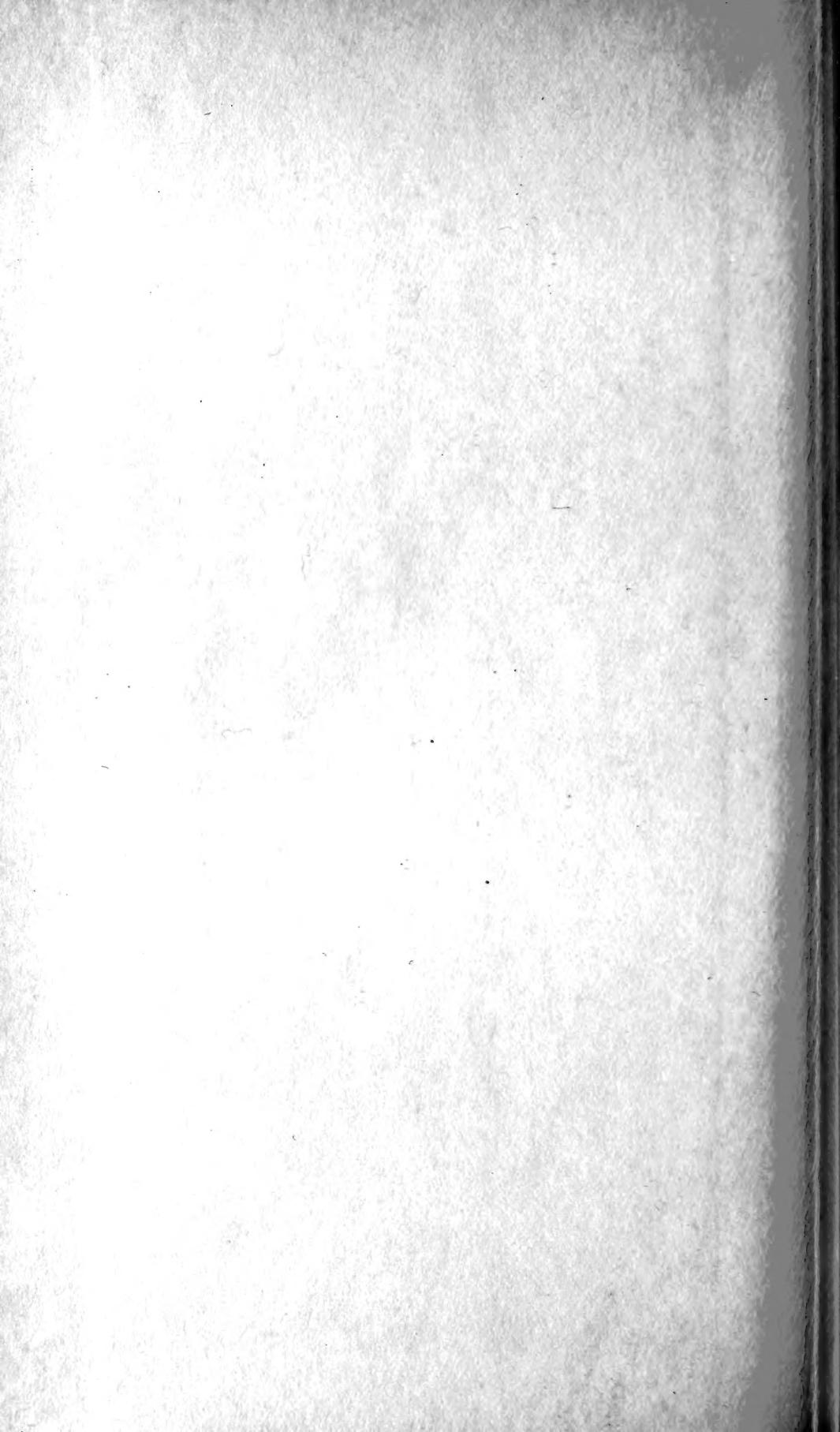
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