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THE
GARDENS' BULLETIN

SINGAPORE

Vol. XVII, Part I

1st November, 1958

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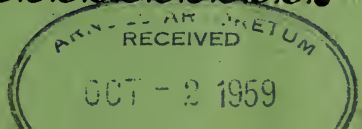
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THE
GARDENS' BULLETIN

SINGAPORE

Vol. XVII, Part I

1st November, 1958

New and Critical Malaysian Plants V*

By A. F. G. H. KOSTERMANS
Forest Service of Indonesia, Bogor

1. *Brownlowia purseglovei* Kostermans—Fig. 1.
(Tiliaceae).

Arbuscula, foliis subobovato-oblongis, paginam inferiorem squamulis rotundatis minutis obtectam. Inflorescentia pauciflora bracteis bracteolisque magnis persistentibus. Petala rosea, oblonga, basin versus subcontracta. Calyx campanulatus, lobis magnis acutis, squamulis dense obtectis.

Typus.—Purseglove 4662 (SING).

Shrub, 3 m. Branches grey-brown, lenticellate. Stipules subulate, up to 12 mm. long, densely scaly. Leaves chartaceous, subobovate-oblong, up to 32 cm. long, 12 cm. wide; top conspicuously, broadly acuminate; base acutish; upper surface glabrous, glossy, nerves impressed; lower surface golden, densely covered with minute, round scales (scales with numerous radial lines); midrib strongly prominent; lateral nerves about 20 pairs, arcuately anastomosing near margin; the basal pair (or pairs) slightly ascendant; veins reticulate, prominulous. Petiole 1 cm. Inflorescence few-flowered, not or hardly branched, densely covered with scales. Bracts and bracteoles large, persistent. Pedicel 6–8 mm. Calyx 6–8 mm., cup-shaped, 3–4 lobed, (lobes slightly more than half the cup, acutish, triangular). Petals 3–5, pink, in bud imbricate, narrowly oblong, up to 3 cm., glabrous, narrowed towards base, apex acutish. Stamens numerous, filaments up to 1 cm. long, slender; anthers yellow, subpelate (opened). The 5 staminodes glabrous, 6

* The series I–IV appeared separately, issued by the Planning Bureau, Forest Service of Indonesia, Bogor, 1954–1956.

mm. long, narrowly lanceolate, acute. Ovary 1–2 mm., obovoid, densely covered with scales; style 9 mm.; stigma inconspicuous.

Distribution.—Only known from type locality.



Fig. 1. *Brownlowia purseglovei* Kostermans.

Bud $\times 5$; flower $\times 5$.

Specimens examined: Sarawak, G. Pueh, alt. 70 m., Sept., fl., Purselove 4662 (SING, BO).

The species is outstanding by its non-peltate, large leaves and large flowers. In the sheet at hand, one opened flower is present, which has 3 calyx lobes, 3 petals and 5 staminodes; there is also one bud, which has 5 petals.

The species is called after Mr. Purselove, former Director of the Botanic Gardens, Singapore, the discoverer of the specimen.

2. ***Aelseodaphne magnifica*** Kostermans, spec. nov.—Fig. 2, 3.
(Lauraceae).

Arbor ramulis teretibus nitidis viridis (in sicco nigris) glabris; foliis chartaceo-coriaceis oblanceolatis ad obovato-ellipticis, acuminatis, basi in petiolum latum decurrente, discoloribus (in sicco). Inflorescentia axillaria paniculata paulo et breviter ramosa, floribus flavibus (post anthesin rubescentibus). Fructus ellipsoideus, niger, sub-obliquus, pedicello nudo impositus.

Tree, up to 32 m. tall; bole 21 m. long, 70 cm. in diameter. Buttresses thick, inconspicuous. Bark yellowish brown, rather flaky. Branchlets smooth, green (black when dried); apical bud acute, minutely sericeous. Leaves alternate, glabrous, chartaceous-coriaceous, glossy green (when dried dark brown beneath), oblanceolate to obovate-elliptical; top acuminate; base decurrent into the broad, up to 1.5 cm. long petiole; midrib, lateral nerves (about 7–9 pairs) and the lax reticulation prominulous (lateral nerves rather erect) on both surfaces. Inflorescences axillary, developing immediately below the new flush, sparsely, minutely sericeous, glabrescent, consisting of panicles of 2–5 cm. long with few and short branchlets; peduncle rather stout. Lateral branchlets bearing 2–4 flowers in axils of minute, triangular bracts. Pedicel rather stout, 2–4 mm. long, sparsely, minutely pilose. Flowers yellow, turning dark purplish red after anthesis, about 3–4 mm. in diameter; outer sepals shorter than inner ones, triangular-ovate, acute 1.5 mm. long; inner tepals ovate, acutish 2–2.5 mm. long. Stamens sessile, densely, minutely pilose; outer ones ovate, acutish, 1 mm. long with introrse, slanting cells; inner ones smaller, rectangular, obtuse, cells lateral; basal glands sessile. Ovary glabrous, ovoid-ellipsoid, 1–1.5 mm. long, style distinct, 1 mm., stigma conspicuous, peltate, laterally incised. Fruit ellipsoid, often a little oblique and club-shaped, glossy blue-black; endocarp 1–2 mm. thick, juicy; cotyledons large, flat-convex.

Typus.—Kostermans 11070 (BO).

Distribution.—Sumatra.

Specimens examined.—Sumatra. Lampong Districts, Gedang Harta, ster., Teijsmann H.B. 4429 (kaju djoos); West Coast Sumatra, Priaman, alt. 400 m., Apr., ster., bb. 6721 (medang djambu; fancy name) (BO, L); Hort. Bogor., culta sub V A 24, Oct., fl., fr., Kostermans 11070 (A, B, BO, BRI, BZF, UC, CAL, LU, CANB, BISH, K, KEP. L, LAE, MEL, NY, P, PNH, SAN, SING, NWS).

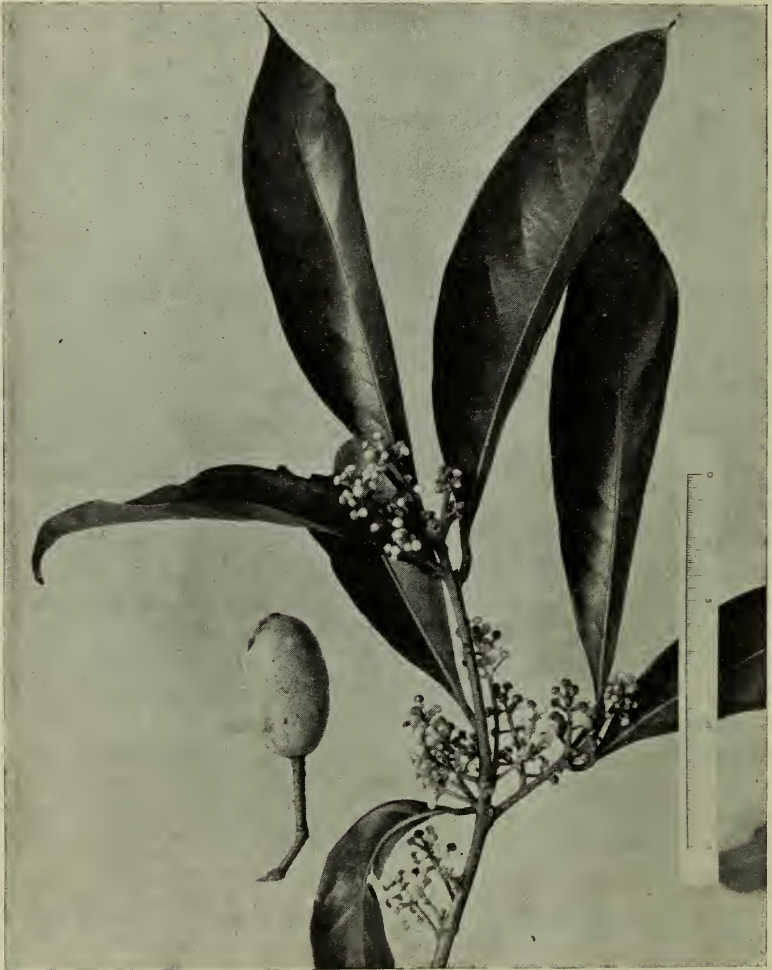


Fig. 2. *Aseodaphne magnifica* Kostermans.
Photo: Bot. Gardens, Bogor, 5th Nov., 1955.

It is possible, that the tree in the Bogor Gardens was grown from seeds of the specimen H.B. 4429. The vernacular names—as is usual in Lauraceae—have no value at all and should be considered as pure fantasy.

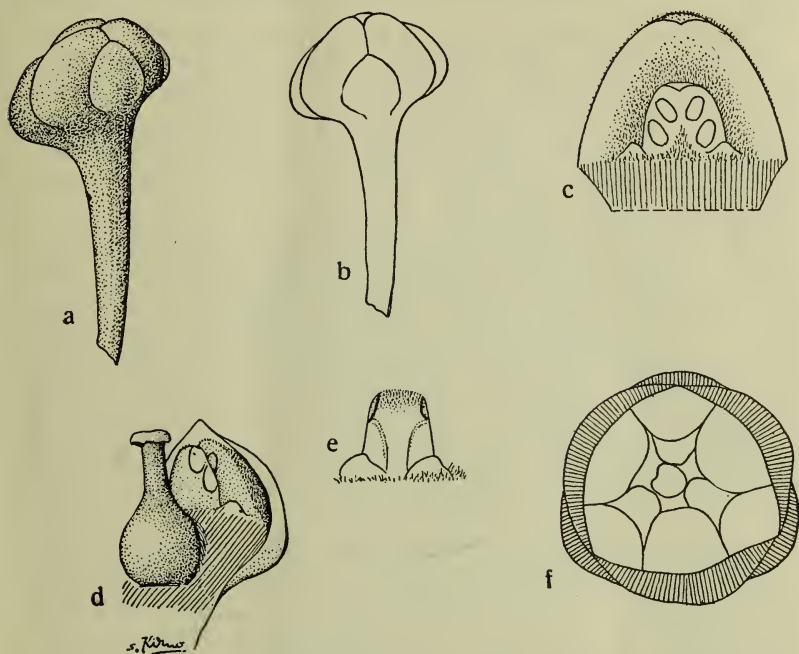


Fig. 3. *Alseodaphne magnifica* Kostermans no. 11070 29 Oct., 1955 Keb. Raya photo.

a & b, flowers $\times 5$; c, outer stamen $\times 10$; d, ovary $\times 10$;
e, inner stamen $\times 15$; f, flower seen from above $\times 10$.

3. *Sympetalandra borneensis* Stapf

(Caesalpinaceae-Dimorphandrae).

Sympetalandra borneensis Stapf in Hook. Icon. 4 (8): t. 2721. 1901; Merrill, Bibl. Enum. Born. pl. (J. Str. Br. Roy. Asiat. Soc. Spec. Numb.) 295. 1921; in Univ. Calif. Publ. Bot. 15: 98. 1929. —Haviland 1628 (K).

Erythrophloeum densiflorum (Elm.) Merr., l.c. (non aliis).—Villamil 52.

Erythrophloeum unijugum Airy-Shaw in Kew Bull. 1939: 180. —Agullana For. Dept. 1780 (K).

Serianthes gigalobium Kostermans in Reinwardtia 2: 357. 1953.—bb. 20030 (BO).

The reason why this species was described under four different names and three different genera originates from the fact, that the

leaves vary between simply pinnate to bipinnate (unijugate and bijugate) and that I described the species from a fruiting specimen, whereas Merrill and Airy-Shaw examined flowering specimens.

With all type specimens at hand now, I have been able to clear up all controversies. I collected several times fruit of this species in the island of Nunukan, where it is common locally on rather loamy soils. The simply pinnate leaves are not only found near the inflorescences, but occur also on sterile branchlets, which are less vigorously developed. Unijugate leaves are quite common among bijugate ones on the same tree.

Consequently Merrill was right in referring the specimen Elmer 20923 to *Sympetalandra borneensis*. Airy-Shaw's contention, that the specimens certainly belong to *Erythrophloeum*, is wrong, as the pods are different: they are non-dehiscent and very thick. *Sympetalandra* is a distinct genus, allied to the African genus *Burkea* Hook. f., which has equally non-dehiscent (but very thin) pods. In leaf characters it does not differ from *Burkea*. The identification of the sterile Sumatra specimens, enumerated in Reinwardtia, is not sure. The seeds have a pink seedcoat. The pods are yellowish green.

Additional specimens (other specimens are mentioned in Reinwardtia, l.c.).—British North Borneo. Sandakan, Kabili For. Reserve, alt. 7 m., Nov., ster., Agama B.N.B. For. Dept. 9953 (BO, K); Kandasari—Tenompok, 12 miles W. of Ranau, Kota Belud, alt. 1500 m., Dec. fr., San 16398 (BO, SAN); Sepilok For. Reserve, 15 miles W. of Sandakan, alt. 50 m., April, in bud, Wood & Charington, San. 16313 (A, BO, BRI, K, KEPONG, L, SING); *ibid.*, June, fl., N.B.F.D. A808 (BO, K); Tawau, along bank of Marutai R., Agullana 1780 (BO, K). Sarawak, Kuching, Sept., in bud, Haviland & Hose 1628 (BO, K). Indonesian Borneo. East Borneo, Nunukan Isl., Nov., ster., Kostermans 8790 (A, BO, K, L, SING, PNH); *ibid.*, Nov., fr., Kostermans 8727 (A, BO, K, L, SING, PNH); *ibid.*, Nov., fr. Meyer 2176 (A, BO, K, L); *ibid.*, young tree, Kostermans 8727A (BO, L).

Living material was brought by me to the Bogor Botanical Gardens, where it is cultivated.

Vernac. names.—Tadarun (Dusun—Kandasari).

4. *Teijsmanniodendron sinclairii* Kostermans, *spec. nov.*—Fig. 4.

Arbor, ramuli apice et petioli et foliorum pagina inferior et inflorescentia minute asperi. Folia elliptica rigide coriacea, petiolo apice incrassato. Inflorescentia racemosa, dense bracteosa, haud vel vix ramosa.

Tree 5 m. tall. Branches and branchlets compressed, stout, grey, the latter, minutely asperate. Living leaves medium green and glossy above with a yellowish tinge, yellowish green beneath. Dried leaves rigid coriaceous, bullate, glossy, glabrous above, less



Fig. 4. *Teijsmanniodendron sinclairii* Kostermans.

After Kiah & Sinclair S.F.N. 40877. Flowering branch (not sure), fruit $\times 5$, part of inflorescence $\times 3$.

glossy and asperate beneath, elliptical, up to 13×25 cm., top acuminate, base acute, midrib prominent in a groove and nerves sunken above; lower surface: midrib prominent, lateral nerves (8–10 pairs) prominent, arcuate, near margin arcuately anastomosing, secondary nerves lax, prominent, reticulation obscure. Petiole stout, 3–4 cm. long, at apex with a conspicuous, globose swelling at the lower surface. Inflorescences axillary, up to 30 cm. long, raceme-like; the inflorescence consists sometimes of a short main peduncle with 2 or 3 long branches. Lower half or one third of inflorescence bare, peduncle stout, compressed, sparsely asperate. Flowers 2–3 together on a very short peduncle in the axils of up to 8 mm. long, narrowly ovate or lanceolate (narrowed towards base) acute, stiff, persistent bracts, purple, with a yellow brown patch on lower lip. Calyx campanulate, 3 mm. long, lobes reflexed, ovate, acutish, 1.5–2 mm. long. Corolla not seen. Fruit cup shallow, 5–7 mm. deep, 10–12 mm. in diam., margin irregularly incised, fruit subglobose to obovoid-globose, glabrous, depressed at apex, 10–12 mm. in diam. with an apical and often a lateral median suture, 2-celled with 2 seeds.

Type specimen.—Sinclair and Kiah bin Saleh S.F.N. 40877 (SING).

Distribution.—Malay Peninsula, Borneo.

In my paper on *Teijsmanniodendron* (in *Reinwardtia* 1: 97. 1951), I stated, that I had no access to the type specimen of *T. holophyllum* Kosterm., in which I included arbitrarily specimens deviating by their tomentum. Moldenke (in *schedae*) considered the pilose specimens (bb. 12144) a variety (var. *pubescens* Mold.) of *T. holophyllum*.

The material, collected by Sinclair and Kiah makes it clear, that the pilose (scabrous) specimens represent a new species, different from *T. holophyllum* not only by its scabrosity but also by the stout inflorescence and larger flowers and fruit. In sterile condition the species is easily recognised by the scabrous (touch) of the lower leaf surface.

Specimens examined.—Malay Peninsula. Trengganu, Sg. Nerus at 16th mile Kuala Trengganu right bank, Sept., fl., fr., Sinclair and Kiah bin Saleh, S.F.N. 40877 (A, BO, K, L, SING). Borneo. Berau, Inaran, ster., bb. 12144 (BO, L).

5. ***Abarema nediana* Kostermans, spec. nov.**—Fig. 5.

Arbor parva ramulis cylindricis laevibus perparce perminuteque tomentellis, foliis bipinnatis bijugatis foliolis chartaceis, late ellipticis obscure acuminatis, basi in petiolulum contracta supra nitida



TYPE

EX HERB. HORT. BOT. REG. KEW.
 FLORA OF NORTH BORNEO.

1917

Non-vern. ...
 Loc. ...
 Hab. ...
 Alt. ...
 Date ...

Family:
 Genus:
 Species:
 Det. d.d. 1917

Fig. 5. *Abarema nediana* Kostermans.

glabra reticulata subtus terna perminute sparseque adpresse pilosa petioluli parvi; glandulis pedunculorum ovalibus, glandulis inter petiolulorum subrotundatis, rachillae basin versus glandulis minimis bigeminis.

Paniculae supra—axillaribus dense minuteque tomentellis, floribus sessilibus dense minuteque adpresse-tomentellis; ovario glabro, stipitato.

Typus.—N.B.F.D. A142 (BO).

Tree 13 m., 10 cm. in diameter; branchlets cylindrical, smooth, sparsely and very minutely pilose, with a few scattered pale tiny lenticels. Leaves bipinnate, bijugate; rachis pilose about 8 cm. long, near its base with an elliptical, about 2 mm. long, slightly raised gland with a central depression; base with 2 short (1 cm.) decurrent spurs; petiolar part 4–5 cm.; rachillae pilose, lower ones 1–2 cm. long, with 1 or 2 pairs of folioles, near their bases with a pair of minute, raised glands; interpetiolar glands raised, almost orbicular, 1 mm. in diameter; petiolules 2–3 mm. long; upper rachillae up to 6 cm. long, with 3 pairs of folioles; folioles chartaceous, broadly elliptical, the apical ones up to 5 × 7 cm., the basal ones 2 × 3 cm., apex obscurely acuminate, base contracted into petiole; above glossy glabrous with prominulous reticulation; lower surface dull with sparse, minute, apressed tomentum; lateral nerves 4–6 pairs.

Panicles slightly above the axils of the leaves, up to 30 cm. long, sometimes with leaves; densely, minutely tomentellous; flowers white, sessile, densely, minutely sericeous-tomentellous; calyx infundibuliform, 1.5–2 mm. long with 0.5 mm. long teeth; corolla 4–5 mm., with 2 mm. long, lanceolate, acutish lobes; staminal tube as long as corolla tube; ovary glabrous, stipitate.

Specimens examined.—Colony of North Borneo. Lumanggas Isl., Simporna, Lahad Datu Forest Distr., seashore. alt. 1 m., Oct., fl., B.N.B. For. Dept., A.142 (BO, K).

The species is named in honour of Mr. Nedi of the Staff of the Herbarium Bogoriense, who during 20 years has accumulated in astonishing knowledge of Indonesian plants and who is a much appreciated assistant in routine identifying.

The species is characterised by the twin glands near the bases of the rachillae.

According to a note on the field label the plant is used for cleaning teeth and seems to have medicinal properties for dental diseases.

On the periodicity of tree-growth in the tropics, with reference to the mode of branching, the leaf-fall, and the formation of the resting bud.

By KWAN KORIBA
Hirasaki University, Japan
(with 3 text-figures)

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§ 1. Introduction

DURING MY STAY at Singapore, from 1942 to 1945, it was quite unexpected to find that there were such various growth-forms of trees compared with the temperate region. In temperate countries deciduous trees are clearly distinguishable from the evergreen, and leaf-fall is in accordance with the winter. Even a slight fluctuation of chilly weather affects the date of leaf-fall, so that the exacting influence of the climate is conspicuous. This holds true, also, in the monsoon region with a dry season.

In Singapore, most trees are naturally evergreen, and some of them are evergrowing in accordance with the favourable climate, but most of the evergreens are intermittent in their growth and some are even deciduous in spite of so uniform a climate, though the bare spell is very short and the flowering or fruiting may go on during that time. Besides, there are some trees, in which the leafing, flowering, etc. are different according to individual branches or stocks. So we can see among trees every possible transition of growth-form from the evergrowing to the deciduous.

Another peculiarity to be pointed out in Singapore is that the leaf-fall does not coincide with the calendar year. Beside those which shed leaves once, twice, or thrice seasonally every year, there are those which shed leaves from every several months to more than one year non-seasonally. Yet there is no exacting change of climate to enforce this leaf-fall, since other trees or even other stocks of the same species remain clad with a green crown.

To elucidate why such diverse behaviour of the tree-growth is displayed was the chief aim of the present investigation.

The periodicity of tree-growth is a natural consequence of the activity of the growing point. But before discussing the detail, it is necessary first to consider the climatic character of the region. As to general features, one may refer to manuals of climatology and related literature.

§ 2. The climate of Singapore

As is well known, south-eastern Asia and Malaysia undergo, as monsoon regions, a distinct dry season alternatively. But in Singapore, lying just between those two regions, the monsoon effect is extremely moderated and there is no truly dry season. The climate is warm and wet, often cloudy, with insolation neither very long nor intense.

The most definite seasonal feature is the rainy season from October to January. The monthly rainfall amounts to 20 cm. occasionally more than 30 cm. (HOLTTUM '40). The excess of precipitation, however, does not affect the tree-growth particularly, as it is drained away by the surface run-off and seepage, though it is beneficial to the seasonal growth of fungi (CORNER '35).

On the other hand a long spell of rainless days, together with intense radiation, affects the periodicity of trees not a little. The seasonal colour of tree-growth may be attributed mainly to such occurrences. The so-called dry spells occur in Singapore twice a year, February to March and July to August, and correspond nearly to the dry season of India and Malaysia respectively. On the mainland of the Malay Peninsula, however, the distribution of the dry season is not the same; it is different on each side of the coast, as well as inland (STEWART '30).

In Singapore, even in the dry months, the rain-fall amounts usually to 13–16 cm., rarely 6 cm. According to HOLTTUM ('40) the number of times in which the monthly rainfall was less than 2.5 inches (= 6.3 cm.) during 50 years (1890–1939) was twenty-two, or once every two years (see Tab. 1a), and the longest drought during 10 years (1927–1937) was 22 days extending from January to February. The frequency of rainless days, continued for 14–20 (Tab. 1b) and 7–13 days (Tab. 1c) respectively during that time, was as follows:—

TABLE I.—DISTRIBUTION OF THE RAINLESS MONTHS IN SINGAPORE

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
<i>a</i>	7	3	1	..	..	6	3	2	..	..	..	during 50 years
<i>b</i>	1	..	..	..	..	4	..	..	..	1	} during 10 years	
<i>c</i>	..	2	4	5	1	5	3	9	2	4	2	..		1

From these data it is discernible that the rainless month can shift one month or more according to the year, indicating the non-seasonal character of drought in Singapore.

As long as the dry spell continues, the temperature rises day by day, and the decrease of humidity is more acute. Intense radiation and decrease of water-content by transpiration seem to induce anthogenesis and accelerate leaf-fall as well. A shower after the dry spell causes, then, new leafing often conspicuously. At any rate, as the climate is fairly uniform, even a short dry spell can give rise to the periodic feature of tree-growth.

Naturally the trees which respond in this way are not very abundant, or are restricted to their susceptible phase only, while others show no special reaction to such a trifling change of climate. Even

among deciduous trees there are those which maintain their proper periodicity regardless of the dry spell.

If one compares the periodicity of tree-growth in Singapore with that of the monsoon regions, north and south, or of the tropics of other continents, one finds that there are some kinds of trees that are evergreen in Singapore, while deciduous in other regions. In this respect, Singapore is one of the most uniform climates in the tropics, and moreover with abundance of tree-species. But, then, why in the district of such a uniform climate such various growth-forms occur, is a question to be considered further.

§ 3. The periodicity of tree-growth in its relation to the mode of branching

The periodicity of tree-growth is derived from the behaviour of the growing point. If all twigs grow continually, producing leaves successively, the tree is "evergrowing". If however the growing point ceases to grow or slows down after forming a certain number of leaves, or tends to form an inflorescence, the growth of the twig becomes intermittent.

But, even if some twigs cease to grow or become flowering twigs, the tree is still evergrowing as a whole, provided that some axillary buds are growing into new twigs. The periodicity is, therefore, not only related with the activity of the single shoot-apex, but also with the mode of branching of trees. Such individual differences in branch-growth in the tropics was noted by SCHIMPER ('98) and various subsequent authors. We may designate it the *manifold growth* of tree-branches.

This behaviour is seen not merely in individual branches or limbs of one tree, but also among trees of the same species. That is, some stocks are just in new leaf, while others are clad with dark green old leaves or in flower—the "stockwise manifold growth", in contrast to the "branchwise manifold growth" on the same tree. Among young avenue trees of *Spathodea campanulata* both forms of manifold growth can be seen, while in old trees all stages of the branchwise manifoldness are mingled together in each tree, so that the stockwise difference ultimately disappears.

Now, trees with intermittent growth are very common in the tropics. New leaf-sprays all over the twigs are often seen. If leaves of the previous season still remain at that time, the tree is evergreen just as in the temperate zone, but if they have fallen off beforehand, it is deciduous, though in the tropics there are various transitions.

The periodicity of the tree-growth is determined therefore in two ways:—

- (1) whether the activity of growing points is continuous, manifold or intermittent, and
- (2) how the growing points are distributed in each branch, terminal or lateral.

The mode of branching in general is well known morphologically, but the periodicity of tree-growth is characterized also by the behaviour of the growing point, which is rather diverse and not always intermittent in the tropics and qualifies the periodical character.

By the combination of these two processes, we get six types of tree-growths as mentioned below:—

THE MODE OF GROWTH AND BRANCHING, AND THEIR COMBINATIONS

- | | | | | |
|--|---|---|---|--------------------------|
| (1) Activity of growing point | { | evergrowing
manifold
intermittent | } | evergreen or deciduous |
| (2) Site of growing points in the twig | { | terminal
lateral | } | |
| (3) Mode of growth of tree | { | terminal-evergrowing
lateral-evergrowing
terminal-manifold
lateral-manifold
terminal-intermittent
lateral-intermittent | } | { evergreen
deciduous |

§ 4. Materials and methods

Trees examined were those:—

- (1) Planted in the Botanic Gardens of Singapore, including exotic trees,
- (2) of the *primary* forest of the Gardens,
- (3) of Bukit Timah Forest Reserve,
- (4) of the *primary* forests of the Water Catchment Area,
- (5) of various other places on the Island and the Peninsula.

The identification of wild trees was entirely dependent on the instruction of Mr. E. J. H. Corner, without whose help the present research could hardly have been accomplished. Dr. R. E. Holttum gave me also advice concerning the leaf-fall. I express here my sincerest thanks to them on this occasion.

To classify the growth-types of trees, as mentioned above, is however not always easy. Especially the distinction of the evergrowing from the intermittent is difficult, as there is no sharp distinction between them (§ 10). If one can see the fresh foliage all

over the twigs, as often is the case in jungles, avenues and gardens, it is certain that the tree is intermittent in its growth, but if one can not catch such a chance, it is necessary to investigate the following accessory criteria:—

- (1) In evergrowing twigs, the leaves are nearly uniform in size, similar in colour except a few young ones, and often with 1–2 ageing leaves at the base. Besides, the internodes are nearly equidistant.
- (2) In trees with intermittent growth, the leaf-size and the length of internodes are not uniform. At the basal part of the shoot of each season, there are some scars of scale-leaves that protected the young shoot initially.
- (3) In trees with intermittent growth, there is usually a sudden change of bark colour, wearing off of epidermis, appearance of cork-layer, lenticels, etc., whereas in continually growing twigs all changes are gradual.

Trees with manifold growth are easily discernible by comparing the branches here and there. Their growth is never continuous, though usually evergreen, and individual branches may be deciduous.

Deciduous trees are very conspicuous at times of leaf-fall. We can find a full account of them in the literature (CORNER '40 and others). The mode of branching has no direct relation to periodic deciduousness.

We shall first examine the mode of branching morphologically and then, combined with the activity of the growing point, the mode of tree-growth in detail.

§ 5. Terminal growth

The terminal growth of trees in the tropics may be grouped into three types, the tuft-trees, the trunked and the ramiferous.

Tuft-trees produce leaves only from their thick stem, as in tree-ferns, cycads, palms, papaya-trees, and they rarely branch. Trunked trees, designated as the monopodial tree, have a main trunk with relatively slender limbs. This form is very abundant in the tropics, not only in gymnosperms, but also in dicotyledonous trees. The ramiferous tree has a short trunk, from which thick limbs subdivide and ramify gradually into slender branches and twigs. Naturally there is no sharp distinction between the latter two. All young dicotyledonous trees grow at first monopodially, but some trees cease sooner or later their terminal growth as their inherent character, though this may be varied more or less by environmental conditions.

The trunked tree sometimes tends to the many-stemmed form near the base, and conversely the ramiferous tree in dense forest may tend to the trunked form up to the high branches.

That there are many monopodial trees in the tropics is one of their characteristics, indicating the favourable conditions of growth. Even in trees with sympodial growth, the pseudo-monopodial form is occasionally seen, as in *Alstonia*. They seem to be suited to dense forest. All these forms are recorded systematically in Corner's book (1940).

Among trees with terminal growth, there are still some distinctions according to whether the organs produced are uniform or not, and how long the apical growth can last. In tree-ferns and most of the palms the kind of organ formed is uniform, while in cycads a set of scales and foliar leaves are produced in each season, so that the growth is intermittent. In the flowering season, then, the female trunk of cycads forms scales, sporophylls and foliar leaves as one set, while on the male trunk, on account of the terminal position of the male cone, the stem-apex, withers and growth proceeds by an axillary bud sympodially. The *Corypha*-palm on the contrary, having formed a terminal inflorescence after about thirty years growth, dies down, while the Sago-palm (*Metroxylon*) succeeds this growth with axillary saplings.

Terminal growth is therefore not necessarily endless. It is a morphological alternative to lateral growth. If the main axis terminates with an inflorescence after some seasons, it is a limited terminal growth, but if the inflorescence is axillary and growth has no morphological limitation, it is an indefinite terminal growth, even if its duration be not very long.

§ 6. Lateral growth

When the growing point dies out or becomes an inflorescence, then one or more lateral buds grow instead and sympodial growth ensues in each season. In some trees, too, chiefly on their horizontal branches, one or more axillary buds of the underside grow more vigorously than the main shoot, which then grows slowly as a short shoot, while the lateral twigs take its place in the continuation of the branch. The same process is repeated in every season, adding new twigs successively. The former two cases may be named "substituting growth" and the latter "apposing growth".

If the growth of lateral buds precedes flowering or dying out of the terminal part, the twig remains evergrowing, but if it falls behind, growth becomes intermittent, though there is no sharp boundary between the two extremes.

1. Substituting growth

Two cases may be mentioned, namely the dying of the terminal bud or twig and the fruiting or decaying of the terminal inflorescence. The inflorescence may be represented either by a single flower, an inflorescence, or the anthocladium (GOEBEL '31), e.g. *Delonix*, but as the morphological details are not important, we may call them all inflorescences.

As a typical case of the dying of the terminal bud, *Xanthophyllum Curtisii* may be mentioned. It is an endemic tree of Malaya, growing twice a year intermittently. Though the shoot is provided with green coriaceous leaves, its terminal bud dies every season and an adjoining axillary bud substitutes the growth of the twig (§ 22, Fig. 1). In *Crataeva*, *Sapium*, and several genera of Leguminosae, a few upper internodes die away and the remaining lower buds develop. The young tree of *Sapium discolor* is especially interesting in respect to its mode of branching. At the end of each season, the apical part of the axis dies away and one of the apparently whorled branches grows upward and takes the place of the main stem. The trunk thus assumes a pseudomonopodial form. Then, after a height of several metres is attained, two branches grow upwards simultaneously, so that the trunk appears pseudodichotomous, and these limbs repeat this mode of branching; so in a fairly tall tree a 'dichotomously branched', flat-topped crown develops. In *Alstonia scholaris* a tall pseudo-monopodial trunk grows up and a handsome pagoda form is assumed, as illustrated in Corner's book, Fig. 15.

2. Opposing growth

This is the so-called "Terminalia-type branching" (RACIBORSKI '01, p. 50; CORNER '40, p. 30), and involves horizontally spreading branches, such as *Terminalia*, *Fagraea*, *Achras*, and *Palaquium*, whether evergreen or deciduous, and occurs even in temperate trees such as *Cornus* and *Idecia*. It is homologous with the rhizomes of *Polygonatum* and many others. In *Tectona* and *Eriobotrya*, when the branches are horizontally directed, the same mode of branching occurs, but growth is usually more or less upwards, and the more upward it is, the more vigorously the main twig grows, tending ultimately to normal ramification. This type of branching is, therefore, a case of geomorphosis caused by hormonal activity in which the branches of the upper side are restricted in their elongation, while those of the underside are accelerated.

So much for the morphology of branching. Let us now consider the growth-forms of trees in general.

§ 7. Evergrowing trees

There are three types of evergrowing trees:—

- (1) Shoots are all evergrowing by terminal growth—"the terminal evergrowing".
- (2) The shoots show a limited growth by
 - (a) dying of apical parts,
 - (b) development of the inflorescence,
 - (c) tending to be a short shoot,but the growth is maintained by the development of substituting or apposing twigs without resting.
- (3) The shoot-growth is intermittent and sometimes deciduous, but the phase of development is manifold according to branches, so that the tree as a whole is evergrowing (§ 8).

Among the evergrowing trees, we may distinguish further two types: the inherent and the environmental. There are many endemic "evergrowing trees of inherent type". But some trees, though evergrowing in Singapore, are intermittent or deciduous in other regions, so that they may be named "the facultative evergrowing".

For instance, *Duabanga sonneratioides*, *Thespesia populnea*, and *Trema orientalis* are deciduous in India (TROUP '21) and *Trema* is even bare for 22 days (WRIGHT '05). *Mimosa sepiaria* and *Psidium guajava* are semideciduous in San Paulo and the former is deciduous in Rio Grande do Sul (30° S) (IHERING '23). *Hibiscus tiliaceus* is intermittent in East Java (FABER '35). All these trees are evergrowing in Singapore.

Naturally it is not certain whether the deciduous habit of such trees is environmental or inherent, as there may exist racial differences in each region among widely distributed species (§ 22).

1. The terminal evergrowing

This is the simplest case of the twig-growth. The terminal part of each twig has a constantly growing bud, forming equal-sized leaves one after another, leaving a few ageing leaves behind. The growing point is protected by outer developing leaves, petioles or stipules. Young leaves may have hairy coverings or secrete gum-resin and are more or less sheathing. The hairs are usually simple, occasionally long, branched, tufted or slimy according to species.

Very often the young bud is covered by an outer leaf or a pair of opposite leaves, the margins of which fit together by entangling hairs so as to make a tube or cone. As the inner bud grows, the

connection of the margin is gradually separated and the next leaf, or leaves, restore the arrangement, as in *Duabanga sonneratioides*, *Horsfieldia brachiata*, and *Camptosperma auriculata*.

The leaves of *Archytæa* and *Gordonia* are glabrous and the young bud is surrounded by the involute leaf-base, or outer leaf respectively, so as to recall the leaf-sheath of *Tradescantia*. When the younger part is protected by the petiole, this is more or less grooved, and in cases of opposite leaves as in Gnetaceae, Apocynaceae, Loganiaceae, etc., the young bud is enclosed between their bases, which often make a tube above the bud filled with an exudation of gum-resin or slime. *Wormia suffruticosa* shows a peculiar form of bud-covering, in which the equitant petiole encloses the bud completely (FABER '35, Fig. 136).

Stipules are often useful for the protection of the bud, too, especially when they are large, as in *Jackia ornata* (CORNER '40, Fig. 190) and *Leea* (LUBBOCK '99, Fig. 188). Trees of Rubiaceae, Polygonaceae, Magnoliaceae, and Moraceae have as well-developed a stipular covering, hood- or cone-shaped, as those of temperate regions. They are described in detail by POTTER ('91), GROOM ('92), LUBBOCK ('99) and others.

a. Tuft-trees

The tree-ferns, most palms and the papaya-tree are the typical monocaulous trees. *Cycas*, *Pandanus*, *Dracaena*, etc. are often polycaulous or branched. The growing point develops steadily, deeply protected by a tolerable number of young leaves. Most palms produce inflorescences at the same rate, one by one after the development of the subtending leaf. In the papaya the surface of the growing point is slightly convex and the leaf-primordia are arranged in 2:3 parastichy. In each primordium, there develops at first the columnar petiole with narrow brim-like lamina on the top. The growing point is therefore in direct communication with outer air, though the laminas of older leaves extend horizontally and make a shelter over the young parts.

b. Evergrowing trunk-tree

α. Trunk and branches both evergrowing

Casuarina equisetifolia, *Canarium odoratum*, *Macaranga triloba*, *Knema malayana*, and *Adinandra dumosa* belong to this category. *Adinandra* represents a typical case of the broad-leaved evergrowing tree. The leaves are formed in 2/5-phyllotaxis and both the main axis and lateral branches grow continually, bearing flowers afterwards in their leaf-axils. In *Canarium* most lateral

branches are drooping and, after growing a few metres without thickening and branching, fall away from the abscission layer at the base: they are, so to speak, a kind of short shoot functionally. *Macaranga* is a well known ant-plant (CORNER '40, p. 263). The ants remove with the growth of twigs to the upper internodes successively. It seems difficult for ants, if the branching be sympodial. The South American ant-trees, *Cecropia* and *Triplaris*, are also terminal in their growth.

β. *Trees with evergrowing trunk*

Glochidion and *Taraktogenus* may be cited. *G. superbum* and others bear on their main axis narrow scale-leaves only, and this main axis grows slowly. In contrast, the lateral branches bear leaves in two rows (CORNER, l.c. Pl. 58). The leaf, or leaves, at the basal part of the twig are small; the next are bigger; and, then, they become smaller again. With further growth of the twig the undulation of the leaf-size is repeated. I observed three such undulations on one twig. This does not however depend on the seasonal change of the climate, as the phase of fluctuation is not the same for all branches. It indicates therefore the very beginning of the rhythmical growth of the twig (§ 10).

γ. *Trees with evergrowing lateral branches*

Anisophyllea disticha and *Horsfieldia sylvestris* may be mentioned as interesting cases. In *A. disticha* the main axis produces only small leaves, and from this axis 5 lateral branches develop in pseudo-whorled arrangement periodically. The leaves on each branch are arranged spirally in 4 rows, but distinctly anisophyllous with two small upper rows and two large lower rows (CORNER l.c. Pl. 15), just like the shoot of *Selaginella*. That the dicotyledonous tree and *Selaginella* can assume an analogous form is very remarkable. Similar instances are also recorded in Hepaticae, Musci and Podostemonaceae (GOEBEL 28, p. 317).

In contrast another species of *Anisophyllea*, *A. Griffithii*, bears the usual coriaceous leaves on the twigs. They are apparently alternate, but, on close examination of the young twig, it is seen that the leaves are opposite, but the upper leaf of each node, on account of a strong hypotropous anisophylly, dies away so early in development that one can hardly find its remains.

Horsfieldia is many-stemmed when grown in the open. The main axis of each stem produces in every season (perhaps half a year) ten leaves in 2/5 phyllotaxis, the lower five of which have long internodes but no axillary branches, while the upper five with short internodes produce axillary branches, which bear big leaves of the

same size (35×6.5 cm.) in two alternate rows equidistantly (± 2.4 cm.). These branches grow continually without noticeable secondary thickening and branching, so that they hang down gradually, attaining finally 3–5 m., producing small flower-clusters in the leaf-axils or on the branch behind the leaves. These branches are therefore likewise short shoots as in *Canangium* (mentioned above). The branches, though without abscission layer, fall off just like a long compound leaf, lying then sinuously on the ground like snakes.

c. Evergrowing ramiferous trees

This is the most usual type of tree, in which from the trunk large limbs ramify gradually to slender branches and twigs. Such trees are generally monopodial in young stages, but sooner or later the main axis ceases to grow or lateral branches grow vigorously and represent main limbs and branches. Of the evergrowing, ramifying type, there are many, for instance *Camposperma*, *Elaeocarpus*, *Commersonia bartramia*, etc.

2. The evergrowing tree with lateral growth

There are two types of growth, the substituting and the apposing, as already mentioned.

a. The substituting growth behind the inflorescence

The flowering of the terminal inflorescence is either seasonal, contemporary or non-seasonal according to species, but new shoots can be seen throughout the year.

In the seasonally flowering trees of evergrowing type, the season is once or twice every year according to species. As once-flowering trees may be named *Parkia speciosa*, *Cassia nodosa*, and *C. siamea*. In the last named, the growth of branches is tolerably irregular and the flowering continues from May to October according to branches, so that it seems rather manifold or represents a transitional case to it. Perhaps the species originated in the monsoon region and is tending to everflowering in Singapore.

As twice-flowering trees, there are *Ervatamia dichotoma*, *Albizza falcata*, *Enterolobium samart*, and *Cassia multijuga*, among which the last named *Cassia* is also irregular in the branch-growth and its flowering continues for three months every season.

Among the contemporary flowering trees, there are shrubby *Coffea* spp. and *Stenolobium stans*. The latter flowers several times every year gregariously, stimulated probably by the temperature-fall, as in *Coffea*. The irregularly branched raceme contains flower-buds of various ages (CORNER l.c. Fig. 44) and only the older

buds react to the stimulus, while younger ones wait for the next chance. New lateral shoots grow all the time irregularly.

As trees of non-seasonal flowering, there are *Cerbera*, *Ochrosia*, *Kopsia*, *Plumeria*, *Ixora*, *Vitex* and others. The flowering is more conspicuous twice every year, but the flowering can be seen at any time, so that it seems to be transitional to manifold growth and flowering. This is especially the case in *Kopsia* and *Plumeria*. *Wormia suffruticosa* has continual substituting growth. The inflorescence is terminal at every node, but the axillary vegetative bud grows early and assumes the terminal position, so that the inflorescence seems opposite to the subtending leaf. *Jatropha multijuga* has the same mode of growth.

b. Apposing growth

Fagraea fragrans grows luxuriously in Singapore with a handsome crown and is well adapted to the soil-conditions. It is originally monopodial, but in open ground develops often "sub-trunks" with big limbs. They branch in *Terminalia*-fashion and are evergrowing. Each short shoot produces one pair of opposite leaves every two months, and counting from the number of leaf-scars, each short shoot dies away after about 6–7 years, but new shoots are added one by one laterally, extending the branches outwards. Flowers in axillary clusters are conspicuous in May and October (§ 12). *F. gigantea* also shows apposing growth in the same fashion.

Apposing growth is not confined to evergrowing trees, but occurs also in trees of manifold and intermittent growth, some of which are deciduous, as mentioned below:—

Manifold: *Achras Zapota*, *Palaquium gutta*;

Intermittent: *Pterocymbium tinctorium*, *Terminalia Muelleri*;

Deciduous: *Sterculia macrophylla*, *Firmiana fulgens*.

§ 8. Trees with branches of manifold growth

So long as a tree shows continuous growth, there is no manifold growing. In lateral-growing trees, if the development of axillary buds occurs in every branch non-seasonally, it may be regarded as a manifold growth in short steps. In typical manifold-growing trees, however, whether the growth is terminal or lateral, one can discern the growing and resting branches, or the vegetative and flowering branches at a glance. This is seen very often in sympodially growing trees, because even a slight difference of the development phase of new shoots behind the dying twig or inflorescence exerts a further shift of growth and this affects the growing phase and emphasizes the individual differences more and more.

This is the usual case of manifold growth accompanied by lateral branching. But there are still two other cases of the manifold growth. The one is the big tree in general. As a tree grows taller, the light-condition, the ascent of sap, etc., become uneven according to the position of the branches, and, so far as the climate is uniform, exerting no seasonal restriction, each branch may submit to a position effect and the result tends to be manifold.

As the second case, various exotic trees may be named. Most of them are adapted inherently to the dry or cold season with intermittent growth, and even under the uniform climate the tendency does not disappear so easily in each twig. By a combination of twig-individuality and position-effect, the manifold growth is emphasized. This is not only the case in the warm region, but observed also in the cool alpine region with uniform climate. For instance, temperate trees as *Magnolia*, *Pyrus* and others, transplanted to the Alpine Garden of Tjibodas (1425 m) of Java, show similar manifold growth (HABERLANDT '93, SCHIMPER '98, FABER '35). I have observed also these features in that Garden, as well as on the summit of Mt. Tankoeban Prahoe (2076 m), where *Vaccinium varingiifolium* shows typical manifoldness remarkably.

So far concerns the branchwise manifold growth. As to the stockwise manifold growth, it is very common in transplanted trees, e.g. *Lagerstræmia flos-reginæ*, *Cassia fistula*, *Delonix regia*, *Spathodea campanulata*, *Hevea brasiliensis* and various other avenue trees. Perhaps at the time of transplanting of nursery trees, a slight difference in treatment, as the cutting away of branches and roots, affects the further growth of the young trees, and, as there is no climatic restriction, each tree or branch take its own way and manifold growth follows gradually.

1. Terminal manifold growth

This is observed in intermittently growing trees and there are transitions from nearly evergrowing to deciduous, e.g. *Myristica fragrans*, *Eugenia aromatica*, *Michelia alba*, *Carapa guianensis* and some genera of Leguminosae.

Myristica seems at a glance to be evergrowing, but really intermittent in a slight degree. In the Moluccas, its native district, the fruit-season is once every year, so the tree in Singapore seems to be converted to manifold growth of nearly evergrowing habit. The axillary flowers develop in ascending order one by one and the fruits of various size are seen in various positions on twigs here and there. For *Eugenia aromatica* the condition seems almost the same, though no flower is seen.

Michelia alba is of continental origin and in the north and middle part of Malaya it is more or less deciduous (CORNER, l.c. p. 434), but in Singapore it is evergreen and manifold. Both the resting and growing bud are covered by the characteristic scale-like stipules of the family. It grows twice every year vigorously, but new shoots can be seen throughout the year with fragrant white flowers, more abundant in some stocks than others.

Carapa guianensis produces brown or light green new shoots here and there over the dark green crown. The resting buds are covered densely by ten or more scale-like petioles even in Singapore. In Ceara (4° S), Brazil, the tree is deciduous (IHERING '23).

Amherstia, *Brownea* and *Saraca* show the most conspicuous manifold growth represented by new, white or brown, hanging shoots mingled with the green crown. Besides, some conifers, such as *Pinus Massoniana*, *P. Merkusii* and others, also grow manifoldly in Singapore.

2. Lateral manifold growth

a. Substitution of the withered apical part

In some trees one or more apical buds of twigs wither after producing a certain number of leaves. New shoots then arise from the buds of the proximal part and substitute with their new growth. The withering has no intimate relation with the season, so that the new growth becomes manifold. *Crataeva Roxburghii*, *Semecarpus sinensis*, *Pistacia formosana*, and *Sapium sebiferum* (deciduous in China) are instances.

b. Substitution of the inflorescence

Tectona grandis grows well in Burma, East Java and other monsoon regions and is deciduous, while in Singapore it tends to be evergreen, though the growth is poor. The development of the shoot is extremely manifold, forming the terminal inflorescence non-seasonally. *Crataeva* (mentioned above) also forms a terminal inflorescence sporadically.

c. Apposing growth

Achras zapota is, though evergreen, distinctly intermittent in the growth of its successive short shoots. The resting bud is covered by petiolar scales and the growth of twigs is fairly manifold, so that the ripening of axillary fruit is non-seasonal. *Palaquium gutta* of the same family shows a similar mode of growth, though nearly evergrowing.

d. Stockwise manifold growth

The leafing, flowering or leaf-fall of each stock proceeds in this case with different phase, indicating that the climatic influence is rather ineffective for periodicity. This is especially noticeable in avenue trees with attractive flowers or young foliage. *Lagerstroemia flos-reginae*, *Cassia fistula*, *Peltophorum pterocarpum*, *Delonix regia*, and young trees of *Spathodea campanulata* give to travellers an impression, that the tropics is the land of everflowering. The bright-red foliage of *Cinnamomum iners* is likewise striking.

The flowering season of *Cycas Rumphii* is also stockwise manifold and, as it is dioecious, the pollination may sometimes be missed, when the trees are not abundant.

§ 9. Intermittent growth

In this case the unfolding of new leaves occurs periodically every year once or more, and full-grown shoots show a fluctuation in the size of leaves as well as in the length of internode, with resting buds on the apex and in the axils. The mode of branching, terminal or lateral, has no direct connection with the periodicity. As trees of terminally intermittent growth, there are *Kurrimia paniculata*, *Quercus conocarpa*, *Durio zibethinus*, and as the substitutingly intermittent ones *Xanthophyllum Curtisii* and *Cleistanthus heterophyllus*. Those with intermittently apposing growth have been stated already (§ 7-2-b).

For the covering of resting buds in the tropics, there are various modes and grades. Some are nearly naked as in the growing bud, but others are covered tightly by scales derived from the petiole, stipules or modified leaf-base or blade.

The axillary buds are usually in the resting condition. They are sometimes naked, sometimes covered by a pair of prophylls. This is also the case in the evergrowing trees (§ 22).

New foliage is usually light green, sometimes brownish red or even blue (CORNER, l.c. p. 85), and often more attractive than the flower. When strolling in the forest, one will notice very often, that many trees are in new leaf gregariously. This appearance is very common after a dry spell of several days, but one can see at any time new leafing here and there, denoting that new leafing is induced either by the weather condition or by the internal activity, facultatively or by a combination of both.

In trees with intermittent growth, therefore, there are three types of the leafing: the seasonal, the contemporary and the non-seasonal. In the seasonal leafing the frequency is 1-3 times every year, twice being the most usual in Singapore. Contemporary leafing is not regular in calendar months, and occurs in accordance

with a slight change of the weather. Non-seasonal leafing is much more irregular. Some instances of leafing are as follows (Roman number denotes the month):—

- (a) Seasonal leafing: once every year: *Emblica officinalis* (III), *Parkia speciosa* (III), *Erythrina lithosperma* (X); Twice a year, chiefly in February to March and August to September after the dry spell: *Kurrimia paniculata*, *Castanopsis* and *Quercus* spp., *Calophyllum inophyllum*, *Garcinia mangostana*, *Parinarium corymbosum*, *Nephelium lappaceum*, *Gordonia* spp.; thrice a year: *Eugenia grandis* (III, VII, XII).
- (b) Contemporary leafing: *Flacourtia rukam* (3 times), *Cinnamomum iners* (3–4 times), *Rhodamnia trinervia* (4–5 times). In *Cinnamomum* one can see, besides the usual contemporary leafing, sporadic leafing according to stocks at any time of year, or the non-seasonal leafing is here more or less combined. In *Rhodamnia* the leafing as well as the flowering in the same district is simultaneous, but the leafing and flowering do not necessarily coincide. Probably flowering is caused by a sudden fall of temperature, while the leafing is induced after a dry spell of weather.
- (c) Non-seasonal leafing: *Mangifera foetida* (less than one year) and many trees with non-seasonal leaf-fall.

§ 10. The transition from the evergrowing to the intermittent

In the tree-growth of the tropics, there are various transitions from the evergrowing to the intermittent and, further, to the deciduous (§ 11 and 22). The first indication of intermittent growth developing from evergrowing is fluctuation of leaf-size. *Bridelia tomentosa* grows continually in its main stem, and the lateral branches bear leaves in two rows alternately. But the leaves are not of uniform size, the spray showing a more or less waved outline as a whole. In long branches one can see three such waves representing three periods of growth. The leaf-size is larger in the middle part and smaller (ca. $\frac{1}{2}$ in size) in the proximal and distal parts of each period with shorter internodes. *Glochidion* of the same family shows likewise a fluctuation of the leaf-size, though it is more or less disturbed when secondary branches appear. Some conifers, such as *Araucaria Bidwillii*, *Dacrydium elatum* and one variety of *Cryptomeria japonica* (var. *araucarioides*), also show this fluctuation.

With further advance of the periodic tendency, a few proximal leaves of each season wrap up the inner part of the shoot, and fall off after development of the latter. For instance in *Rheedia madruno*, one or two leaves, though green, are merely $1/5$ of the normal length. In *Gordonia singaporeana* the first leaf of each season is small, light green and falls early. The second leaf is also a little smaller than usual, brownish-green in colour containing anthocyan, falling likewise early, and from the third leaf onwards the normal form is assumed. In *Myristica fragrans* the resting bud is naked and the proximal two leaves embrace each other, protecting the inner leaves, and fall early after elongation of the shoot.

With still further development of the intermittent tendency, the growing point becomes a resting bud, formed after the production of a number of leaves, initiated by primordia as incomplete coverings, or well-developed scales, wrapping a number of younger leaves. The bud-envelope is represented sometimes by incomplete leaves, at other times only by petioles or stipules without blade. When the petiole serves as the covering, the lamina does not develop well (*Achras zapota*). When the leaf is sessile, the covering may change gradually from scales to the normal leaf (*Lucuma*), and, in the cases of the stipulate leaf, the entire leaf-element may form at first a scale (*Aporosa nigricans*), or at first only stipules are formed and then, after forming some prophylls, the foliar leaves develop abruptly (*Kurrimia paniculata*) or with gradual transition (*Brassaia actinophylla*).

How shall we then define the intermittent growth in contrast to the evergrowing, as they are only of gradual change in nature? It seems, however, adequate to define the shoot as evergrowing, when leaves at the onset of the new shoot, even if small in size, remain as assimilating leaves, as in *Bridelia* and *Rheedia*. But, if the leaves, even if green, are distinctly small and fall off early (*Myristica*) or show a difference in size and colour (*Gordonia*), one may define the shoot-growth as intermittent. Such a rhythmic character of the shoot is quite independent of climatic changes and is undoubtedly caused by inherent hormonal activity on the growing point, by which the formation, growth and senescence proceed periodically, often with a pre-determined number of leaves (§ 23).

KLEBS ('15) once claimed that the periodicity of tree-growth could be controlled artificially. But the continual growth of trees is seen only in evergrowing trees or saplings, which latter tend then to rhythmic growth. The opinion that the supply of minerals may cause the evergrowing or intermittent growth is also inconceivable, as in so uniform a climate as Singapore both types of tree, the

evergrowing and intermittent, flourish side by side, and also stockwise manifold growth occurs. At any rate, the basic cause is the inherent factor, by which the trend to periodicity is determined.

§ 11. Deciduous trees

In evergreen trees with intermittent growth, the older leaves fall off after new leafing. But there are trees in which leaf-shedding precedes new leafing, exposing thus naked branches, and thereby characterising the deciduous tree. In them three phases of development, leaf-fall, naked branches and new leafing, follow successively. The mode of branching is not intimately related, whether it is the terminal (*Ficus*, *Hevea*), the substituting (*Cassia fistula*, *Lagerstromia* spp., *Sapium discolor*) or the apposing growth (*Terminalia catappa*, *Sterculia macrophylla*).

The naked phase is usually not very long in the tropics, though flowering or fruiting may even proceed during this spell, e.g. *Parishia insignis*, *Cratoxylon formosum*, *Firmiana fulgens*, *Parkia javanica*, *Cochlospermum religiosum*, and *Oroxylum indicum*. In regions with a long dry spell, the number of such flowering trees increases much more (TROUP '21).

1. Transition from the intermittent evergreen to the deciduous

In Singapore the resting period of trees is rather short and sometimes indistinct. Usually the spell is one week or so, rarely a few days only. Moreover there are some trees, in which new leafing begins before leaf-fall has finished. Various irregularities occur too.

As an instance, a para-rubber tree in the Botanic Gardens showed in March, 1944, from the top downwards, a transition of new foliage, naked branches, tinted leaves and old green leaves, and in April of the next year the same nuance of phases. The tree took for the leaf-change of the entire crown nearly three months.

Swietenia macrophylla from Central America is, so to speak, a deciduous tree, but most avenue trees of it have emitted new brown shoots by the time the old leaves are falling off. *Dyera costulata* is deciduous, but I saw once on a big tree in the Gardens that the old leaves remained on a few of the lowest limbs until the next period of leaf-change. Trees tend in general to be more irregular in their periodicity, the bigger they grow.

Thus the transition from the deciduous to the intermittent-evergreen may be classified in four stages:—

- (1) Holodeciduous: entire crown becomes bare at least for a few days: *Peltophorum pterocarpum*.

- (2) Semideciduous: new and old foliage, as well as naked branches, appear irregularly according to the height, direction, etc. of branches: *Hevea brasiliensis*.
- (3) Vice-deciduous: leaf-fall is finished during one week promptly, but new shoots appear before old leaves fall off completely: *Swietenia macrophylla*.
- (4) Semi-evergreen: some branches do not shed leaves till next season, tending to be intermittent-evergreen: *Dyera costulata*.

Naturally these grades of the leaf-fall are not absolutely constant, and may be shifted according to year or district. Deciduous trees of N. Malaya can easily become semi-deciduous in Singapore, if the season is not sufficiently dry.

Both the leaf-fall and new leafing occur in most trees nearly simultaneously, but in some the leaf-fall proceeds gradually for 2-4 months, while the new leafing occurs at once, as in *Sapium discolor* and *Terminalia subspatulata*. These cases indicate that the new leafing does not necessarily follow on the formation of the abscission layer of old leaves. Both of them are independent processes (§ 18) and, if the former occurs earlier than the latter, the tree is evergreen, while it is deciduous when the former is delayed.

2. The leaf-period and the date of leaf-fall and leafing

The duration of the leaf-bearing period of deciduous trees in Singapore is three months to more than two years. They may be seasonal or non-seasonal, and the latter may be contemporary.

Seasonal leafing or leaf-fall is in most cases once or twice in a year, chiefly after a dry spell, rarely thrice. Non-seasonal leafing is sometimes shorter than one year and sometimes longer according to species. We may designate them as the "shorter" and "longer" leaf-period of deciduous trees respectively.

(a) The average date of leafing of seasonally deciduous trees (The names in brackets indicate exotic trees: e: early, m: middle, and l: later part of the month given in Roman numerals) (HOLT-TUM '40, CORNER '40).

(1) Once every year			(2) Twice every year		
(<i>Canarium rufum</i>)	..	V, e	(<i>Couroupita guianensis</i>)	15/III, 20/IX	
(<i>Cariniana</i> sp.)	..	VIII, m	<i>Elaterospermum tapos</i>	..	I, VII-VIII
(<i>Hymenaea courbaril</i>)	..	II	<i>Peltophorum pterocarpum</i>	12/II, 10/VIII	
(<i>Kigelia pinnata</i>)	..	I, l	(<i>Pentaspadon officinale</i>)	III-V, X-XI	
<i>Parkia javanica</i>	..	II, l	<i>Terminalia catappa</i>	..	2/II, 11/VIII
<i>Terminalia subspatulata</i>	..	IV, e	(3) Thrice every year		
			<i>Ficus caulocarpa</i>	..	I, l; VII, e; XI, e

(b) The mean leaf-period of the non-seasonal deciduous trees (HOLTTUM, l.c.).

(1) Shorter Period	Months	(2) Longer Period	Months
<i>Ficus variegata</i>	6.1-6.5	(<i>Hevea brasiliensis</i>) ..	13.3
<i>Sterculia macrophylla</i> ..	6.9-7.0	(<i>Homalium graniflorum</i>) ..	13.7
<i>Adenantha pavonina</i> ..	7.25	<i>Anisoptera megistocarpa</i> ..	13.8
(<i>Delonix regia</i>)	8.8	<i>Cedrela glaziovii</i> ..	14.0
<i>Cratoxylon formosum</i> ..	9.1	<i>Caesalpinia ferrea</i> ..	14.2
<i>Lagerstroemia flos-reginae</i> ..	8.1-9.4	<i>Parishia Maingayi</i> ..	15.6
<i>Cassia fistula</i>	9.1-10.5	<i>Heritiera elata</i> ..	20.5
(<i>Salmalia malabarica</i>) ..	9.3-10.5	(<i>H. macrophylla</i>) ..	26-37
<i>Cassia nodosa</i>	11.7		

§ 12. The flowering season

The flowering season may similarly be arranged into four groups: continuous, seasonal, contemporary and non-seasonal.

Continuous flowering follows as a natural sequence in some evergrowing trees, in the leaf-axils of which the flower buds are formed, though evergrowing trees are not necessarily everflowering. Seasonal flowering takes place 1-3 times every year according to species, and in definite season. Contemporary flowering occurs, though not at a definite season, in all trees of a species in the same district simultaneously. Non-seasonal flowering is indefinite in the calendar year and can vary by branches and stocks according to species, so that branchwise and stockwise manifoldness appear.

Flowering occurs sometimes in consequence of the development of new shoots, on which the flower is afterwards formed. This is especially the case with the terminal inflorescence of the shoot of each season. But in trees with axillary, ramiflorous, or cauliflorous flowers no such relation exists or climatic conditions are the chief cause.

Among trees with evergrowing shoots, about half flower continuously, while the rest are either seasonal, contemporary or non-seasonal. Most manifoldly growing trees are also non-seasonal in flowering, but some are seasonal in relation to the climate. Among intermittently growing trees, the seasonal leafing shoot is also seasonal in flowering, and on the non-seasonal leafing shoot follows generally the non-seasonal flowering, too.

1. The flowering of evergrowing trees

Evergrowing trees are not all everflowering. If the flowers are formed in the axils of twigs and open successively, they are everflowering. But if the flowering is controlled by the weather, it may tend to seasonal or contemporary flowering. If the shoot growth is substituting and the inflorescence is terminal, the flowering may become seasonless according to the shoot growth. And when the formation of flower buds is sporadic, as in the lateral branches of *Anisophyllea disticha*, so the flowering is optional or non-seasonal, even if the branches grow continuously. The following instances are the chief cases of flowering types of the evergrowing trees:—

- (a) Everflowering: *Carica papaya*, *Adinandra dumosa*, *Archytæa Vahlîi*, *Commersonia bartramia*, *Glochidion* spp., *Macaranga* spp., *Hibiscus* spp., *Thespesia populnea*, *Scaevola frutescens*, *Sesbania grandiflora*, *Leucaena glauca*, *Mimosa sepiaria*, *Solanum Wrightii*, *Symplocos fasciculata*, *Wormia suffruticosa*, *Psidium guajava*, *Melastoma malabathricum*.
- (b) Seasonal flowering: Twice a year: *Casuarina* spp., *Fagraea fragrans*, *Artocarpus*, *Morinda*, *Gardenia*, *Horsfieldia*. Once a year: *Hydnocarpus*, *Elaeocarpus* spp.
- (c) Contemporary flowering: *Stenolobium*, *Coffea*, some Orchids.
- (d) Non-seasonal flowering: *Arthrophyllum*, *Bridelia*, *Canarium*, *Leea*, *Mallotus*, *Rhizophora*.

2. Seasonal flowering

This is intimately correlated with the climatic course, but two cases must be distinguished. The one is that in which the leafing is associated with the season, so that the flowering occurs as a consequence also seasonally. The other is that the flowering is induced directly by the seasonal change, independent of the leafing. To the former belong the evergreen, the intermittent and the deciduous trees either with the terminal or axillary inflorescence, and to the latter the evergrowing and intermittent-growing trees with either terminal, axillary or cauline flowers. Some instances are tabulated below. The number in brackets indicates the frequency of flowering in every year.

a. Seasonally leafing tree

Flower terminal:	deciduous— <i>Peltophorum pterocarpum</i> (2).
Flower axillary	evergreen { <i>Eugenia grandis</i> (3). <i>Garcinia mangostana</i> (2).

b. Seasonally flowering tree

Flower terminal—*Fagraea auriculata* (1).

Flower axillary—*Fagraea fragrans* (2), *Casuarina* spp. (2),
Erythrina subumbrans (1).

Flower ramiflorous—*Horsfieldia sylvestris* (2).

Flower cauliflorous—*Durio zibethinus* (2).

Casuarina equisetifolia is distributed from Australia to the eastern coast of India, adapted to typical monsoon regions. So, even under evergrowing conditions in Singapore, it shows two flowering seasons, probably as a specific character. The flowering of *Fagraea fragrans* is however a little different. The flower-buds are formed in the dry spells of February and July and open in May and October. The flowering is especially conspicuous in May (HOLTUM '35), but it fluctuates more or less according to the year. For instance, in February, 1945, it was rainy and a short spell of rainless days came in April, so that most trees were seen in flower July to August. In big trees, however, some branches flowered in May tending to be slightly manifold. Besides, some young trees flowered in March or in December of the previous year; thus even a stock-wise difference was noticed. For the anthogenesis of *Fagraea* there is necessary, therefore, the timely co-operation of the internal tendency with the external climatic course.

Generally, if the formation of flower-buds is controlled by weather and in one season the weather is not effective enough, so the trees can not react uniformly all together. In some stocks or branches the bud-formation can diminish or not occur. Then this irregularity can exert a compensatory after-effect at the next season, so that even seasonal flowering tends to be seasonless or manifold.

3. Contemporary flowering

In this case the young buds formed can not flower right away; they rest in a certain stage of development, waiting for the sudden fall of temperature by a shower, by which they are stimulated to grow anew, and after a certain number of days all flowers of the district open gregariously. They are called the temperature-flowers (CORNER, l.c.p. 38).

The most conspicuous gregarious flowering was studied with *Dendrobium crumenatum*, an epiphytic orchid, in detail (COSTER '26, KUIJPER '33). Among trees and shrubs, *Pterocarpus indicus*, *Murraya paniculata*, *Randia macrantha*, *Stenolobium stans*, and *Coffea* spp. may be named (HOLTUM '40, CORNER '40). The inflorescence of *Pterocarpus* follows on the new leaf-growth;

the buds are formed in successive stages of development, and the old buds react to the temperature fall, while the younger ones wait for the coming chance, so that the flowering of an inflorescence is divided into several stages with pauses of a few days or more. The flowering of *Pterocarpus tinctorius* of Africa is also divided into four periods (v. NOLDE '40). *Stenolobium stans* forms the inflorescence throughout the year and one can see gregarious flowering about ten times every year. Besides, *Flacourtia rukam* shows 2-3 times and *Rhodamnia trinervia* 4-5 times, flowering and fruiting.

4. Non-seasonal flowering

This is seen in shoots and stocks of manifold growth with the inflorescence either terminal, axillary or ramiflorous.

a. Branch-growth manifold

Inflorescence { terminal—*Cassia splendens*, *Vitex*, *Kopsia*,
Ixora.
axillary—*Michelia*.

b. Stock-growth manifold

Inflorescence terminal—*Lagerstroemia flos-reginae*.

Anthocladium terminal—*Delonix regia*.

Inflorescence ramiflorous—*Cassia fistula*.

Branch and stockgrowth manifold—inflorescence terminal—*Spathodea*.

The shoot of *Kopsia* produces a terminal inflorescence after some pairs of leaves are formed, and, while the flower-buds are still young, the lateral branches grow out to a tolerable size. This mode of growth is repeated irrespective of the season, so that both the flowering and the shoot-growth go on non-seasonally together. In *K. singapurensis*, though the flowering season predominates in two seasons every year, yet one can see some flowers at any time, and in *K. fruticosa* the flowers are seen throughout the year. *Thevetia*, *Ochrosia* and *Cerbera* of the same family, and *Ixora* and *Vitex* show similar behaviour.

Spathodea produces a terminal inflorescence on each substituting new shoot, and each inflorescence bears scores of buds opening successively, so that old trees are decorated with big flame-red flowers all over the crown the year round.

Among the four groups just mentioned, the everflowering and the non-seasonal ones are controlled inherently, while the contemporary and seasonal ones, though inherent originally, are actually induced at the last step by some trifling change of the weather.

In the humid region of the temperate zone, the formation of flower-buds is controlled generally by the temperature and photo-period, and in trees it is induced chiefly by the seasonal change of temperature, while a dry spell, even if it may affect the abundance of flowers, does not control anthogenesis. In Singapore, on the contrary, there is no seasonal change of temperature and photo-period, but the length of the dry spell, accompanied by intensified insolation and thermoperiod, and the sudden fall of temperature during a shower are the chief meteorological conditions. Some species of trees are sensitive to such slight weather changes for their anthogenesis.

§ 13. The fruiting season

The ripening of fruit after flowering takes usually 2–5 months according to the species. In some cases flowering is the morphological sequence of the leafing, but in others not. In the former case, leafing, flowering and fruiting are three consecutive processes, while in the latter the season of fruiting is subject only to the flowering. But the ripening of fruits is sometimes affected by their position on the branches or the inflorescence. For instance, the raceme of *Adenanthera pavonina* develops soon after the leafing of every seven months period (§ 11–2), and it flowers gradually during two months, but the ripening of pods continues for several months, so that the glossy red seeds are dispersed nearly throughout the year.

In Singapore anthogenesis is induced chiefly in the dry spells of February and July; the flowering follows two months later, and the fruiting is most abundant in June to July and January. This is remarkable in durian, mangosteen and rambutan, though one and the same tree does not produce every season regularly. According to OCHSE ('31), these fruits appear in Java only once every year with longer duration than in Singapore.

The fruiting season of the everflowering *Averrhoa* and *Psidium* and of the manifoldly flowering *Achras* is extremely long, so to speak nearly non-seasonal, though with fluctuation. *Flacourtia rukam* fruits 2–3 times contemporarily. *Papaya*, *Musa* and *Ananas* show stockwise manifoldness of fruiting, so that they serve as good table-fruits throughout the year.

§ 14. The frequency of species in the four types of periodicity

The number of species I could examine personally or extract from the literature (RIDLEY '22-24, CORNER '40) amount to 543, belonging to 298 (211 + 87 exotic) genera and 73 families (after ENGLER's system). There are still 13 other families in Malaya containing trees, which I could not investigate.* *Achras*, *Aleurites*, *Anacardium*, *Anona*, *Carica*, *Ceiba*, *Delonix*, *Hevea*, *Jatropha*, *Leucaena*, *Muntingia*, *Plumiera*, *Psidium*, *Sesbania*, *Spathodea*, *Thevetia* and others are included as exotic genera. Under the exotic species observed, those that are not common in Malaya are all those planted in the Botanic Gardens, Singapore. Among exotic trees enumerated in the Appendix, there are four families not indigenous to Malaya, namely Salicaceae, Bixaceae, Papayaceae and Cactaceae. Besides, there are some families or genera in which only exotic species are treated, though the families or genera themselves are indigenous to Malaya, as Pittosporaceae, Polygonaceae, Proteaceae, Solanaceae, Thymeliaceae, as well as various genera.

Naturally there is no boundary between shrub and tree, and there are many shrubs that grow continually just like young trees, but shrubs as *Lantana* and *Ardisia* are omitted from the list, as there are many trees in these families, while big evergrowing shrubs of Goodeniaceae, Solanaceae and Asclepiadaceae are added.

Among the Malayan families, those containing evergrowing trees amount to 35, or nearly the half of the total families examined. Families containing deciduous trees amount to 32, or about the same as those of the evergrowing ones. Compared with them, the families containing intermittently growing trees are the most abundant, namely 48, or including the exotic families 52. The number of species in each group was as follows (exotic species added in brackets), though sharp boundaries between the growth-forms do not exist:—

evergrowing	manifold	intermittent	deciduous
103 (46)	14 (26)	154 (60)	108 (31)

It may be remarked, however, that the deciduous trees are all easily noticeable in contrast with the evergrowing trees, while the latter are not distinguishable unless actually examined, so that the number of the latter given above seems distinctly less than the actual rate. Concerning the intermittently growing trees, as the writer observed only a few species of the genera which contain

* Gonystylaceae, Staphyleaceae, Sabiaceae, Samydaceae, Styraceae, Acanthaceae, Caprifoliaceae, Crypteroniaceae, Cunoniaceae, Epacridaceae, Monimiaceae, Hermandiaceae, Opiliaceae.

many similar species, the number given above is also distinctly less than the actual rate. The manifoldly growing trees are much more numerous in exotic species than in the Malayan (26:14).

At any rate it may be asserted that among all tree-species of Malaya the evergrowing trees, even with the addition of Palmaeae, Coniferae and tree-ferns, amount to less than 20 per cent, probably 15 per cent. The deciduous trees total about 5 per cent over the whole Malay Peninsula, though some of them do not shed leaves in Singapore. The remaining 75 per cent are the usual evergreen trees with intermittent growth.

In Java, according to KOORDERS ('98) the deciduous trees amount to about 5 per cent among indigenous ones, distributed chiefly in the eastern and middle Java (FABER '35, p. 374). In Ceylon according to WRIGHT ('05, p. 463), deciduous trees make about 14 per cent among 650 indigenous species and 6 per cent (17 species) among endemic species.

The occurrence of deciduous trees in dicotyledonous families is fairly even, just like the evergrowing trees, being more abundant in big families (see Appendix).

How such a circumstance has been derived, is a thesis to be discussed further. If one observes the deciduous trees more closely, they are not all mesophytic; there are even hygrophilous-deciduous trees living in swampy ground, and contrarily there are some hygrophobic trees unable to grow in as wet a district as Singapore. From these facts, the interrelation of the deciduous trees and the environment seems much more indirect.

§ 15. Comparison of the leaf-fall and leafing periods of Singapore with those of Ceylon and Java

So far we have dealt with the behaviour of tree-growth in Singapore and Malaya. Now, if we compare its features with those of Ceylon and Java, it is very instructive to discover what characters of periodicity are easily affected by external influences. The most remarkable difference among the deciduous trees in these three regions is the calendar data of the leafing related to the monsoon.

From India to Indo-China the rainy season extends from May to October, especially rainy from June to September, and the dry season in winter from November to April. Temperature is relatively low in the first part of the dry season from December to January, while it is very hot from March to May on account of fine weather, but then, despite the sun's higher position, it gets cooler on account of the cloudy sky (WRIGHT '94, TROUP '21, CHAMPION '36). These changes of seasonal climate deviate naturally

with the distance and direction of the ocean as well as the mountain range. For instance in Ceylon, the south-west monsoon predominates from February to July and the north-east monsoon from August to January, so that the seasonal change is three months earlier, and moreover it differs according to the south-western side and north-eastern side of the island (WRIGHT l.c.). But as a whole, the general feature of the seasonal change in S.E. Asia is as mentioned above.

In India the deciduous trees of northern origin shed their leaves usually during the winter, those of southern origin mainly in the second half of the dry season, indicating the hereditary habit of their birth-place. In Peradeniya (473 m.) February is the most rainless and driest season, and about half of the deciduous trees (47 per cent) shed their leaves in this month; before and after that month the proportion decreases gradually until in the rainy season of September it attains the minimum (2 per cent) (WRIGHT, l.c.).

In Buitenzorg the monthly mean maximum temperature is 29° – 31° and the mean minimum 21° – 22.5° , so that there is no veritable seasonal effect on the growth of the plant (SCHWEIZER '32). Of the rain-fall, however, there is a notable fluctuation, though it is sufficient all over the year. From July to September the mean monthly rain-fall amounts to 135 mm., while in October it is 706 mm. On the other hand, in Soemaran, Middle Java, while in February the rain-fall amounts to 300 mm., in July to August it is less than 10 mm., and eastwards it diminishes more. In Pasoeruan, East Java, from August to September the mean rain-fall amounts to a few millimetres only (COSTER '23). Eastwards in Lesser Sunda Islands it diminishes more and more, with a longer dry spell, so that it tends to be the typical monsoon climate (RENSCH '30).

Thus the dry and rainy seasons are in Ceylon and Java diametrically opposite, while in Singapore, situated in the intermediate region, the climate is mild and non-seasonal. It is instructive therefore to compare the leaf-period of these three regions.

The leaf-period of various trees has been reported in India, Ceylon and Burma by WRIGHT ('94), TROUP ('21), STAMP ('25), CHAMPION ('36), in Java by VOLKENS ('12), SIMON ('14), COSTER ('23), and in Singapore by HOLTUM ('31, '40), CORNER ('40) and others. If we compare the leafing period or the leaf-fall season of some deciduous trees reported commonly in these regions, we can find a striking contrast between them, as has been stated by many authors already.

TABLE 5

The leafing or leaf-fall period in Singapore, Ceylon and Java after HOLTUM, COSTER and WRIGHT, l.c. (Month in Roman number).

Trees	SINGAPORE		CEYLON		EAST JAVA
	leaf-period (months)		leaf-fall period	bare days	leaf-fall period
<i>Adenanthera pavonina</i> ..	7.25	(6.0-8.5)	X-XII	30	—
<i>Delonix regia</i> ..	8.8	(7.7-10.6)	IV-V	—	VIII-X
<i>Lagerstroemia flos-reginae</i>	9.2	(8.9-9.4)	XII-I	27	—
<i>Salmalia malabarica</i> ..	9.9	(9.3-10.5)	XII-I	ca. 3 months	VII-X
<i>Cassia fistula</i> ..	10.6	(9.1-10.5)	II-III	18	VIII-X
„ <i>nodosa</i> ..	11.7	(11.0-12.1)	I-III	—	V-VII
<i>Tamarindus indica</i> ..	12.9	(10.0-17.7)	III-IV	—	VIII-XI

These trees in Singapore are, except *Tamarindus*, in their leaf-period all shorter than one year, while in other districts the leaf-fall is one year regularly with a shift of nearly half a year in the leaf-fall season. According to these data, the difference of climate has two effects on the periodicity—the shifting of the period as well as the leaf-duration. In other words, the active period of the tree-growth is transformed rather flexibly by environmental conditions. This is also the case with the grade of leaf-fall (§ 16), while the bud-forming ability, as we will see later (§ 23), is rather constant.

The vegetative period seems, therefore, the most easily movable character of trees in accordance with the change of climatic cycle. According to WRIGHT ('05, p. 7) the flowering season of *Acacia dealbata*, indigenous to south-eastern Australia, has been entirely shifted following the climatic cycle in the Nilgiris in India. It flowered from 1845 to 1850 in October just as in Australia, but then the flowering season was gradually advanced, in 1860 to September, in 1870 to August, in 1878 to July and lastly in 1882 to June, just the spring season of the new habitat. It took about forty years for the seasonal acclimatization. Whether a tree is able to acclimatize by lengthening the active period, the writer could not find a suitable example, though it seems not impossible according to the circumstances. In the trees mentioned in Table 5

(above), it is not known in what sequence they have had their active period transformed.

In non-seasonally leafing trees in Singapore, some are shorter and others longer than one year in their leaf-period (§ 11-2). *Cratoxylon formosum* in Singapore has a leaf-period of 9.1 months, while in Penang (HOLTTUM '40) and even in East Johore (CORNER '40) it shows a one year cycle normally, though the bare spell is not known. Probably the real vegetative period is longer than in Singapore. In contrast, the Para-rubber tree has in Singapore 13.3 months leaf-period, while it shows even in North Malaya 12 months regularly and in Ceara (4° S), Brazil, it stands two months in the resting condition. Singapore seems in this respect to be a favourable habitat for rubber production. For trees with a period of more than 13.7 months, we have no data from other districts to compare.

If one assumes that the leaf-period including the rest period* of deciduous trees is one year normally, except those with a half-year period, then this habit is maintained in those districts with distinctly dry or cold seasons irrespective of the length of the rest-period, and the periodicity in Singapore is shortened or lengthened according to the species as stated above. But in those regions with a long dry season, the vegetative period becomes far shorter than one year, so that the same trees with a short leaf-period at Singapore might display their proper length of activity, while those with a longer period might have lengthened their activity under the favourable conditions of Singapore. But if the active period of trees in Singapore be their natural length, then the length in dryer districts should be a forced one destined to become one year.

Very interesting in this respect is the fact that *Terminalia catappa*, which has a half-year period in the tropics and sheds leaves in Singapore about January to February and July or August, tends in Rio de Janeiro (23° S), according to a letter from Mr. Corner, to be of one year cycle with a long rest period in winter (May to October) when the leaves are gradually shed: it has, therefore, six months vegetative period grading into six months rest. The length of rest period seems, therefore, to be a flexible character, by adjustment of which the shifting of seasonal change is attained. Besides, there may be some trees in which the length of their activity has already become inherent at each habitat.

Trees of northern origin, as *Fagus*, *Carpinus*, *Ulmus*, etc., are provided probably with a one-year period, but those of southern origin as *Ficus*, *Mallotus*, *Albizzia*, of which some allied species

* The flowering and fruiting may occur during either the leaf-period or the resting period according to the species.

in the tropics grow continually, produce in the temperate zone their leaves until summer and close the shoot into a dormant bud in autumn. In these trees it is not clear whether the annual periodicity is inherent or induced. Leaves have their own life-time, but the shoot can continue its growth so far as the bud does not close.

§ 16. The grade of leaf-fall of trees in various districts

In Singapore, not only the leaf-fall and the length of active period, but also the grade of leaf-fall, are different from those of the other districts. Many species of trees occur on the Continent, in Malaysia and in other regions, aboriginally or by introduction. If one compares the behaviour of leaf-fall in these regions, the relative habit of trees against the dry season can be seen.

- (1) Evergrowing in Singapore, but deciduous in other districts:—

Trema orientalis (Himalaya to Polynesia).

Ficus elastica (Himalaya to Java. Leaf-fall in Ceylon II–IV irregularly).

Duabanga sonneratioides (India to N. Malaya. Leaf-fall in India in IV, the hot season).

- (2) Exotic trees evergrowing or evergreen in Singapore, but deciduous in original districts:—

Melia azedarach (N. India).

Antidesma bunius (Himalaya to Australia).

Sapindus mukorosii (China).

Mimusops elengi (India, Burma, Ceylon).

Tectona grandis (S.E. Asia. Leaf-fall in India XI–III, in Java VII–IX).

Tectona hamiltoniana (Burma, deciduous in hot season).

- (3) In Singapore semi-deciduous, in other districts deciduous:—

Ficus religiosa (India).

Tamarindus indica (Africa to Asia).

Albizia odoratissima (Himalaya to Siam).

Dillenia indica (India, Siam, Malaya).

- (4) Deciduous in N. Malaya, evergreen in S. Malaya:—

Elateriospermum tapos (W. Malaysia).

Dillenia ovata (China, Siam, W. Malaysia).

The effect of the dry season on the leaf-fall is clearly to be seen.

§ 17. The deciduous habit and the height of crown

Most shrubs and young trees in the tropics are evergrowing, while tall trees are often deciduous. It is stated that in the highest stratum of the primary forest in the tropics many deciduous trees are to be seen (RICHARDS '52). Indeed, with the raising of the crown, not only the ascent of sap gets difficult, but also the insolation and wind are far more intense than in the lower strata, so that the lifting high over the forest canopy may induce the deciduous habit or the habit may relate with the height of crown. *Dyera* and *Irvingia* are instances of deciduous trees more than 200 feet high. But there are also tall evergreen trees of the same height, as *Balanocarpus* and *Dryobalanops*. Trees projecting higher than 100 feet are more numerous among evergrowing trees than deciduous ones in Malaya and India (CORNER '40, TROUP '21), though this may be due chiefly to the abundance of evergreen species in the tropics. Tall trees in the same family are sometimes evergreen and sometimes deciduous as shown below. (Deciduous trees and the height of trees in feet in brackets).

Juglandaceae: *Engelhardia spicata* (100), (*E. nudiflora* 100);

Moraceae: *Artocarpus elasticus* (150), (*Antiaris toxicaria* - 150);

Leguminosae: *Parkia speciosa* (150), (*Koompassia excelsa* 150-260);

Anacardiaceae: *Melanorrhoea Wallichiana* (150), (*Melanorrhoea* sp. 150, *Pentaspadon* 2 spp. 150);

Sterculiaceae: *Pterospermum javanicum* (150), (*Sterculia macrophylla* 150).

It may be understood that tall trees are not all deciduous. Moreover there are many deciduous trees of relatively low height, as for instance: *Excoecaria agallocha* (30), *Cassia fistula* (30), *Sterculia rubiginosa* (30), *Flacourtia rukam* (40), *Lanea grandis* (50) and many others.

Even if the deciduous habit is fitted for the highest story of the forest, the bare period is usually short, and in wet regions or in the wet season it seems rather a waste of time for photosynthesis. If one examines the deciduous trees more closely, it becomes clear that the deciduous habit is not merely related with dryness alone. Viewed from their distribution in the tropics, the deciduous trees are not all xerophobic, on the contrary some are even hygrophobic as stated below.

§ 18. Deciduous trees and their habitats

In the temperate zone the texture of the leaves of deciduous trees and of evergreens are clearly distinguishable, namely membranous versus coriaceous, while in the tropics of uniform climate both kinds of leaf-texture are found as a generic character either in deciduous or evergreen trees, whether their habitat be wet or dry. One can not decide, therefore, from the leaf-texture alone either habit or habitat. This may be attributed to the circumstance that, under uniform climate, trees are allowed to grow continually, irrespective of their leaf-texture. On the other hand, even if the leaf is coriaceous, it tends to be deciduous, if the abscission layer is formed earlier than the new leafing, as in *Ficus caulocarpa* and others.

Most deciduous trees are mesophytic, but there are also some hygrophilous and hygrophobic trees, though the water-condition of the soil and of the air is not necessarily the same.

Hygrophilous deciduous trees indigenous to Malaya, growing in lowland forest or swampy ground are *Anisoptera megistocarpa*, *Beilschmiedea malaccensis*, *Canarium rufum*, *Excoecaria agallocha*, *Mallotus* sp., *Terminalia phellocarpa*, and *T. subspathulata*. The *Mallotus* sp. is an undergrowth tree deciduous in the swampy forest and shows that the deciduous habit can develop even in wet forest. *Excoecaria* grows in the mangrove zone. Among trees of wide distribution, some are hygrophilous and deciduous. For instance, *Cedrela toona* grows on wet soil of valleys and riversides; *Bischofia javanica* is a deciduous tree, which however tends to be evergreen in wet ground (TROUP '21). The teak-tree of monsoon regions tends to be semi-deciduous on riversides in the flood-zone (SIMON '14, COSTER '23), but in Singapore its growth is inferior and manifold (§ 8-2). Probably the shoot is hygrophobic, but the root is slightly hygrophilous. Trees which are semi-deciduous or evergrowing in S. Malaya, but deciduous in other districts, seem generally to be mesophytic or slightly xerophobic.

Among deciduous trees there are some which seem rather hygrophobic. SCHIMPER ('98, p. 262) stated that some trees shed leaves in the wet season. In Ceylon there are also about 2 per cent of deciduous trees, which shed leaves in the September rainy season (WRIGHT, '05). In Java *Spondias mangifera* sheds leaves in the wet season of January to April, and *Tetramelis nudiflora* in December (SIMON '14). In Trengganu (Malaya), an unidentified species of *Melanorrhoea* sheds its leaves in October and November at the beginning of the rainy season (CORNER, '40).

Leaf-fall occurs, not only after senescence, but also after a few days in the dark or under a wet bell-jar, in high temperature or other abnormal conditions. In the tropics the rainy season is often accompanied by damp and gloomy weather, so SIMON imagined that the leaf-fall may be attributed partly to these conditions. Naturally such a habit seems rather rare among deciduous trees in general, but there are still some that, considered from their distribution, seem to be hygrophobic. They are trees, which, in spite of their distribution widely in S.E. Asia or Malaysia or further to Australia or Africa, do not occur in Malaya or S. Malaya, as for instance:—

Ailanthus malabarica: India to N. Malaya.

Albizia lebbec: Africa to India and Australia.

Alstonia scholaris: Ceylon to N. Malaya, Java and Philippines.

Anthocephalus cadamba: India to north of Johore, Java to New Guinea.

Butea frondosa: India to China and Java, but not in Malaya.

Dillenia aurea: India to N. Malaya and Java to Philippines.

Diospyros montana: India, Australia.

Feronia limonia: India, Siam to N. Malaya.

Flacourtia indica: India, Malaysia.

Garuga pinnata: Himalaya to Siam, Java and eastwards.

Hymenodictyon excelsum: India to N. Malaya, Java to Philippines.

Neesia altissima: Siam to Penang, West Malaysia.

Oroxylum indicum: India, China to N. Malaya, Malaysia to Philippines.

Tetrameles nudiflora: India to N. Malaya, Java to Timor.

Ailanthus flowers and fruits in Penang, but it does not thrive in S. Malaya even under cultivation (BURKILL '35). *Tetrameles* sheds its leaves in the rainy season, as mentioned above.

Roughly speaking, the deciduous habit is an internal process, in which the abscission layer is formed in a quick tempo. Its final step may be precipitated by some physiological disturbance as dryness, wetness or other condition according to the species. In a non-seasonal warm climate the habit does not matter very much, but in the temperate or monsoon regions it may have a survival value.

§ 19. The systematic occurrence of deciduous trees

Among 73 dicotyledonous families that the writer could investigate, there are naturally many families which contain no deciduous tree, such as Casuarinaceae, Elaeocarpaceae, Fagaceae, Loganiaceae, Magnoliaceae, Malvaceae, Myricaceae, Myristicaceae, Myrsinaceae, Myrtaceae, Rhamnaceae, Rhizophoraceae, Symplocaceae, Theaceae and some other small families (see Appendix), though most of the families, if they occur in temperate regions, contain deciduous trees.

Now, the deciduous trees in the tropics are distributed in various families fairly evenly, just as are the evergrowing ones. Families rich in genera and species are generally rich also in deciduous trees, though not proportionally.

Some genera contain several deciduous trees. For instance, *Artocarpus* (contains 2 deciduous species), *Ficus* (5), *Parishia* (4), *Spondias* (4), *Dillenia* (3), *Cratoxylon* (3), *Terminalia* (5), and *Alstonia* (6), that is, 8 genera, in 6 families. But these families contain also evergrowing species, except Guttiferae, indicating how easily the periodic habit can vary even in one and the same family.

Among the 73 families investigated, 17 Malayan families contain both evergrowing and deciduous trees, namely: Anacardiaceae, Apocynaceae, Bombacaceae, Combretaceae, Dilleniaceae, Dipterocarpaceae, Euphorbiaceae, Hamamelidaceae, Lauraceae, Leguminosae, Lythraceae, Meliaceae, Moraceae, Rubiaceae, Sapotaceae, Sterculiaceae and Ulmaceae. If one takes exotic trees into account, the following 8 families may be added: Anonaceae, Bignoniaceae, Flacourtiaceae, Guttiferae, Lecythidaceae, Rutaceae, Sapindaceae and Tiliaceae.

Of these families, the following genera contain trees of both forms of growth: *Gironniera*, *Ficus*, *Bridelia* and *Mallotus*. The genera which contain a few deciduous trees among intermittently growing ones are many (see Appendix).

Besides, there are a few tropical genera which contain among many evergreen trees only one deciduous species:—

TABLE 6

Species	NUMBER OF SPECIES		Deciduous
	In the world	In Malaya	
<i>Beilschmiedia (malaccensis)</i>	20	15	1
<i>Dalbergia (loiveri)</i>	120	15	1
<i>Canarium (rufum)</i>	100	12	1
<i>Mallotus</i> sp.	100	25	1
<i>Lucuma (Maingayi)</i>	50	8	1

These trees are therefore, so far as the Malayan species are concerned, the single deciduous species of each genus.

Moreover, even in the tropical families Anonaceae and Dipterocarpaceae, some deciduous trees are seen, and in the genus *Ilex*, most species of which are evergreen even in the temperate zone, *I. macrocarpa* in Malaya is semideciduous. There are also a few monotypic genera with deciduous species, namely: *Elateriospermum tapos* of W. Malaysia, which is in S. Malaya semideciduous, and *Feronia limonia*, which is distributed from India to the northern boundary of Malaya, is deciduous. Further in some genera of the tropics, only the single Malayan species is deciduous, though it is not known whether the other species of each genus are also deciduous or not:

Altingia excelsa: 2 spp. in the tropics.

Irvingia malayana: 4 spp.

Trigonachras acuta: 9 spp.

Tetrameles nudiflora: 4 spp.

As these cases indicate, deciduous trees occur even in a wet and warm climate, so the origin of the inherent deciduous factor seems not very complicated and can be developed in various families and genera rather optionally. The formation of the abscission layer before new leafing is its fundamental condition, and the habit can be continued so long as it is not a handicap in the struggle for existence.

§ 20. The geographical distribution of deciduous trees

In Malaya there are endemic deciduous trees, some of which spread all over Malaya, but others are confined to the northern or southern part of the peninsula. Besides, there are indigenous deciduous trees common to S.E. Asia or Malaysia. With Sumatra the affinity is the most intimate, but there are also trees common to the Philippines, New Guinea, and the Pacific Islands to Australia. On the other hand, there are also trees common to islands of the Indian Ocean and Africa, and a few show the most wide distribution over all these regions.

If most Malayan deciduous trees are the same as those of the Continent, we may assume that most of them have migrated from S.E. Asia, where a distinct dry season predominates, whereas if the trees in common are few, the relation of the deciduous habit with dryness is not essential. On the other hand, if the Malayan

elements have more in common with those of Malaysia and remoter districts, it seems more probable that at least some Malayan elements may be hygrophilous deciduous trees common to the Oceanic Islands, though even in Malaysia there are wide regions with a long dry spell. If, again, endemic deciduous trees are abundant, the habit seems to have developed of itself by mutation. Naturally such a test tells nothing about the actual course, yet it is not without interest to see the trend of the deciduous habit.

For this purpose the writer divided the deciduous trees of Malaya into three Groups: (1) those endemic to Malaya, (2) those common with the Continent, and (3) those common with the Pacific region, each with subdivisions.

		No. of species	Total
1) Endemic species of Malaya			
a: throughout the Malay Peninsula	..	22	} 32
b: the northern half	.. ..	4
c: the southern half	.. ..	6
2) Common to the Continent			
a: S.E. Asia to Philippines, New Guinea or Pacific Islands		12	} 49
b: S.E. Asia or Africa to Australia	.. ..	7
c: S.E. Asia to Malaysia	.. ..	20
d: S.E. Asia to Malay Peninsula	.. ..	10
3) Common to the Pacific Islands			
a: Indian Ocean to the Pacific	2	} 26
b: Malaysia to the Pacific	.. ..	1
c: Malaysia	.. ..	3
d: West Malaysia	.. ..	20

The number of species in these groups is in ratio of 32: 49: 26. In Malaya therefore the deciduous species common with those of the Continent are much more than the endemic ones (49: 32), but the relation with the Malaysia and Oceanic Islands is not much less, or the difference is not very significant. The groups, here classified, are however based only on a territorial distinction. But in E. Malaysia there are some islands with distinctly dry season (RENSCH '30) and Oceanic Islands have few species in common with Malaya. The most similar region, both in the climate as well as in the species in common, is W. Malaysia. If one divides all the named regions roughly into two, the wet and the dry, so the number of species of the former, including Malaya and W. Malaysia amounts to $32 + 20 = 52$, and that of the rest distributed in more or less dry regions amounts to 55, so that the both groups are nearly equal. In this respect the deciduous trees of Malaya tend in their affinities neither to the dry, nor to the wet regions.

But if a species continues its distribution after having acquired the deciduous habit, it is not enough to relate this to the present climate alone. It is necessary to consider conditions in the past. Let us examine, therefore, the past geological history of the Malay Peninsula and see whether there were some changes that might have induced the deciduous habit.

§ 21. The geological history of the Malay Peninsula

Malaya is not an ancient peninsula. It originated, together with W. Malaysia in the Cretaceous. The foundation of the Peninsula consists of conglomerate, the materials of which flowed down from the Gondwanaland and spread over both the northern and southern Hemispheres in the Mesozoic (SCRIVENOR '28). Since then, until the mid-Tertiary, the climate of the eastern Hemisphere was mild and tropical plants ranged widely from Asia to Europe. Fossil plants embedded in London clay of the Old Tertiary are common to families and genera of South China and Malaya today and even several closely related species were found (REID and CHANDLER '33). The climatic gradient from south to north of these regions was gentle and probably warm and cloudy, so that even the tropical zone was not very hot, as at present, and the temperate zone was not very cold in winter.

When the winter is not very cold, the tropical flora can flourish, as the summer is warm enough for growth. The tropical rain forest in Asia spreads at present over 28° north latitude from north-eastern Burma to the Himalayan district. At Sibsagar (27° N.), where the tropical rain-forest still predominates, the mean minimum in January is 49° F., and in the extreme attains 42° F. The rain-fall amounts to 95.5 inches (= 242.5 cm.), but chiefly in summer, while in December only 0.5 inches (= 1.3 cm.) falls, and yet there exists the rain-forest (CHAMPION '36). According to BROOKS ('22) the mild climate in the arctic regions of the Tertiary would have been attained by increasing inflow of warm surface-water from the tropics to the pole by topographical changes, even without the change of the earth's axis or continental drift.

In the Miocene Malaya made up, together with the West Malaysian Islands, the so-called Sundaland, faced eastwards to the Sahul Shelf including New Guinea and Australia, with which it was connected sometimes by a land, sometimes by a chain of archipelagoes (MERRILL '23, LAM '27, ARLDT '38). In the Pleistocene, Java separated first, then Borneo and Sumatra and lastly the Malay Islands which later were connected with the Continent.

Such a chronological sequence of W. Malaysia is shown well in the floristic affinity of its parts. So far as the Malay Peninsula is concerned, the difference of the floristic composition north and south of 77° N. makes the estimation probable (SYMINGTON '43). In the Pleistocene the Glacial Periods were repeated, and migration and changes of growth-form were also striking.

During such bewildering changes, what kind of trees gained the ability to form the resting bud is not clear. Considering the northern hemisphere as a whole, trees with the ramifying growth, as *Ginkgo*, seemed easily to endure the unfavourable season by forming resting buds. Most conifers continued their monopodial growth by forming buds in winter. *Dadoxylon indicum*, a Permian conifer of Gondwanaland in India, shows distinct growth-rings in the trunk (SEWARD '33). Also some fossil-woods with growth-rings have been found in Europe and Alaska (BROOKS '22), though most of the ancient fossil-woods show ringless wood. Naturally, even in trees with the intermittent growth, so far as the shoot-growth is manifold, the formation of growth-rings tends to be indistinct (COSTER '27, '28), so that the presence or absence of growth-rings alone can not give the evidence of intermittent growth and bud-formation.

In the era of Sundaland, the climate of Malaya was probably like present-day Burma (compare the maps in MERRILL '23 and LAM '27), where from the tropical wet forest along the western coast to the thorn-forest of the midland several transitional vegetation are seen (STAMP '25, CHAMPION '36) (§ 18). At least there would have existed some districts with a long dry spell in the Sunda-midland of that era. Therefore, if some trees originated in Sundaland, like the Dipterocarpaceae, the birth place of which is inferred to lie between Borneo and Malaya (SYMINGTON l.c.), they may have acquired the deciduous habit in spite of the tropical origin. In this respect, the comparative study of resting buds and growth behaviour in general of tropical trees may tell us the previous history of their ancestors.

But, since the formation of the Malay Peninsula, there have elapsed ten thousand years or more, and, considered from the viewpoint of adaptation, it seems rather strange to have perpetuated for so long a time the deciduous habit in a uniform climate. Perhaps among the genetic characters some are easily formed but not easily reversed, while others behave inversely, though we do not know how the deciduous and bud-forming characters are realized as internal processes. The transformation of the bud-forming

character within a certain systematic group in respect to the range of distribution tells us however something about the evolutionary change of the growth habit of trees indirectly (§ 24).

§ 22. The transition of shoot-growth from the evergrowing to the deciduous

The growth process, whether periodic or not, is essentially an inherent character. Even if it is automatic, it is realized only when the external conditions allow, while under abnormal conditions it can be realized only with difficulty. On the other hand, the paratonic reaction goes on subject to environmental change, sometimes freely and sometimes enforced by it, so that the reaction proceeds either actively or passively, and varies widely in its behaviour. Or, in other words, the internal and external factors work together intricately.

Trees of ancient types show mostly non-periodical gradual growth. Perhaps the ancestors of all phyla of trees were non-periodic in their growth and so far as they remain in wet and warm regions, they have continued their habit unaltered, as for instance, tree-ferns, cycads and palms with single thick stem, in which substituting growth is not generally permitted. Most conifers show the monopodial growth as much as possible, even if provided with the means of substitution. In dicotyledonous trees, the mode of branching is represented in various ways. The tropical trees of primitive families show mostly monopodial growth, but even in trees of advanced families, so far as they grow in a favourable environment, monopodial growth still predominates, while in the temperate zone sympodially ramifying trees are usual, especially those with slender twigs. This is partly due to the dying out of the apical parts through physiological dryness, as may be estimated by the number of wilting buds, which are more abundant after a severe winter. But in some trees terminal buds die in summer as an inherent character, as in *Tilia*, *Ulmus*, *Syringa* and others. In either case the more easily the substitution occurs, the more adaptable is the tree to severe and variable conditions.

But, even in Singapore, there are a few trees in which the terminal bud dies out (§ 9) as *Xanthophyllum Curtisii* and *Crataeva Roxburghii*. The resting buds of the former (Fig. 1), both terminal and axillary, are peculiar in construction. They are protected by a pair of prophylls ca. 0.5–1.5 cm. long, forming an acute quadrangular white pyramid, very conspicuous amidst the dark green leaves. The inside of the scales consists chiefly of an air chamber with a tiny bud at the base. What teleological meaning

such a construction has is not clear, but absorption and conduction of heat of insolation will be relieved at least for a while. In spite of such a structure, the terminal bud dies away early every season as an inherent process. The ancestor of the species seems therefore to have been well adapted to dry spells, though in Malaya, especially in Singapore at present, no such crisis may happen.

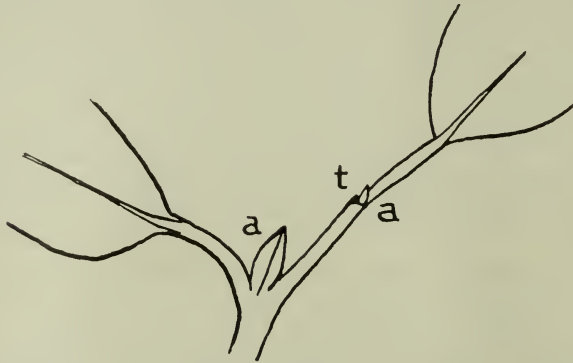


Fig. 1. *Xanthophyllum Curtisi*.

t, terminal bud withered; a, axillary buds.

On the other hand, among some families and genera of the intermittently growing habit, one can find a few species of the evergrowing habit in Singapore. For instance, *Girroniera subaequalis*, *Elaeocarpus sphaericus*, *E. stipularis*, *Camposperma auriculata*, *C. minor*, *Adinandra dumosa*, *Archytaea VahlII*, and *Symplocos fasciculata*. Perhaps there may be still more. As most trees of these families and genera are distributed on the Asiatic Continent and are intermittent or deciduous in their growth, so these evergrowing species seem to have acquired the habit in Malaya.

In temperate regions, all trees, whether evergreen or deciduous, are intermittent in their growth, forming the resting buds and shedding leaves in a definite season. But when they are transplanted to warmer regions, their behaviour differs specifically. For instance, the beech-tree transplanted to southern regions sheds leaves though with delay, ultimately, subject to the autonomic periodicity, while fig and mulberry-trees transplanted to the tropics grow continually, becoming positive in activity on account of the favourable conditions.

Conversely, trees of southern origin as *Robinia*, *Sterculia* and others, do not close the shoot in the temperate regions, but form new leaves continually and indefinitely until the arrival of the cool season, when the bud-forming process is at length induced. The

palms in the temperate zone, for instance *Trachycarpus excelsa* of Japan, show intermittent growth, flowering in late spring by sending out 5-7 inflorescences at once from the axils. The morphological sequence is just the same as in tropical palms with axillary inflorescences, which appear however in the tropics after development of successive leaves with equal intervals, one by one, non-seasonally. The flowering of palms in the temperate regions is, therefore, externally controlled intermittent growth, though it is not known whether this periodic flowering has become inherent or is still reversible in warmer regions.

There are besides a few widely distributed trees which are ever-growing in Singapore, but deciduous under seasonal climate, as *Trema orientalis*, distributed from India to Polynesia. We can not say which of the two regions is the normal and which is the phenocopy (GOLDSCHMIDT '35), or whether each represents an ecotype (TURESSON '30).

Physiological reactions are controlled naturally by prevailing conditions, but so far as a species shows a local difference in its activity, even if of slight character, it is not easily modified by mere transplantation to other localities. In the temperate regions the same species of tree from the north is generally earlier in leafing as well as in leaf-fall than that from the south; the former is more frost-resistant than the latter. The variation is fixed as an autonomic character. As a rare case, it was found, however, in *Carya* of temperate America, that a southern species was more frost-resistant than a northern species (WHITE '35); it indicates the existence of a genetic character not apparent in the original southern district. TURESSON ('30) has found in ca. 30 perennial plants distributed widely in Europe and Asia, north and south as well as inland and coastal, that the species in each locality forms an ecospecies in flowering, height of stem and so forth, adapted to the local environment. Even in the photoperiodic response, FÜRSTAUER ('40) found in *Epilobium hirsutum*, which spreads from Abo (61° N.), Finland to Kirstenbosch (34° S.), S. Africa, that the photoperiodic response is long day in the high latitude, short day in the low latitude and neutral in intermediate regions, representing hereditary local races.

Similarly the periodicity of the tree-growth in each locality seems mainly of inherent character (see also § 25). Recently the behaviour of polygenes in various quantitative characters has been taken up in the experimental field and analyzed in detail (see for instance: MATHER et al '43, WOODWORTH et al '52). The local difference of the periodic behaviour of trees seems in this respect to be an instructive theme for further study.

§ 23. The morphological development of the resting bud with special reference to the formation of scales

For the formation of the resting bud three procedures are involved: (1) the growth in length is retarded by the development of a rhythmic tendency, (2) the leaf-primordia formed on the growing point cease to grow further till to the next season, and (3) some primordia metamorphose into the protecting members, though in the tropics these processes are gradually simplified.

In primitive tropical families, as Anonaceae and Myristicaceae, most of the trees are evergrowing without closing the shoot. The formation of buds is in this respect a change of growth reaction for protection of the growing point against unfavourable conditions. But the restriction of the shoot growth does not necessarily cause the formation of bud-scales. The latter is an independent process, and trees destitute of that ability, when restricted in their growth by drought, can not form a resting bud, e.g. *Carica*, *Acalypha*, *Jatropha*, *Hibiscus*, *Lantana* and others (COSTER '23).

In tropical trees with intermittent growth, the terminal portion of the resting shoot is usually not covered by scales, but loosely by a few young leaves, provided often with dense hairs or gum-resin. Morphologically, these procedures are far simpler than the metamorphosis of foliar organs.

But some deciduous trees, the genera of which are of continental origin, as *Kurrimia* and *Pygeum*, are provided with well-formed scales, and those from central and tropical America, as *Achras* and *Couroupita*, with metamorphosed succulent petioles. Even in evergreen species of *Quercus* and *Castanopsis*, which originated in calid regions, the buds are covered with dense corky scales, like those of the temperate species. The same holds true with trees transplanted from the calid regions such as *Eryobotrya*, *Cinnamomum*, and *Pittosporum*. Scaly leaves are here not only the reduced phyllome, but with suberification added.

In trees of Magnoliaceae, Moraceae, and Rubiaceae, in which the terminal bud is protected, as a family character, by a pair of stipules or petiolar bases, the growing shoot can become a resting bud without special morphological contrivance so that the trees of these families are found in various growth-forms from the evergrowing to the intermittent or even to the deciduous, and distribute themselves widely in calid regions.

The development of foliage leaves of intermittently growing shoots is sometimes gradual with transition from scales or protective leaves to normal ones in each season, but usually the change is as abrupt as in temperate trees of the northern origin, in which even a definite number of foliage leaves is laid down in the bud

(LUBBOCK '99). For instance in *Fagus*, *Carpinus*, etc., after development of new shoots during one month or so, the twig terminates with apical and axillary buds of the next spring without growing further, notwithstanding that the season is just getting warmer. Bud-formation here is, therefore, not induced by low temperature, but only by an inherent process.

In *Carya* of N. America, at first about seven scales are found during spring and early summer as the covering of the bud for the next spring; 3-4 pairs of foliage leaves follow during the summer and, then, 2-3 heteromorphic scales, which represent the outermost scales of two years later and shed themselves soon after the growth of the inner bud (FOSTER '31). Similar development of foliar organs is seen also in *Aesculus* (FOSTER '29). In *Pinus sylvestris*, a tiny bud of two years hence is already formed on the tip of the bud of the next year (LUBBOCK, l.c.), and in *Salix reticulata* of the arctic region, the new shoot is formed two years and a half in advance, in accordance with the short vegetative season (RESVOLL '25). Even in *Shorea Hemsleyana* of Dipterocarpaceae, on the top of each bud is formed a young tiny bud of two seasons later (Fig. 2).

The tree is endemic to S. Malaya and Sumatra and ecologically has no need to form such a young bud with hurried tempo. At

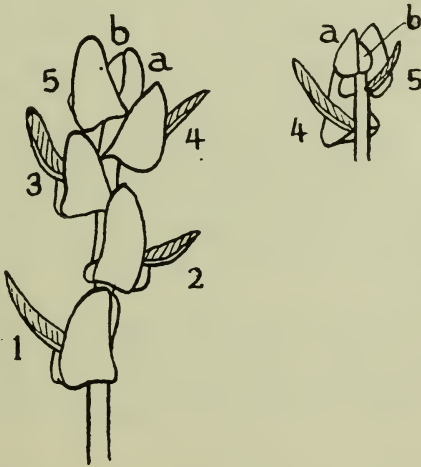


Fig. 2. *Shorea Hemsleyana* \times ca 4/5. Right figure seen from the opposite side.

A bud just elongating, with leaves 1-5, and with young bud of next season on the top covered by stipules a and b. (Compare SYMINGTON '43, p. 71) (ca. 4/5).

any rate, such a process is hardly conceivable without the assumption of a specific hormonal activity.

All these cases show that the formation of buds is not a direct reaction to unfavourable climatic change. On the contrary, it occurs as an inner process rhythmically after development of foliage leaves, either in warmer or in colder regions, and even in the case where low temperature or drought induce bud-formation, it is only an indirect condition and not able to cause bud-formation by itself, unless the plant is endowed with bud-forming ability genetically.

If we summarise the development of the resting bud from the ever-growing to the deciduous, it may be written as follows:—

- (1) Evergrowing bud.
- (2) Periodic fluctuation of leaf-size on the shoot.
- (3) Change of proximal leaves of each period to protecting leaves, small in size, often more hairy or producing anthocyan, etc. and falling early.
- (4) Protecting leaves reduced to scales, often represented by petioles or stipules, embracing or surrounding the young shoot tightly and often corky.
- (5) Young bud ceases to grow after forming a definite number of foliar organs.
- (6) Young bud hastens further to form still younger bud of two seasons later.

Each species of trees has its own rank of bud-development, as mentioned above.

In the evergrowing shoot leaf-fall keeps pace with the opening of new leaves, one after another. After acquiring the periodic tendency, however, the basal leaves fall early, while the laminar leaves remain longer as assimilating organs and the more the periodic tendency is intensified, the more simultaneous become leafing or leaf-fall.

In conclusion, the formation of the bud is realized by the intricate co-operation of the hereditary characters and the environment. In the tropics the formation of buds is often autonomic, while in the temperate zone the seasonal change may induce it.

AXILLARY BUDS: Now, concerning the axillary buds, they are in some shoots just bare like the terminal one, as in *Alangium Ridleyi*, *Adenanthera pavonia*, *Delonix regia* and many species of Anonaceae and Myristicaceae. In *Spathodea campanulata* the prophylls are also green, though different in shape. But in most

cases they are protected by a pair of prophylls, rather tightly even in evergrowing shoots. In the evergrowing *Averrhoa* and *Caesalpinia sappan*, although the terminal bud is bare, the axillary buds are protected by prophylls, and in *Sterculia ferruginea* they are covered with many scaly stipules besides the prophylls. Naturally most of the axillary buds remain dormant without further growth, except when they develop as cauline inflorescences after a long spell.

It may be seen, therefore, that in the wet tropics the grade of protection of axillary buds is manifold and not intimately related with the mode of the shoot-growth.

§ 24. The retrogression of the bud-forming ability

Bud-forming ability does not always proceed unidirectionally to the complication of scale-members. As already stated (§ 22), some tropical trees, viewed from the systematic and comparative standpoints, seem to be transformed from the intermittent to the evergrowing, together with retardation of the bud-forming ability. For instance the genus *Adinandra*, which is distributed mainly in mountainous regions of S.E. Asia to Malaysia, produces well-protected buds, whereas *Adinandra dumosa* spreads over the lowland of W. Malaysia growing continually, forming no resting bud. *Gordonia* of the same family spreads over the highlands of tropical regions widely, while *G. singaporeana* grows in the lowlands of Malaya, and, though the growth is slightly intermittent (§ 10), never forms a resting bud, and suggests equally the transition to the evergrowing. The genus *Alangium*, distributed from Africa to the Pacific Islands and Formosa, seems distinctly intermittent in its growth, but *A. Ridleyi*, an endemic species of Malaya, has no scales in the resting bud, which is covered only by two young leaves as if nearly evergrowing. *Peltophorum pterocarpum* is deciduous with leaf-fall twice every year, well adapted to the monsoon-regions ranging from Indo-China to Malaya and further to Australia; in Singapore, however, it does not close the bud, which is covered only by a few basal leaves densely clad with hairs. There may be many more cases of such a retrogression of bud-formation.

Thus bud-formation goes on, either in evergreen or deciduous twigs, not always parallel with the cessation of shoot-growth. Under a favourable climate, the bud can be much simplified. The formation of bud-scales is therefore a different process that may or may not accompany the retardation of shoot growth. But, as one

looks at trees as a whole, including those of the temperate zone, the two processes are seen to be correlated with each other, and the more tightly the bud is closed, the more intermittent is its mode of growth. Though originally different, these two processes are combined together by natural selection, except under uniformly favourable conditions. The internal processes of bud-formation are not clear, but hormonal activities derived from inherent characters undoubtedly control this behaviour. Periodicity of tree-growth as a whole is, indeed, sufficiently comprehensible only when one assumes hormonal activity as an inherent process.

§ 25. The intermediation of hormonal activity on the process of periodicity

As stated above, the formation of scales, foliar leaves, etc. in a definite order around the growing point of trees rhythmically is not caused by the direct effect of climatic changes, but as a consequence of internal specific processes that ought to be attributed to the quantity and distribution of respective hormones. An interesting example of abnormal scale formation caused evidently by the disturbance of hormonal distribution, was observed by the writer in a growing shoot of *Lucuma Maingayi* (Fig. 3).

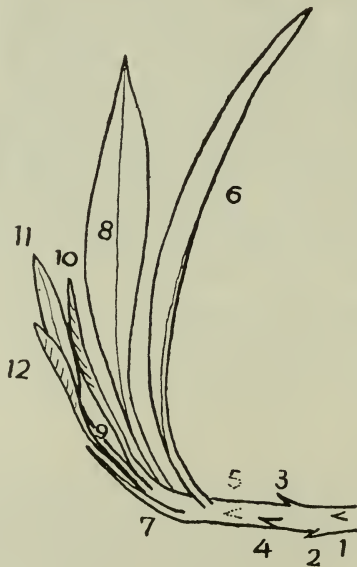


Fig. 3. A young shoot of *Lucuma Maingayi* grown horizontally.

In a new shoot with scales and foliage leaves in 2/5 phyllotaxis, the 1st to 5th phyllomes were scales and the 6th, 8th and 10th were foliage leaves, while the 7th and 9th between the above mentioned leaves should have been foliage leaves but were typical scales. The new shoot was in horizontal position and the reverted scales were on the underside. It is therefore conceivable that some hormones, destined for green leaves or an antihormone to such, received disturbance on both sides, upper and lower, at the beginning of differentiation, and as a result the disorder ensued, just like the behaviour of auxine in geotropic response (SCHRANK '50). This fact shows that the final form of the leaf is not predestined by the primordium. It may also be inferred that in *Kurrimia* and others mentioned previously (§ 23), at the beginning of formation of the resting bud, some hormones appear that prevent the normal development of foliage leaves, and after exhaustion of the same, the primordia tend to be normal. But in *Carya* (FOSTER, l.c.) the leaf-forming hormone seems to be exhausted after the appearance of a definite number of leaves, and then an inversed course of hormonal activity takes place forming the scales again.

The shoot of *Bridelia* shows the first indication of the rhythmic growth of leaf-size, as already mentioned (§ 10). If the leaf-size is determined absolutely by the quantity of nutrient materials, it seems more probable that the basal or apical portion of the shoot in each season would produce the larger leaves. In most tropical trees with intermittent growth, the leaves at about one-third from the base of the new shoot tend to be the largest, but in *Cassia* and others the leaf-size increases in the terminal direction. In other words, there is no rule concerning the distribution of leaf-size in shoots of each season. Similarly in temperate regions it is manifold according to species (DENNERT '26). As the leaf-primordia around the growing point are uniform in size, so the subsequent difference in size should result from the mode of cell-division induced by the activity of the respective hormones, while each cell attracts its own nutritive materials from below.

In the shoot of each season, the internodes belonging to the scales and incomplete leaves are generally very short, but in some species they grow much longer than those of the foliar leaves, for instance in *Actinodaphne malaccensis*, *Phoebe macrophylla*, *Knema laurina*, *Diospyros lanceifolia*, *Ptycopyxis costata* and the basal portion of apposed twigs of the Terminalia-type. It is clear therefore, that there is no causal connection between leaf-size and length of internode, even if in most cases they are more or less

proportional. Were they to be connected, it might be attributed to nutrition, but, as it is not really so, it ought to be attributed at least to two groups of hormones, which effect the leaf-size and the length of the internode respectively. They can behave independently according to species.

Now, concerning the leaf-fall, it is well known that this is affected by the formation of the abscission layer and the separation of cells along it. The layer is formed generally at the base of the petiole, for the formation of which some hormonal activity should be concerned.

For instance, the tomato does not form the abscission layer on the leaf, but the fruit is provided with a junction, from which it separates at maturity. But there was found a mutant which failed to form the junction, so that the ripe fruit was detached from the receptacle (BUTLER '36). This shows that a genetic factor controls the hormonal activity. The abscission layer is not formed, however, always in a definite position. The leaf-cutting of the sweet potato sometimes forms the abscission layer abnormally in the middle of petiole (YASUI '46). This fact indicates that, during the formation of the layer, some substance, probably a precursor of a hormone of cell division, descends from the lamina through the parenchyma downwards and meets on the way with an ascending substance from the petiole and is activated by it. That the abscission layer has a smooth surface, may be attributed to the flatness of the diffusion front, even though it is often curved according to species (PFEIFFER '28).

The formation of an abscission layer is relatively rare in tree-ferns, monocotyledonous trees, and herbs. Even in conifers some do not form it, as *Cunninghamia*, *Araucaria*, *Cryptomeria*, while *Taxodium*, *Metasequoia*, etc. form it at the short-base, just like *Canarium odoratum*, *Sonneratia acida*, and *Populus nigra*. In dicotyledonous trees, whether evergreen or deciduous, and whether in the tropics or in the temperate region, this process goes on regularly. Especially in the temperate region it occurs not only before the new leafing, but also before the severe winter, well understood as the adaptation. In trees of one and the same species, a delicate difference of various characters is often found, especially in cultivated forms. For example, in Para-rubber trees grown in the same plantation, some shed the leaves earlier, but some later, and this is characteristic of each clone. As to the quality and yield of the latex a similar difference is seen (SCHWEIZER '32). In avenue trees of *Aesculus*, *Fagus*, and *Ulmus* there are seen also a

difference of leafing and leaf-fall according to trees, which show the same difference every year (LUBBOCK l.c., WELLENSIEK '34). This is also seen in *Ginkgo*-trees, the so-called living fossil. Whether these characters may be transmitted through seeds or not wants experimental proof, but at all events the last step of the physiological process is realized by the activity of cells induced by hormones, by which the kind of materials, the amount and time of secretion, their co-operation or antagonism, etc. are determined inherently, even if their actions are affected at the same time by external conditions.

In herbs, there are many cases in which the seasonal behaviour has been genetically investigated. For instance in *Hyoscyamus niger*, there are annual and perennial races, but the habit can be altered by low temperature or by grafting (MELCHERS '39). Concerning the periodicity of the nyctinastic movement of *Phaseolus multiflorus*, there was found an inherent variation of 15–35 hours at 22° C. according to individuals, and the statistical mode for one cycle was 25 hours (BÜNNING '33). Yet under natural conditions their proper cycle is controlled to 24 hours. Moreover, there is a difference of the cyclic course of movement. In some individuals the leaves sink quickly and lift slowly, while others behave in the inverse way (BÜNNING '36).

The effect of synthetic hormones on the flower-formation and the ripening or abscission of fruits is well known. The fruiting of papaya-trees is noteworthy in this respect. Axillary female flowers open successively and continually, but the further development of them ceases after 10–20 fruits are formed, though all flowers are evenly pollinated, and after a few months the next crop begins forming a second group of fruits, and so on; it seems nothing but a hormonal control.

In Singapore there are some trees which do not flower or bear fruit, as for instance *Ravenala madagascariensis*, which flowers and fruits in Burma. *Borassus flabellifera*, *Nephelium litchi*, and *Bouea macrophylla* can ripen in Penang. It is said that the sterility may be attributed to the wet climate. But it is not clear, whether a wet climate alone is responsible, or whether intense insolation or a definite thermoperiod (WENT '48, '49) or photoperiod is needed. After all, it ought to be related with the production of the hormone-complex.

In effect, the periodicity of tree-growth is controlled by various hormonal activities as well as by the environment. Some hormones are formed as an inherent character almost invariably, but others

are more or less controlled by the external conditions. The hormones that partake in bud-formation and other autonomic processes are formed nearly independently of seasonal conditions, especially under the uniformly favourable climate. The formation of hormone in the case of leaf-fall or of abscission layer becomes the more intense, the more susceptible the tree is or the more severe the climatic changes. Conversely, the more favourable the conditions or the more insensitive the tree, the more autonomic is the production of hormones.

§ 26. Conclusion

If we compare trees in tropical and temperate regions, each group shows many adaptive characters. In the tropics there are many monopodial trees of primitive type, while in the temperate regions most trees, except some conifers, are ramiferous with slender twigs provided with numerous growing points in the form of axillary buds, which are able to substitute injured parts. Regeneration is easier in conifers than tree-ferns, and in dicotyledonous trees than monocotyledonous ones, as may be seen from the fact that monocaulous thick-stemmed trees scarcely extend further north than the calid region.

The existence of deciduous trees in the tropics of uniform climate is, however, not adaptive in its nature. The habit is not directly concerned with water or temperature relations. It is an inherent character in its origin, just like the evergrowing and intermittent growth-habit.

In the temperate region, from the systematic point of view, most deciduous trees are of northern origin, but in the tropics the deciduous trees are distributed in various families fairly evenly, being generally more abundant in larger families. There are various genera which contain both evergrowing and deciduous species, and even in some genera of tropical origin one can find a few deciduous species. The periodic habit of trees seems, therefore, to arise in any region in any family, so long as certain changes of hormonal activity can occur.

Geographically, the deciduous species of Malaya are related with those of both Continental Asia and Malaysia, though the former has slightly more species in common than the latter. If one divides all the related regions roughly into two, the wet W. Malaysia and other drier districts, so the number of deciduous species is also nearly the same. Thus the deciduous habit has no preference for the dry or wet habitat.

Considered from the geological conditions in the past, Malaya constituted in the early Pleistocene the western part of the Asiatic continent, the so-called Sundaland, and there might have been many chances for origination of deciduous trees in the midland of that era, which were distributed then to the coastal region, now representing the Malay peninsula, where they have retained their habit unaltered. But there are, on the other hand, some genera, most species of which are intermittently evergreen, that occur on the mountain region inland with some species distributed in the lowland with evergrowing habit. Growth-habit seems, therefore, not generally changeable, yet possibly so in some genera.

Periodicity of tree-growth is the rhythmical advance of the growth-process realized by various consecutive reactions. Partial aspects of it, like leafing, leaf-period, leaf-fall, etc. show sometimes even clonal variations with respect to the calendar date, which occur fairly precisely according to stocks. Such trivial characters have originated internally and are transmitted to the offspring. It has been called the *stockwise* variation in this paper.

The real process is not known, but, so far as it appears as an external character, it stands in direct bearing with the environment, and the more favourable the condition of the district, the more freely the inherent ability exhibits itself; conversely, the more unfavourable the local condition, the more restricted is the playground of expression, whether autonomic or paratonic. And the more restricted the existing conditions, the more adaptive seems the character to one's eye, and the more favourable the condition, the more untidy becomes the habit.

After all, the periodic habit, or the change of it, is not necessarily the adaptive, but, so far as the environment permits the habit, the tree can exist competently mingled with trees of other habit. That in Singapore such various growth-habits are displayed may be attributed to these circumstances.

§ 27. Summary

(1) In the tropics of uniform climate, as at Singapore, there are in tree-growth various transitions from the evergrowing to the deciduous, so that it is not enough to classify the trees simply as evergreen and deciduous as in temperate regions.

(2) Periodicity of tree-growth is characterized by the activity of the growing point as well as by the mode of branching. The former includes the continuous, the intermittent and the manifold growth, and the latter the terminal and the lateral branching. By

combination of these two categories, one can distinguish six types of tree-growth morpho-physiologically. They may be classified further in detail.

(3) Evergrowing trees are everleafing with the growing bud at the apex of the twig, and the leaf-size and the length of internode are uniform.

(4) Leafing of intermittently growing trees is seasonal, contemporary or non-seasonal, and at the end of each period a resting bud forms on the shoot-apex. Leaf-size and the length of internode are variable, usually with a sudden change in appearance of the cork-layer between each period.

(5) Manifoldly growing trees show a branchwise difference in the developmental phase caused (*a*) by dying out of the terminal bud or the apical portion of the twig or by forming the inflorescence; (*b*) by trees growing to a fairly big size; and (*c*) by the exotic nature of trees with intermittent growth, their branches having a strong inherent tendency to rhythmical growth, which is shifted, however, according to individual branches under the uniform climate.

(6) The deciduous trees are rather conspicuous in their appearance, but they represent only a special case of intermittent growth, the distinction being only whether leaf-shedding proceeds or lags behind the leafing, whence arise all sorts of transitions.

(7) The leaf-period of deciduous trees in Singapore varies from three months to more than two years according to species, usually with a short bare spell, but this has nothing to do with the hibernation of temperate trees. The frequency of seasonal leaf-fall is 1-3 times per annum according to species, that of the contemporary ones 3-4 times, and among the non-seasonal ones some are shorter and others are longer than one year.

(8) Four categories of flowering can be distinguished, as in the case of leafing. Everflowering is limited to a certain number of evergrowing trees, while the rest are seasonal, contemporary or non-seasonal, just as in the intermittent and manifoldly growing trees. Ever- and non-seasonal flowerings are autonomic in nature, while seasonal and contemporary flowerings are chiefly determined by trifling changes of the weather.

(9) In Malaya, evergrowing trees together with the manifold ones compose at most about one-fifth of the total indigenous tree-species, and the deciduous about one-twentieth, the rest being the intermittent evergreen trees.

(10) Deciduous species occur there fairly evenly in various dicotyledonous families. Most of these families include not only the usual evergreen trees with periodical growth, but also evergrowing as well as deciduous ones, indicating that the deciduous habit may occur in various families rather optionally.

(11) Some trees, though deciduous in other regions as India and Malaysia, may be evergreen in Singapore, while others are not seasonal in their leaf-shedding.

(12) In the Malay Peninsula there are, besides endemic deciduous trees, those common with Continental Asia or the Oceanic Islands—chiefly W. Malaysia—or those distributed in both regions, so the deciduous trees as a whole show no preference as to the habitat, whether dry or wet.

(13) There is also no intimate relation between the deciduous habit and the height of crown, tall evergreen trees being more abundant than deciduous ones. Low deciduous trees are also met with not infrequently.

(14) Deciduous trees are, moreover, not all the same in water relations. There are, besides many mesophytic trees, some hygrophilous and others hygrophobic, the former growing in wet swampy forest and yet deciduous, while the latter do not occur in S. Malaya.

(15) The Malay Peninsula, as a land on the Sunda Shelf, was during the Tertiary period a part of the Asiatic Continent together with W. Malaysia, so that under the then predominating climate there might have originated a number of deciduous species in the midland of that area, which retained the same habit unaltered, while others seem to have changed their habit from the periodic to the evergrowing after the formation of the present peninsula since the Pleistocene.

(16) Generally, intermittent growth, whether evergreen or deciduous, is accompanied by the formation of a resting bud. But these two processes are not always carried on in the same degree. Under a favourable climate the latter is more easily simplified than the former.

(17) The formation of leaf-scales may be attributed to hormonal activities. Similarly the formation of the abscission layer, the length of periodic activity and many other characteristics of trees are all controlled internally and show even clonal differences. This is especially evident in the uniform climate like that of Singapore, where various growth-habits are displayed without restriction, whereas in the temperate or monsoon regions the external control predominates.

Appendix

The periodicity of tree-growth in four types, together with localities. Exotic genera and species in parenthesis.

Abbreviations

Periodicity types: e: evergrowing, m: manifold, i: intermittent, d: deciduous.

Localities

Ad: Andaman Islands	J: Java	S: Sumatra
Af: Africa	Jam: Jamaica	SAf: South Africa
Am: America	Jp: Japan	SCh: South China
As: Asia	M: Malaya	SEA: South-East Asia
Ass: Assam	Mc: Mascarene Islands	Si: Siam
Au: Australia	Med: Mediterranean	SM: South Malaya
B: Borneo	Mg: Madagascar	Sol: Solomon Islands
Br: Brazil	Mo: Molucca	T: Tenasserim
Bu: Burma	Ms: Malaysia	Ti: Timor
CAM: Central America	Mx: Mexico	Tr: Tropics
Cd: Calid Regions	NAu: North Australia	TrAf: Tropical Africa
Ce: Celebes	NB: North Borneo	TrAm: Tropical America
Ch: China	NC: New Caledonia	TrAs: Tropical Asia
Cosm: Cosmopolitan	NEM: North-East Malaya	TrM: Tropical moun- tains
Cy: Ceylon	NG: New Guinea	Ven: Venezuela
EAs: Eastern Asia	Nic: Nicobar Islands	WI: West Indies
EMs: East Malaysia	NM: North Malaya	WMA: West Malayan Archipelago
Eu: Europe	NT: North Temperate	WMs: West Malaysia
F: Formosa	P: Pacific Islands	WP: Western Pacific Islands
Hm: Himalaya	Per: Peru	
Hond: Honduras	Ph: Philippine Islands	
I: India	Po: Polynesia	
IC: Indo-China	Q: Queensland	
IO: Indian Ocean		

Genera	Distribu- tion	No. of species	Do of Malaya	Species	Localities	e m i d
Alangiaceae						
Alangium	Am-P	22	7	Ridleyi	m	i
Anacardiaceae						
(Anacardium)	Am	8		(occidentale)	SAm	i
Bouea	I-Mo	5	2	microphylla	WMs	
Camposperma	As,Af,Am	10	3	auriculata	WMs	e
"	"	"	"	macrophylla	WMs	i
"	"	"	"	minor	M	e
Dracontomelum	I, Ms, P	5	1	mangiferum	NM	d
(Lansea)	Af, I	12		(grandis)	I	d
Mangifera	SEA-Ms	40	20	caesia	WMs	i
"	"	"	"	foetida	WMs	i
"	"	"	"	(indica)	I	m
Melanorrhoea	WMs	15	10	malayana	NM	d
Parishia	Bu, Ad, WMs, Ph	10	5	insignis	Ad, M	d
"	"	"	"	Maingayi	M	d
"	"	"	"	paucijuga	M	d
"	"	"	"	pubescens	M	d
Pentaspadon	T, M, B	few	3	officinale	M	d
(Pistacea)	Med, As, Mx	5		(formosana)	F	m
(Pleioygnium)	Q	1		(Solandrii)	Q	m
Semecarpus	TrAs, Au, Po	40	10	vernificera	F	m
Sorindaea	Af, Mg	20		madagascariensis	Mg	m
(Spondias)	TrAs, TrAm	6		(cytherea)	P	d
"	"	"	"	(lutea)	Am	d
"	"	"	"	(monbin)	Am	d
"	"	"	"	(pinnata)	I-Mo	d
Anonaceae						
Anaxagorea	Am, As	8	2	javanica	Si, M, B, S	i
(Anona)	Am,Af,As	60		reticulata	WI	d
Canarium	Bu-Au	2	2	odoratum	Bu-Q	e
Drepananthus	S-NG, Ph	8	4	pruniferus	M	e
"	"	"	"	ramiflorus	M, S	e
Polyalthia	As, Af, Au	60	40	Beccarii	M, B, S	e
"	"	"	"	stenopetala	M	e
Xylopia	Tr	100	16	ferruginea	M, S, B	i
Apocynaceae						
Alstonia	Af, As, Au, Po	30	6	angustifolia	S, M, B	d
"	"	"	"	angustiloba	M	d
"	"	"	"	latifolia	M, B	d
"	"	"	"	macrophylla	NM, B, Ph, NG	d
"	"	"	"	scholaris	I, Cy, Ms, Au	d
"	"	"	"	spatulata	WMs	d
Cerbera	I-WP	5	2	manghas	Ms	e
"	"	"	"	odollam	I, M, S	e
Dyera	M, S, B	2-3	1	costulata	M	d
Ervatamia	Tr	170	10	corymbosa	M	e
"	"	"	"	dichotoma	I, Cy	e
Kopsia	SEA	12	7	fruticosa	Bu	e
"	"	"	"	singaporensis	M	e
Ochrosia	Mc,As,Po	12	7	oppositaefolia	Mc, As	e
(Plumeria)	Am	3		(acuminata)	Mx	m
"	"	"	"	(obtusata)	Am	e
(Thevetia)	Am	10		(peruviana)	Am	e

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Aquifoliaceae						
Ilex	Cd	200	2	cymosa	WMs	i d
"				macrophylla	WMs	
Asclepiadaceae						
(Calotropis)	Af, As	3	1	(gigantea)	I	e
Araliaceae						
Arthropodium	Ad-NG	10	8	diversifolium	WMs	e
(Brassaia)	Au	1		(actinophylla)	Au	i
Schefflera	ETr	80	30	heterophylla	M, S	i
Bignoniaceae						
(Catalpa)	Am, EAs	10		(longissima)	WI	m i d
(Jaccaranda)	SAM	30		(filicifolia)	SAM	
(Kigelia)	Af, Mg	3		(pinnata)	Af	d
Oroxylum	I, NM, C, Ph	1	1	indicum	I-Ph, NM	m
(Spathodea)	Af	2		(campanulata)	Af	e
(Stenolobium)	Mx-SAM	4		(stans)	SAM	e
(Stereospermum)	ETr	20		fimbriatum	Bu-NM	d
(Tabebuia)	Cd			(rosea)	Mx	i
"				(triphylla)	WI	m
Bixaceae						
(Bixa)	Am	1		(orellana)	Am	e
(Cochlospermum)	Tr	12		(religiosum)	I	d
Bombacaceae						
(Adansonia)	ETr	10		(digitata)	Af	d
(Ceiba)	TrAm	10		(pentandra)	Tr	d
Durio	As	12	6	zibethinus	Ms	i
Neesia	WMs	6	3	altissima	M, B, S, J	
(Ochroma)	SAM, WI	1		lagopus	Br	e
(Pachira)	Am	4		(aquatica)	Am	i
"				(cyathophora)	Am	i
Salmalia	Af, As, Au	11	2	malabarica	Hm, Cy, Bu, Ms, Au	d
"				Valetoni	Au, Ms	d
Borraginaceae						
Cordia	Tr	300	4	dichotoma	SEA, Ms, Au, Po	i
"				(sebastina)	TrAM, WI	i
"				subcordata	I-WP	m i
"				(umbraculiformis)	TrAm	i
Burseraceae						
Canarium	Af, I, Ms, Po	109	12	(album)	IC	i
"				nitidum	M	i
"				rufum	M	d
Santiria	Ms	30	15	laxa	M	i
"				(rostrata)	B	i
"				rubiginosa	Bu, IC, M, S, J	d
"				tomentosa		d

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Cactaceae						
(Cereus) (Peireskia)	Am Tr, Am, WI	300 19		(hexagonus) (grandifolia)	Am Am	e i d
Capparidaceae						
Crataeva "	Tr	20	2	religiosa (Roxburghii)	ETr I, Cy, IC, Si	m m
Caricaceae						
(Carica)	Am, Af	21		(papaya)	Am	e
Casuarinaceae						
Casuarina "	Au, Ms, I	23	1	equisetifolia (sumatrana)	I-P Bu, WMA	e e
Celastraceae						
Elaeodendron Kurrimia "	Cd I, Ms	30 3-4	1 2	(quadrangulatum) paniculata robusta	Br I, WMs I, WMs	e m i
Combretaceae						
Lumnitzera "	IO-WP	2	2	coccinea racemosa	Af-P Mc-P	e e
Compositae						
Vernonia	Cd	500	8	javanica	I, Ms	i
Datiaceae						
Tetrameles	Ms, Ph	1	1	nudiflora	I, NM, J, Ti	d
Dilleniaceae						
Dillenia " " " " Wormia " " "	As, Au As, Au, Mg	10 20	6 4	aurea grandifolia indica ovata reticulata albiflos excelsa pulchella suffruticosa	I, Si, NM, J, Ph M I, Si, M WMs, IC, T M M, NB M, S, B M, S, B WMs	d d i i d e i i e
Dipterocarpaceae						
Anisoptera Dipterocarpus " "	Bu-NG I-Ce	17 69	7 34	megistocarpa grandiflorus Kunstleri Lowii	SM, S Ad, Si, Ph S, NM M, S, B	d d d d

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Dipterocarpaceae—contd.						
Dryobalanops	B, M, S	6	2	aromatica	B, M, S	e
Hopea	I-NG	56	9	mengarawan	S, SM	i
Pentacme	Bu-Ph	6	1	siamensis	Bu, Si, IC, NM	d
Shorea	I-Mo, Ph	95	58	Curtisii	Si, M	i
"				Hemsleyana	NM	i
"				leprosula	Si, M, S, NB	d
"				(robusta)	I, Bu	i
"				sumatrana	A, M	i
Ebenaceae						
Diospyros	I-Bu-J, Au	300	70	cordifolia	I, Si, Ms, Au	d
"				(ebenum)	I, Cy	i
"				lanceifolia	WMs	i
"				(mollis)	S	i
"				oblonga	M	i
Elaeocarpaceae						
Elaeocarpus	I, Ms, Au	100	30	ferrugineus	M, B	i
"				littoralis	Bu, Si, WMs	i
"				Mastersii	WMs	i
"				obtusus	Bu, M, S, B	i
"				petiolatus	IC, WMs	i
"				polystachyus	M, B	i
"				sphaericus	I, WMs	e
"				stipularis	IC, WMs	e
Erythroxylaceae						
Ixonanthes	SEA-MG	11	2	icosandra	M, S	i
"				reticulata	M, S, B	d
Euphorbiaceae						
Acalypha	Tr, Saf	400	3	siamensis	Si, NEM	i
Agrostistachys (Aleurites)	I, Ms, Ph	11	3	sessilifolia (moluccana)	M, Mol	i
Antidesma	Af, As, Au	140	21	(bunius)	I-Au	e
"				(diandrum)	I-Bu	i
Aporosa	As-NG	60	20	Benthamiana	M-S	i
"				bracteosa	M, S, B	i
"				nigricans	M	i
Baccaurea	As, Au	60	22	Kunstleri	M	i
"				latifolia	M	i
"				macrophylla	M	e
"				malayana	M	i
"				parviflora	M, S	i
"				pyriformis	M	i
(Bischofia)	I, Ms, Po	2	1	(javanica)	I, Ms, Po	d
Bridelia	ETr	50	8	retusa	I, Si, M	d
"				tomentosa	I, Ms	e
Claoxylon	Mg, As, P	57	4	indicum	I, Ms	d
Cleistanthus	Af, I, Ms	110	30	heterophyllus	M	i
Croton	Cd	500	10	(eleuteria)	Am	e
"				(laevifolium)	IO	i
Elatiospermum	WMs	1	1	tapos	M, S, J	d
Emblica	As, Am	11	1	officinalis	SEA	i
Euphorbia	Cd	750	10	neriifolia	I, Ms	e
Excoecaria	ETr	26	3	agalloca	Af-Au	d
Glochidion	As-Au	130	24	laevigatum	M	e
"				microbotrys	M	e
"				sericeum	M, B, J	e
"				singaporensis	SM	e
"				superbum	SM-Ph	e

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Euphorbiaceae—contd.						
(Hevea)	Amazon	12		(brasiliensis)	Ms	d
(Hura)	Am, WI	2		(crepitans)	SAm	i
(Jatropha)	Am, Af	150		(multifida)	Am	i
Macaranga	ETr	200	24	javânica	Si, IC, M, S, J	e
"				triloba	WMs	e
Mallotus	As, Af	100	25	sp.	SM	d
"				paniculatus	Ch, Si, Au	e
Microdesmis	As, Af	2	1	(casearifolia)	T, Ch, B	e
Pimelaedendron	Ms	4	1	Griffithii	M	i
Pycopyxis	Ms	1	1	costata	Ms	
Sapium	Am, As	100	3	discolor	Ch	d
"				indicum	I, Ms	e
"				sebiferum	Ch	m

Fagaceae						
Castanopsis	CdAs	40	15	Andersonii	M	i
"				inermis	SM	i
Quercus	Eu, As, NG, Am	400	40	(bambusaefolia)	Ch	i
"				conocarpa	WMs	i
"				craterophora	M	i
"				hysterix	WMs	i
"				lucida	WMs	i

Flacourtiaceae						
Flacourtia	I, Ms	10	3	indica	I-Mc (not Sm)	d
"				jangomas	ETr	d
"				rukam	I, Ms	i
Homalium	Tr	50	8	grandiflorum	Si, M	d
Hydnocarpus	I-Ms-Ph	30	7	(anthelmintica)	Si, IC	i
"				Kurzii	Ass, Bu, T	e
Pangium	WMs	2	1	edule	Ms	d

Goodeniaceae						
Scaevola	Au, ETr	2	1	frutescens	I-Po	e

Guttiferae						
Calophyllum	Tr	50	25	inophyllum	I-WP	i
Cratoxylon	As, Ce, Ph	12	5-6	arborescens	WM	i
"				formosum	IC, Ms, Ph	d
"				ligustrinum	I, WM, Ph	d
"				Maingayi	T, IC, Si, M, S	d
Garcinia	ETr	100	40	atroviridis	Bu, M	i
"				(dulcis)	J, B, Ph	m
"				(ferruginea)	IC	i
"				Forbesii	S, M	i
"				Hombroiana	Nic, M	i
"				(Livingstonii)	TrAf	i
"				mangostana	M	i
"				xanthochymus	SEA, Ms	i
Kayea	I, Ms	12	11	ferruginea	Ad, M	i
Mesua	I, J	2-3	2	ferrea	Hm-M	i
(Rhedea)	Am, Mg	17		madruno	CAM	e

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e	m	i	d
Hamamelidaceae									
Altingia	I, Ms, Ch	2	1	excelsa	I, M, J				d
Bucklandia	Hm, Bu, Ms	1	1	populnea	M	e			
Rhodoleia	M, Ch	3	2	ovalifolia	M				i
"				Teysmannia	M, S				i

Juglandaceae									
Engelhardtia	I-Ch, M	10	4	nudiflora	M				d
"				Wallichiana	M				i

Lauraceae									
Actinodaphne	EAs, Ms	50	15	bancana	M				m
"				malaccensis	SM				m
Beilschmiedia	Tr	20	15	malaccensis	SM				d
Cinnamomum	As, Au, WP	150	17	(camphora)	Ch, F, Jp				m
"				iners	I, WMs				m
"				(zeylanicum)	I, Cy				m
Cryptocarya	Cd	50	17	Griffithii	M, B				i
Lindera	As, NAm	60	14	lucida	SM, WMs	e			
Litsea	As, Au	200	56	gracilis	M				i
"				megacarpa	M				i
"				singaporensis	M				i
Phoebe	As, Am	40	6	grandis	WMs				i
"				macrophylla	M				i
"				opaca	M, J, S, B				i

Lecythidaceae									
Barringtonia	Af, As, Au	30	15	asiatica	ETr				i
"				(acutangula)	I, Si, IC				i
"				racemosa	I, Ms, Po				i
(Bertholetia)	Br	1		(excelsa)	Br				d
(Couroupita)	Am	4		(guianensis)	Guiana				d
(Lecythis)	Am	45		(ollaria)	TrAm	e			
(Napoleonca)	Waf	5		(imperialis)	TrAf				i

Leguminosae									
(Acacia)	Au, Af	450		(auriculiformis)	NAu				m
"				(catechu)	I, Bu, Si				m
"				(confusa)	Ph, F				i
"				(glomerosa)	SAm				m
"				(interjecta)	WI	e			
Adenanthera	ETr	3	2	bicolor	Cy, M				d
"				pavonina	I, Ch, Ms, Mo				d
Albizzia	ETr etc	100	4	falcata	EMs	e			
"				(odoratissima)	Hm, Bu, Cy, Si				d
(Amherstia)	Bu	1		(nobilis)	Bu				m
(Andira)	Am, Af	25		(inermis)	SAm, WI, Waf				i
(Baphia)	Af, Mg	30		(nitida)	TrAf				i
(Brownea)	SAm, WI	15		(ariza)	New Granada				m
"				(capitella)	Ven				m
"				(coccinea)	Jam				m
"				(grandiceps)	Ven				m
"				(macrophylla)					m
(Butea)	SEA, Ch, J	3		(frondosa)	I, Bu, Ch, J				d

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e	i	d
Leguminosae—contd.								
Caesalpinia	Tr	100	9	(coriaria)	Am	e		d
"				(ferrea)	Br		i	d
"				sappan	I, Ms			
Cassia	Tr	400	17	(excelsa)	Br		i	d
"				(fistula)	I, Cy			d
"				(javanica)	J, S, Ph			d
"				(leptophylla)	Br			d
"				(multijuga)	TrAm	e		d
"				nodosa	Bu, Ch, WMs			d
"				siamea	I, Ms	e		
"				(splendens)	Am	e		
Cynometra	Tr	20	3	inaequifolia	Si, WMs, Ph		i	
"				ramiflora	I, Cy, Ms		i	d
Dalbergia	As, Au, Po	120	15	(Oliveri)	Bu, Si			d
(Delonix)	Af, Mc	3		(regia)	Mg			d
Dialium	SEA	15	8	Wallichii	M		i	d
(Enterolobium)	Am	6		(saman)	SAm	e		d
Erythrina	Tr	30	5	fusca	Mc, I, Ms, P			d
"				indica	I-P			d
"				lithosperma	Bu, M		i	d
"				subumbrans	Bu, WMs, Ph			d
(Gliricidia)	Am	4		(sepium)	CAm			d
(Haematoxylon)	Am, WI	1		(campechianum)	Am		i	d
(Hymenaea)	Am	8		(courbaril)	WI			d
Inocarpus	Am, Ms, P	1	1	edulis	Ms-P		i	d
Intsia	ETr	12	2	Bakeri	Si, WMs, Ce			d
Koompassia	IC, Ms	4	2	bijuga	Mc-Po			d
"				excelsa	M, S, B			d
"				malaccensis	M, S			d
(Leucaena)	Am, P	9		(glauc)	SAm	e		d
(Lonchocarpus)	Am, Af, Au	120		(cyanensis)	Waf		i	d
Millettia	Af, I, Ms, Au	150	15	atropurpurea	Bu, Si, WMs		i	d
"				(Manni)	TrAf			d
(Mimosa)	Am, As, Af	300		(sepiaria)	SAm	e		d
(Myroxylon)	Am	8		(toluiferum)	Am			d
Parkia	Tr	10	3	javanica	Ms			d
"				speciosa	I-J		i	d
Peltophorum	Tr	7	3	dasyrachis	Si, S, M			d
"				pterocarpum	IC-M-Au			d
(Pentaclethra)	Am, Af	3		filamentosa	Am		i	d
"				(macrophylla)	Af			d
(Phyllocarpus)	Br	1		(septentrionalis)	Br	e		d
(Piptadenia)	TrAm	45		(colubrina)	Br		i	d
Pithecellobium	TrAs, TrAm	60	10	ellipticum	WMs			d
"				jiringa	WMs		i	d
"				microcarpum	S, M, B			d
Pongamia	I-Fiji	few	1	pinnata	SFA-P			d
(Prosopis)	Cd	25		(juliflora)	Am	e		d
Pterocarpus	Tr	15	1	indicus	Ms			d
Saraca	I-Ms	20	7	bijuga	Si, M		i	d
"				declinata	Si, M, S, J			d
"				(indica)	I		i	d
"				thaipingensis	M			d
(Sesbania)	Tr	40	2	(grandiflora)	EAs	e		d
Sindora	I-Ms, Af	9	5	coriacea	M			d
"				Wallichii	M			d
Sophora	Cd	25	1	tomentosa	I-P		i	d
Tamarindus	Af, As	1	1	indica	TrAs			d
(Tetrapleura)	Waf	3		(Thonningii)	TrAf		i	d
(Trachylobium)	Af, As	3		(verrucosum)	Eaf, Mc			d

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Loganiaceae						
Fagraea	TrAs, WP	60	20	auriculata	M, J, IC, Ph	i
"				fragrans	T, Si, Ms	e
"				gigantea	S, SM	e
"				Ridleyi	SM	i
Lythraceae						
Duabanga	Hm-Ph	2	1	sonneratioides	I-NM	e
Lagerstroemia	CdAs, Mg, NG, Au	20	3	floribunda	Bu, Si, M	d
"				flos-reginae	I-Au, NM	d
"				ovalifolia	WMs	d
Sonneratia	As-P	4-5	3	acida	I-P	e
"				alba	I-P	e
Magnoliaceae						
(Magnolia)	As, NAM	21		(fusca)	Ch	e
Michelia	I-Ms	12	5	(alba)	J	e
"				champaca	I, M	e
Malvaceae						
Hibiscus	Tr	150	12	macrophyllus	IC, Si, WMs	e
"				(rosa-sinensis)	Ch?	e
"				(schizopetalus)	EAF	e
"				tiliaceus	Tr	e
Thespesia	Af, As, Au	6	1	populnea	ETr	e
Melastomaceae						
Memecylon	ETr	150	35	heteropleurum	M, S, B	i
Pternandra	Ms	18	5	capitellata	T-M	i
"				coerulescens	var. WMs-Mol	i
"				Jackiana	M, B	e
"				echinata		
Meliaceae						
Aglaia	I, Ms, Au	90	40	trichostemon	M, B	e
Carapa	Tr	6	3	(guianensis)	SAM	m
Cedrela	As, Am	16	3	(glaziovii)	Am	d
Chisocheton	I, Ms	30	11	spicatus	M	i
(Chloroxylon)	I, Cy	1		(swietenia)	I, Cy	d
Melja	ETr	12	4	(azedarach)	Hm	i
(Swietenia)	Am	5		(macrophylla)	Hond	i
"				(mahogani)	WI	i
Moraceae						
Antiaris	Af, I, Ms	3-4	1	toxicaria	I, Ch, Ms	d
Artocarpus	As-P	50	20	bracteatus	NM	d
"				(communis)	P	e
"				dadah	WMs	d
"				Gomezianus	WMs	i
"				rigida	WMs	i
(Castilloa)	Am, Cuba	3		(panamensis)	Mx, Per	e
(Cecropia)	SAM	30-40		(peltata)	SAM	e

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e	m	i	d
<i>Moraceae—contd.</i>									
Ficus	Cd	600	100	alba	WMs	e			
"				(calophyllus)	J		i		
"				caulocarpa	I-Ms			d	
"				elastica	Hm-J	e			
"				glomerata	As, WMs			d	
"				indica	I, Ms		i		
"				(irregularis)	Ce		i		
"				(Kurzii)	J		i		
"				lepicarpa	WMs		i		
"				religiosa	Hm I			d	
"				superba	WMs			d	
"				variegata	I, Ch, WMs, Ph			d	
Streblus	I, M, SCh, Ph	2	1	asper		e			

<i>Myricaceae</i>									
Myrica	Cd	40	1	Farquhariana	M			i	

<i>Myristicaceae</i>									
Horsfieldia	As-NG	55	19	globularia	M, J, Ce	e			
"				(grandis)	Cy			i	
"				(sylvestris)	Cy	e			

<i>Myrsinaceae</i>									
Aegiceras	As, Au	2	1	corniculatum	I-NG	e			

<i>Myrtaceae</i>									
(Eucalyptus)	Au, EMs	200		(corymbosa)	Au			i	
"				(longifolia)	Au	e			
"				(Naudiniana)	Au		e		
"				(robustus)	Au				
Eugenia	Tr	1,000	150	(aromatica)	Mo		m		
"				densiflora	WMs			i	
"				javanica	Ad, WMs			i	
"				(liliiformis)				i	
"				longiflora	WMs			i	
"				malaccensis	Ms			i	
"				myrtifolia	I, M			i	
"				polyantha	Bu, WMs			i	
"				Ridleyi	M			i	
"				spicata	I-J			i	
Melaleuca	Au, Ms, M	130	1	leucodendron	T, WMs, Mol			i	
(Psidium)	Am	120		(guajava)	TrAm			i	
Rhodamnia	Tr	60	2	trinervia	T-Au			i	

<i>Nyctaginaceae</i>									
Pisonia		60	2	(alba)	Ms (not M)			i	
"				excelsa	Ms				d

<i>Ochnaceae</i>									
Ouratea	SAm	80	4	corymbosa	M			i	
"				crocea	M			i	

Genera	Distribu- tion	No. of species	Do. of Malaya	Species	Localities	e m i d
Olacaceae						
Gonocaryum	Bu, M	4	2	longe-racemosum	M	e
Ochnostachys	B, M	1-2	1-2	amentacea	B, M	i
Scorodocarpus	M, B	1	1	bornensis	B	i
Oxalidaceae						
Averrhoa	Ms	2	2	bilimbi	Ms	e
"				carambola	J, EMs	e
Connaropsis	M, B	8	8	Griffithii	M	i
"				macrophylla	M	i
Pittosporaceae						
Pittosporum	ECd	60	3	(tobira)	Ch	i
Polyglaceae						
Xanthophyllum	Ms, I, Au	30	21	Curtisii	M	i
Polygonaceae						
(Triplaris)	SAm	10		(americana)	SAm	e
"				(surinamensis)	SAm	e
Proteaceae						
Buckinghamia	Q	1		(celsissima)	Au	i
(Grevillea)	Au	170		(robusta)	Au	i
(Stenocarpus)	E Au, NC	15		(sinuatus)	Au	i
Rhamnaceae						
Zizyphus	Cd	100	10	calophylla	M, B, S	i
"				(Jujuba)	I-Ch	i
"				(mauritiana)	IO	m
Rhizophoraceae						
Anisophyllea	TrAs, Af	10	7	disticha	WMs	e
"				Griffithii	M	i
Bruguiera	As-Eaf	5	4	gymnorhiza	ETr	e
Ceriops	ETr	1	1	Candolleana	ETr	e
Gymnotroches	Si, Ms	2	1	axillaris	M	e
Kandelia	I, Ms	1	1	Rheedii	Ms	e
Rhizophora	Cd	3	2	conjugata	ECd	e
"				mucronata	ECd	e
Rosaceae						
Parinarium	Tr	50	12	corymbosum	Ms	i
Pygeum	Waf	30	15	parviflorum	WMs	i
"				polystachyum	NM	d
Pyrus	NTemp- TrMt	70	1	granulosum	I-Ms	d
Rubiaceae						
Adina	ECd	10	2-3	rubescens	M	d
Anthocephalus	I, Ms	2	1	cadamba	I-NM	d
Canthium	ETr	100	10	dicoccum	SEA-Ms	e
"				glabrum	Si, M	e

Genera	Distribu- tion	No. of species	Do. of Malaya	Species	Localities	e m i d
Rubiaceae—contd.						
Gardenia	ETr-Temp	70	10	carinata (coronaria)	M Bu	e
"						
Ixora	ETr	120	20	congesta multibracteata	T, M SSi, M	e e
"						
Jackia	M, S, B	1	1	ornata	M	e
"						
Morinda	Tr	50	7	citrifolia	I, WMs, P	e e
"						
Randia	Tr	100	25	elliptica	M	e
"						
"				anisophylla	S, M, B	e
"				macrophylla	S, M	i
Scyphiphora	As, Au	1	1	hydrophyllacea	As, Au	e
"						
Timonius	As, Po	30	10	Wallichianus	M	e
"						
Urophyllum	As, Af	40	13	hirsutum	M	i
"				streptopodium	M	e
Rutaceae						
(Aegle)	I	1		(marmelos)	I	e
"						
Atalantia	Hm, Au	10	6	spinosa	I, Bu, Si, M	i
"						
Feronia	I, Si	1	1	limonia	I, Si	d
"						
Glycosmis	SEA, Ms	20	8	chlorosperma	WMs	i
Salicaceae						
(Salix)	Cosm	160		(tetrasperma)	I-Ch	d
Sapindaceae						
Erioglossum	As-Af	4	1	rubiginosum	M	i
"						
(Filicium)	As-Af	3		(decipiens)	I, Cy	e
"						
Guioa	I, Ms, Au	60	4	pubescens	WMs, Ph	i
"						
Lepisanthes	As	20	5	cuneata	M	i
"						
(Litchi)	Ch	1		(chinensis)	Ch	i
"						
Nephelium	As, Au	70	16	lappaceum	Ms	i
"						
"				ophioides	M	i
"						
Paranephelium	I-Ms	8	3	macrophyllum	Si, NM	i
"						
Pometia	I, Ms, Au	7	4	pinnata	I, Ms, Po	i
"						
Trigonachras	Ph, M	9	1	acuta	SM	d
"						
Xerospermum	I-Ms	20	6	muricatum	M	i
Sapotaceae						
Achras	Mx, CAm	1		(zapota)		e
"						
Lucuma	Am, As	50	8	Maingayi	M, S, B	d
"						
Madhuca	I-Ms	40	21	Kingiana	M	i
"						
(Mimusops)	ETr	20	2	(elengi)	I, Bu, Cy	i
"						
Palaquium	I, Ms, Po	100	14	Clarkianum	M	d
"						
"				gutta	S, M, B	e
"						
"				Maingayi	M	d
"						
"				obovatum	T, M, S	d
"						
Payena	Ms	12	12	dasyphylla	M, J, S	e
"						
(Pouteria)	Am	30		glabra (suavis)	Uruguay	i
Simarubaceae						
Eurycoma	IC, Ph, B	2	2	longifolia	IC-M, S, B	i
"						
Irvingia	Af-Ms	4	1	malayana	IC-M, S, B	d
Solanaceae						
Solanum	Cd	1,225	16	(Wrighti)	Bolivia	e

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Sterculiaceae						
(Cola)	Af	50		(acuminata)	TrAf	e
Commersonia	Au, P, Ms, Ch	8	1	Bartramia	Ch, Ms, P	e
(Dombeya)	Af	100		spectabilis	TrAf	e
Firmiana	I-Ms	2	1	fulgens	M	d
Heritiera	As, Af, Au	7	2	elata	M	d
"				littoralis	I-P	i
"				(macrophylla)	Bu	d
Kleinhovia	Mc-Po	1	1	hospita	M	d
Pterocymbium	Bu, WMA Ph	2	2	javanicum	Bu-Ph	d
"				tubulatum	M	d
(Rheevesia)	Hm-Ch	3		(thyrsoides)	Ch	e
Scaphium	Bu, IC, M, B	4	3	affine	M	d
"				linearicarpum	M	d
Sterculia	Tr	200	20	(carthaginensis)	Am	d
"				ferruginea	Ph	d
"				foetida	Af-Au	d
"				macrophylla	WMs	d
"				parviflora	I M	d
"				rubiginosa	I, IC, WMs	d
Tarrietia	I, Ms, Au	10	6	javanica	WMs	i

Symplocaceae						
Symplocos	Cd	300	30	fasciculata	M, S, B, J	e
"				rubiginosa	WMs	i

Theaceae						
Adinandra	SEA	20	10	acuminata	Ms	i
"				angulata	NM	i
"				dumosa	M, S, J, B	e
"				Hulletti	SM	i
"				integerrima	M, IC	i
"				macrantha	M (mountain)	i
"				maculosa	M (mountain)	i
"				parvifolia	M (mountain)	i
"				villosa	M (mountain)	i
Archytaea	TrAm, Ms	4	2	Vahli	Si, Ms	e
Gordonia	CdAs, Am	20	10	penangensis	M	i
"				singaporeana	M	i
Pyrenaria	I-M	7	2	acuminata	M	i
Ternstroemia	As, Am	300	6	bancana	M	i
(Thea)	SEA, Ch, Jp	40		(cochin-chinensis)	IC	i

Thymeliaceae						
(Phaleria)	I-Ms	12		(Blumei)	S, J, B, Ce, Mo	i

Genera	Distribution	No. of species	Do. of Malaya	Species	Localities	e m i d
Ulmaceae						
Gironniera	SEA	12	4	nervosa	WMs (not Java)	d
"				subaequalis	SEA	e
Trema	Tr	30	3	angustifolia	WMs	e
"				orientalis	Hm-Po	e
"				variegata	SEA-Ms	e
Verbenaceae						
Avicennia	Tr	4	4	alba	I-Ms	e
"				intermedia	M	e
"				lanata	M	e
"				officinalis	I-Po	e
Callicarpa	Tr	50	7	(Rheevessii)	SCH	e
(Citharexylum)	Am	20		(quadrangulare)	Am	i
Gmelina	As, Au	12	1	(arborea)	I	i
Premna	ECd	50	13	tomentosa	I-WMs, Ph, Tim	i
(Tectona)	I, Bu, Si, Ph	3		(grandis)	Bu, Si, EJ, Ph	m
"				(Hamiltoniana)	I	i
Vitex	Cd	140	16	(capitata)	TrAm	m
"				coriacea	NM	i
"				pubescens	TrAs	m
Violaceae						
Alsodeia	Tr	50	19	Maingayi	SM	i
Vitaceae						
Leea	As, Af, Au	70	12	aequata	WMs	c
"				angulata	WMs	c
"				indica	I-P	c
"				rubra	IC-J, NM	c

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Plant Communities on Singapore Island

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DESCRIPTIONS OF plant communities on Singapore Island are infrequent in the literature. This is perhaps natural because attention has been directed in the first place to the identification of the members of its rich flora. General papers have been published by Corner (1941) and others, and one or two papers concerning the specific make-up and dynamic behaviour of the vegetation also exist. The first of these was a paper published by I. H. Burkill in 1919, and constituted the record of his observations upon a piece of then 30-year-old secondary forest (belukar) which he had cut down for the purpose of developing the Botanic Gardens. Burkill's data are very full, and can be represented as shown in Table 1, in such a way as to indicate the reproductive status of the principal species. In selecting from Burkill's data for presentation in this table, I have chosen the species present in reasonable amount, or sometimes have been guided by the importance of the species concerned in other communities. Those which are lumped together at the end of the Table under "Others" amount to 25 per cent of the total number of individuals recorded and comprise some 95 further species.

It is clear that the Common Ivy-Palm (*Arthrophyllum diversifolium*), whose population is present in all size classes, has been growing and reproducing successfully for a considerable period on this site. It is in this case the nearest equivalent to what is meant by a dominant in other climates. The Leechwood (*Anisophyllea disticha*) is here its principal shrubby partner. The Broad-leaved Oil Fruit (*Elaeocarpus petiolatus*) of which two large specimens are recorded, has evidently not been reproducing itself successfully until recently.

By analogy this might well be called an *Arthrophyllum/Anisophyllea* Mixed Forest indicating that, while in the conventional sense no dominant species was present, the Common Ivy Palm and the Leechwood appear to have been the most successful and characteristic species.

Table 1 is prepared in such a way as to render a comparison with the results obtained by the present author elsewhere (Gilliland, 1952) readily possible.

TABLE 1

THIRTY-YEAR-OLD BELUKAR: BOTANIC GARDENS: SINGAPORE
DATA OBTAINED FROM BURKILL, 1919*

SAMPLE AREA 13,680 SQUARE FEET

Species	0-1	1-3	3-5	5-7	Over 7	Total	%
<i>Arthropylum diversifolium</i>	125		10	16	13	164	5.5
<i>Rhodamnia trinervia</i>	.. 229		—	2	11	242	8.2
<i>Cinnamomum iners</i>	.. 315		2	4	—	321	10.8
<i>Timonius wallichianus</i>	.. 107		2	1	—	110	3.7
<i>Macaranga triloba</i>	.. 106		—	1	—	107	3.6
<i>Adinandra dumosa</i>	.. 91		—	1	4	96	3.2
<i>Elaeocarpus petiolatus</i>	.. 34		—	—	2	36	1.2
<i>Gordonia singaporeana</i>	.. 25		1	1	1	28	.9
<i>Gynotroches axillaris</i>	.. 85		1	—	—	86	2.9
<i>Pygeum polystachyum</i>	.. 1		—	1	—	2	.1
<i>Ixonanthes reticulata</i>	.. —		—	—	1	1	—
<i>Anisophyllea disticha</i>	.. 345		—	—	—	345	11.6
<i>Elaeocarpus mastersii</i>	.. 199		—	—	—	199	6.7
<i>Gironniera nervosa</i>	.. 190		—	—	—	190	6.4
<i>Palaquium bancanum</i>	.. 144		—	—	—	144	4.8
<i>Eugenia grandis</i>	.. 139		—	—	—	139	4.7
Others	.. —		—	—	—	754	25.5
Totals	.. 2,135		16	27	32	2,964	99.8

* Gard. Bull. S.S.2:5:145, 1919.

Holtum, in a paper published in 1954, recorded those plants which constitute what he called "Adinandra belukar" and gave his observations upon the species which behaved as pioneers, initiating succession on this island. Table 2 summarises his findings. There are trees and shrubs, perennial herbs and climbers. My own observations fully confirm Professor Holtum's conclusions with regard to these species.

TABLE 2

PIONEER 'ADINANDBRA BELUKAR'; SINGAPORE ISLAND
DATA FROM HOLTUM, 1954†

TREES AND SHRUBS	<i>Melastoma malabathricum</i>	<i>Macaranga javanica</i>	<i>Archytea vahlii</i>
	<i>Adinandra dumosa</i>	<i>Ficus alba</i>	<i>Fagraea fragrans</i>
	<i>Wormia suffruticosa</i>	<i>Rhodamnia trinervia</i>	<i>Myrica farquhariana</i>
PERENNIAL HERBS	<i>Lycopodium cernuum</i>	<i>Gahnia tristis</i>	<i>Spathoglottis plicata</i>
	<i>Gleichenia linearis</i>	<i>Scleria laevis</i>	<i>Arundina graminifolia</i>
	<i>Eriachne pallescens</i>	<i>Bromheadia palustris</i>	<i>Imperata cylindrica</i>
CLIMBERS	<i>Nepenthes rafflesiana</i>	<i>Nepenthes gracilis</i>	<i>Nepenthes ampullaria</i>

† Mal. Jour. Trop. Geogr. 3:27, 1954.

At the corner of the "catchment area" which forms part of the Nature Reserves on Singapore fronting Lornie Road and adjoining the Royal Singapore Golf Course, occurs a large specimen of the tree *Ixonanthes reticulata* prominent amongst the species of a manifest secondary woodland. An examination of the ground at this site disclosed evidence of military occupation in the shape of slit trenches, latrine pits, foundations of temporary buildings, etc. from which it is logical to deduce considerable occupation of the area, with its concomitant destruction of the vegetation, during the 1941-6 period.

By a fortunate chance Mr. Corner, in discussing the Ten Men Tree in his well-known 'Wayside Trees of Malaya' mentions this specific locality for the tree. In correspondence he notes that he can confirm the existence of this species at this site in 1934. So we are not without some history of this particular area. The Ten Men Tree has stood for at least twenty years—a fact confirmed by the size of the bole of a large specimen, which has a girth of more than ten feet—and has survived severe disturbance which occurred around it some ten to fifteen years ago.

This area was transected by chain using the technique described in the paper referred to (Gilliland, 1952). However, since so many plants and species were present only 1,000 feet of transect were enumerated. Furthermore, in this case the records of each chain length (600 sq. ft.) of the transect were recorded separately. In this way it became possible to estimate from the recurrence of a species in each or fewer of the 10 separate sub-samples, its degree of "faithfulness" in the community. Faithfulness is here used upon a different scale from that normally employed by continental sociologists, but the result is of sufficient interest to make the record worth while. Table 3 presents a summary of the results obtained.

TABLE 3
SUMMARY
SAMPLE AREA 6,000 SQUARE FEET
Diameter Classes

Species	0-1	1-3	3-5	5-7	Over 7	Total	%
Surviving Trees	40	6	2	3	8	59	2.1
Seral Relics	109	2	—	—	—	111	4.0
Human Casuals	4	3	1	1	—	9	.3
Present Community: Trees	1564	61	7	2	1	1635	59.2
Shrubs	268	2	1	—	—	271	9.8
Lianes	295	2	—	—	—	297	10.7
Next Stage: Trees	161	5	—	—	—	166	6.0
Shrubs	34	1	—	—	—	35	1.3
Lianes	99	—	—	—	—	99	3.6
Unidentified	74	4	—	—	—	78	2.9
Totals	2648	86	11	6	9	2760	99.9

The number of plants recorded in the first place makes it clear that this forest is much more dense than that investigated by Burkill—the area is approximately half. A total of ninety-five species was recorded together with some which could not be identified; approximately the same total.

Secondly by making use of the concept of 'faithfulness' it is possible to separate out the 'present community' from the succeeding community or next stage. Further by the use of Holtum's records and Corner's notes on the Ten Men Tree and for other reasons, three other groups can also be distinguished.

TABLE 4a
HUMAN CASUALS
DIAMETER CLASSES

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
<i>Acacia auriculiformis</i>	.. —	3	1	1	—	5	2	
<i>Thevetia nerifolia</i> ..	.. 2	—	—	—	—	2	1	
<i>Nephelium lappaceum</i>	.. 1	—	—	—	—	1	1	
<i>Garcinia mangostana</i>	.. 1	—	—	—	—	1	1	
Totals ..	4	3	1	1	—	9	—	0.3

TABLE 4b
SURVIVING TREES

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
<i>Ixonanthes reticulata</i>	.. 6	—	—	2	7	15	8	
<i>Alstonia</i> sp. ..	.. 2	1	1	—	—	4	1	
<i>Gordonia singaporeana</i>	.. 11	5	—	1	—	17	5	
<i>Horsfieldia</i> sp. ..	.. —	—	—	—	1	1	1	
<i>Gynotroches axillaris</i>	.. 21	—	1	—	—	22	5	
Totals ..	40	6	2	3	8	59	—	2.1

TABLE 4c
SERAL RELICS: TREES & SHRUBS

Species	0-1	1-3	3-5	5-7	Over 7	Fid.	Total	%
<i>Macaranga javanica</i>	.. 26	—	—	—	—	26	8	
<i>Adinandra dumosa</i> ..	.. 23	2	—	—	—	25	4	
<i>Fagraea fragrans</i> ..	.. 19	—	—	—	—	19	5	
<i>Tetracera assa</i> ..	.. 19	—	—	—	—	19	7	
<i>Archytea vahlii</i> ..	.. 8	—	—	—	—	8 ¹	2	
<i>Vitex pubescens</i> ..	.. 3	—	—	—	—	3	2	
<i>Ficus chrysocarpa</i> ..	.. 8	—	—	—	—	8	2	
<i>Macaranga triloba</i> ..	.. 1	—	—	—	—	1	1	
<i>Adinandra</i> sp. ..	.. 2	—	—	—	—	2	2	
Totals ..	109	2	—	—	—	111	—	4.0

Together with the following ground flora of herbs:

Stenochlaena palustris, *Cleidemia hirta*, *Lygodium microphyllum*, *Melastoma malabathricum*, *Gleichenia linearis*, *Nepenthes ampullaria*, *Gahnia tristic*, *Nepenthes rafflesiana*, *Scleria* sp., *Phyllanthus niruri*, *Bromhædia palustris*.

Table 4 presents the detailed records of the Surviving Trees, the Seral Relics and the Human Casuals.

The surviving trees are so called from their presence in mature form coupled with a poor representation amongst the seedling stages. The Ten Men Tree is typical and it will be recalled that Corner records this as being present in 1934. It is suggested that during the period of the disturbance and subsequently, it has been unable to reproduce and that only now with the return of forest conditions is it beginning to be able to reproduce effectively. It produces an abundant crop of fruit and seed every year but as yet the seed have not been able to germinate and gain a foothold.

The seral relics are those recorded as making up part of the 'Adinandra belukar' or pioneer community and these, with the possible exception of the 'tiup-tiup' (*Adinandra dumosa*) itself, which seems to grow fast enough to avoid shading, are now on their way out as the result of the re-establishment of forest conditions. *Macaranga javanica*—the Blue Mahang—although present and with a high degree of faithfulness, in my opinion will not grow to be larger than a seedling in the conditions of shading which now obtain. With this list of trees and shrubs should be read the list of species in the undergrowth. These likewise are members of the 'Adinandra belukar' and will not long survive the shading. Holttum specifically notes that the Orchid *Bromheadia palustris* does occur in shade but never manages to flower in such conditions.

The Human Casuals are interesting. The first two are commonly cultivated plants; the first as a street tree and the second as an ornamental shrub while the next two are the 'rambutan' and the 'mangosteen', both everyday tropical fruits.

TABLE 5a
PRESENT COMMUNITY: TREES
DIAMETER CLASSES

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
Rhodamnia trinervia ..	265	31	3	1	1	301	10	10.9
Elaeocarpus petiolatus ..	38	8	3	—	—	49	8	1.4
Elaeocarpus mastersii ..	98	—	1	—	—	99	10	3.6
Oncosperma sp. ..	73	—	—	1	—	74	7	2.7
Eugenia longiflora ..	491	3	—	—	—	494	10	17.9
Garcinia griffithii ..	76	2	—	—	—	78	7	2.8
Cinnamomum iners ..	32	1	—	—	—	33	10	1.2
Pithecellobium clypearia ..	27	2	—	—	—	29	7	1.1
Eugenia grandis ..	21	4	—	—	—	25	8	0.9
Guoia pubescens ..	16	4	—	—	—	20	8	0.8
Timonius wallichianus ..	18	2	—	—	—	20	9	0.8
Angelesia splendens ..	17	3	—	—	—	20	8	0.8
Artocarpus kunstleri ..	17	1	—	—	—	18	8	0.7
Calophyllum floribundum ..	328	—	—	—	—	328	10	11.9
Garcinia cowa ..	35	—	—	—	—	35	7	1.3
Xylopia ferruginea ..	12	—	—	—	—	12	7	0.4
Totals ..	1564	61	7	2	1	1635	—	59.2

TABLE 5b

PRESENT COMMUNITY: SHRUBS

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
<i>Champereia manillana</i>	.. 102	2	—	—	—	104	10	3.7
<i>Anisophyllea disticha</i>	.. 80	—	—	—	—	80	8	2.9
<i>Ixora congesta</i>	.. 58	—	1	—	—	59	10	2.1
<i>Lasianthus</i> sp.	.. 28	—	—	—	—	28	7	1.1
Totals	.. 268	2	1	1	—	271	—	9.8

PRESENT COMMUNITY: LIANES

<i>Rourea splendens</i>	.. 96	2	—	—	—	98	8	3.5
<i>Fibraurea chloroleuca</i>	.. 86	—	—	—	—	86	10	3.1
<i>Ericybe princei</i>	.. 64	—	—	—	—	64	10	2.2
<i>Calamus</i> sp.	.. 30	—	—	—	—	19	7	0.7
<i>Strychnos malaccensis</i>	.. 19	—	—	—	—	19	8	0.7
Totals	.. 295	2	—	—	—	297	—	10.7

UNDERGROWTH CONSISTING OF:--*Davallia* sp.; *Taenitis blechnoides*; *Selaginella* sp.; *Curculigo villosa*; *Dianella ensifolia*; *Hornstedtia martinicensis*; *Centotheca lappacea*; *Panicum nodosum*.

This list represents what I would consider to be, with the aid of the use I have made of faithfulness, the present community. All the plants noted have a fidelity to the sub-samples of the transect of seven or over. (See column 7 of table 5).

The undergrowth consists of plants typical of forest conditions on Singapore Island; the lianas will not excite comment and the leechwood appears again amongst the shrubs, though the False Olive (*Champereia manillana*) exceeds it here in number of individuals and development.

The trees are most interesting in that amongst them there is only one species which shows a distribution over all the size classes; seedling; sapling; young tree; mature tree and the large tree, namely the Silver Back (*Rhodamnia trinervia*). It is clear that it was present at the time of the disturbance and has not only survived that disturbance but has been able, in doing so, to extend its territory and to become the characteristic plant of the present community. This is in keeping with its record by Holttum as amongst the pioneer shrubs. The Broad-Leaved Oil Fruit in this instance has been much more successful than in the case of Burkill's sample. Considering the comparative success of the False Olive (*Champereia manillana*) we might legitimately describe the present community as a *Rhodamnia/Champereia* forest. We would note that both the Common Kelat (*Eugenia longiflora*) and the Bintangor (*Calophyllum floribundum*) are commencing to play a significant role but that as yet they are present only as seedlings and saplings.

TABLE 6a
NEXT STAGE: TREES
DIAMETER CLASSES

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
<i>Milletia atropurpurea</i> ..	38	—	—	—	—	36	3	
<i>Cratoxylon formosanum</i> ..	23	—	—	—	—	23	5	
<i>Calophyllum</i> sp. I ..	21	—	—	—	—	21	6	
<i>Calophyllum</i> sp. II ..	13	—	—	—	—	13	5	
<i>Garcinia</i> sp. ..	11	—	—	—	—	11	4	
<i>Onchostachys amentacea</i> ..	8	1	—	—	—	9	3	
<i>Elaeocarpus</i> sp. ..	7	1	—	—	—	8	5	
<i>Lindera lucida</i> ..	8	—	—	—	—	8	3	
<i>Arthrophyllum diversifolium</i> ..	6	1	—	—	—	7	4	
<i>Daemonerops</i> sp. ..	6	1	—	—	—	7	4	
<i>Ilex cymosa</i> ..	4	—	—	—	—	4	3	
<i>Litsea grandis</i> ..	4	—	—	—	—	4	3	
<i>Plectocomia</i> sp. ..	3	1	—	—	—	4	2	
<i>Randia anisophyllea</i> ..	3	—	—	—	—	3	3	
<i>Palaquium</i> sp. ..	3	—	—	—	—	3	3	
<i>Eugenia garcinifolia</i> ..	3	—	—	—	—	3	1	
<i>Baccaurea parviflora</i> ..	1	—	—	—	—	1	1	
<i>Aquilaria malaccensis</i> ..	1	—	—	—	—	1	1	
Totals ..	161	5	—	—	—	166	—	6.0

TABLE 6b
NEXT STAGE: SHRUBS

Species	0-1	1-3	3-5	5-7	Over 7	Total	Fid.	%
<i>Wikstroemia ridleyi</i> ..	22	—	—	—	—	22	5	
<i>Psychotria</i> sp. ..	3	—	—	—	—	3	3	
<i>Gnetum macrostachyum</i> ..	2	—	—	—	—	2	2	
<i>Canthium</i> sp. ..	2	—	—	—	—	2	2	
<i>Clerodendron diversifolium</i> ..	2	—	—	—	—	2	2	
<i>Tetracera sylvestris</i> ..	1	—	—	—	—	1	1	
<i>Chasalia chartacea</i> ..	1	—	—	—	—	1	1	
<i>Dracaena</i> sp. ..	—	1	—	—	—	1	1	
<i>Strophanthus</i> sp. ..	1	—	—	—	—	1	1	
Totals ..	34	1	—	—	—	35	—	1.3

NEXT STAGE: LIANES

<i>Willughbeia coriacea</i> ..	91	—	—	—	—	91	3	
<i>Piper</i> sp. ..	3	—	—	—	—	3	2	
<i>Artabotrys</i> sp. ..	2	—	—	—	—	2	2	
<i>Thottia grandiflora</i> ..	2	—	—	—	—	2	2	
<i>Paedera verticillata</i> ..	1	—	—	—	—	1	1	
Totals ..	99	—	—	—	—	99	—	3.6
Unknowns ..	74	4	—	—	—	78	—	2.9

This list represents those species of trees, shrubs and lianes which, by virtue of their low fidelity to the sub-samples of the transect, constitute evidence of invasion of the present community by the elements which will constitute the next phase in the succession back to high forest. The majority of plants recorded are seedlings and all have in common a considerable shade-tolerance as seedlings. There may be species whose natural distribution follows a pattern of such wide dispersion that they would not be caught in a sub-sample of 600 square feet. For that reason they would normally be expected to show a low fidelity figure in a

transect such as this. We may be confident, however, that such species will be revealed by continuing work along these lines for they will always be distinguished by a low fidelity.

In these analyses certain species have been brought into prominence by means of transect enumeration. These species appear to characterise particular stages of the succession which will, in course of time, restore the high forest. By analogy with the behaviour of those in other less fortunate climates, where dominance develops, they may well be used to name the stages involved. Three stages of secondary forest succession on Singapore island then emerge:

1. *The Adinandra Belukar* (Holttum, 1954)

Clearly the length of time that this will occupy the ground depends largely upon the degree of prior destruction of the habitat. Over on Kent Ridge where it occupies the site of abandoned plantations it will be many years before the reaction of this pioneer community is able to ameliorate the habitat sufficiently for further development to occur, while in the instance at the Lornie Road/Golf Course site it is just as clearly already on its way out after some ten to fifteen years.

2. *The Rhodamnia/Champereia* stage

The Silver Back/False Olive community now holds the ground but clearly has within it the seeds (or better seedlings) of the next stage.

3. *The Arthrophyllum/Anisophyllea* stage (Burkill, 1919)

This Common Ivy Palm/Leechwood community is the one which Burkill so carefully annotated thirty-five years ago and which then represented the progress of belukar which had held the ground for thirty years.

Discussion

Corner (1940), Holttum (1930: 1940) and Koriba (1947) have given a great deal of attention to the phenological behaviour of our plants with special reference to time of flowering and the formation of new leaves—to the beginnings more especially of deciduousness—while Corner (1951) particularly in developing his Durian Theory, has given prominence to the concept of the moist tropical forest environment as the primal land habitat. It has been suggested that the deciduous habit and the seasonal flowering condition may have become consolidated by migration to north and south, requiring those functions to become seasonal in pattern. Let us suppose that Singapore were to suffer a severe

drought of say three months duration—that in fact that the climate were suddenly to become monsoonal. The plants which would be most severely affected would be those with the shallowest and least developed root-systems—in fact it would be the seedlings which would suffer first. The Silver Back is recorded among the pioneer plants of the Adinandra Belukar which means that it is relatively hardy. The figures show clearly that it is the best adapted to the earlier conditions of the present community. Hence the effect of such a calamitous drought would be to bring the Silver Back into vastly greater relative prominence. It would begin in fact to display the characters of a dominant from a less favoured climate than our own. The concept of a primal vegetation in the humid tropics fits these facts of community structure, and this analysis of the *Rhodamnia-Champereia* community lends support to that hypothesis by indicating how a development of dominance in response to the demands of a harsher climate could come about.

The use of the term “faithfulness” = “fidelity” in this context unhappy; a future paper will propose a more neutral term.

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Juncaceae, a new family record for Malaya

By J. H. KERN

Foundation Flora Malesiana, Leyden

AMONG SOME unidentified sedges from the Malay Peninsula kindly sent to me for identification, I found two sheets of *Juncus prismatocarpus* R.BR., collected by H. M. BURKILL in the Cameron Highlands. It seems worthwhile to mention these collections in a short note, as up to the present Juncaceae were unknown from the Malay Peninsula.

Juncus prismatocarpus extends from Ceylon through S.E. Asia to Japan and Kamtchatka, and southward to Australia, Tasmania, and New Zealand. In Malaysia it is known from N. Sumatra, West and Central Java, the Philippines, and New Guinea (see BACKER in *Flora Mal. I*, 4: 213. 1951).

MALAY PENINSULA. Pahang: Cameron Highlands; summit of Batu Brinchang, open rough waste, 6,660 ft. Sept. 1, 1956, H. M. BURKILL 783 (L); Break Pressure Tank Hill, open waste land, 4,900 ft. Sept. 5, 1956, H. M. BURKILL 823 (L).

The habitat of *J. prismatocarpus* is in Malaysia in the mountains, between 3,000 and 9,000 feet above sea-level, along pools, on marshy plains, along swampy banks of brooks and rivulets, but occasionally on drier heath lands, always in *open* places.

The anthropogenous habitat in the Cameron Highlands might cast some doubt about its being native in the Malayan uplands, where it now occurs as a ruderal. The fact that it has never been found before in Malaya and this new habitat would at first glance point to a new, rather recent introduction.

If the species was introduced it is most likely that it is due to man who, after the rather recent opening of the Cameron Highlands, the building of bungalows, etc., has frequented this pleasant resort. The tiny, oblong ribbed seeds measuring only $\frac{1}{2}$ – $\frac{3}{4}$ mm. in length may easily have been brought along with luggage or, more possibly, have adhered to shoes or clothes of people who have formerly either paid a visit to mountain resorts in Ceylon, India, Burma, North Sumatra or Java. One could imagine for example visits of botanists, tea-planters, or tourists. How long the seed will retain its viability under these circumstances is unknown.

Another explanation is more likely, however, namely that it is native and was hitherto overlooked because of its scarcity due to

the paucity of its ecological niche. Open somewhat marshy localities must have been extremely scarce before the opening of Cameron Highlands. Once the opening of the highlands started, man greatly extended the area of its potential occurrence.

A similar swarming out of native mountain plants of restricted occurrence over newly opened land occupied by man has been described by Dr. VAN STEENIS)* from various mountains in Java in which several native species invaded plantations as weeds in large quantity or acted as roadside ruderals. A similar behaviour has been observed in the European Alps and THELLUNG has called such plants on new, anthropogenous habitat, apophytes) †.

Juncus prismatocarpus may in Malaya well belong to this class and may originally have occurred very locally in the Camerons from which focus it has spread to the newly opened land, thereby greatly increasing in number. It is quite possible that other ecologically heliophytic plants may 'escape' from their small, precarious niches in the densely forested hills and show their existence in this unexpected way.

* Bull. Jard. Bot. Btzg III, 13 (1935) 303.

† Bot. Jahrb. 53 (1915) Beibl. 116, p. 38 footnote.

Ararocarpus — A Monstrosity

By JAMES SINCLAIR

SCHEFFER in Ann. Jard. Bot. Buit. 2 (1885) 10 described a monotypic Annonaceous genus, *Ararocarpus* from material collected by himself in Java. He named it *Ararocarpus velutinus* and compared it with *Annona* which differs from it in having only one seed to the carpel but which is similar in respect of its fused carpels. The carpels of *Ararocarpus* are, however, free at their apices for a short distance.

For a long time I tried unsuccessfully to locate the type specimen as I thought that there might be a possibility of the plant occurring in Malaya. Boerlage's picture of it in *Icones Bogoriensis* 1 (1899) Tab. 40 was then all I had seen of it. I followed Hutchinson, Kew Bull. (1923) 255 and placed it in the *Annonineae* along with *Annona*, *Raimondia* and *Rollinia* (non Malaysian genera) on account of the fused carpels [Sinclair in Gard. Bull. Sing. 14 (1955) 167 and 177]. I failed, however, to see that it ought not to be placed in that group on account of the several seeds per carpel.

I eventually found the type specimen of *Ararocarpus velutinus* in Leiden in April 1956 and then the picture was clear. I saw what *Ararocarpus* was. Boerlage, l.c. page 84, was not so far wrong when he placed it next to *Meiogyne* in his scheme of classification on account of the numerous seeds per carpel and the similar petals. He did, however, associate it with *Annona* in the same scheme and not unnaturally because of the fused carpels. He also described (with a query) a variety *tenuifolia* of *Ararocarpus* from a sterile specimen in Bogor, l.c. page 123.

Ararocarpus is actually a freak of *Meiogyne virgata* (Bl.) Miq., a species which has a wide distribution, occurring in Malaya, Borneo, Java and Sumatra. It is rather variable in the size of the leaves and the breadth of the petals. The carpels are sessile or nearly so and often touch each other at the base. The average number is 3 but sometimes 1, 2, 4 and 5 occur. In Scheffer's specimen there are 8–12 carpels and here, apparently, on account of their large number, they had no room to expand laterally so a fusion took place, resulting in the abnormal fruit. Naturally such monstrosities are rare so one need not be surprised when the plant was never collected again.

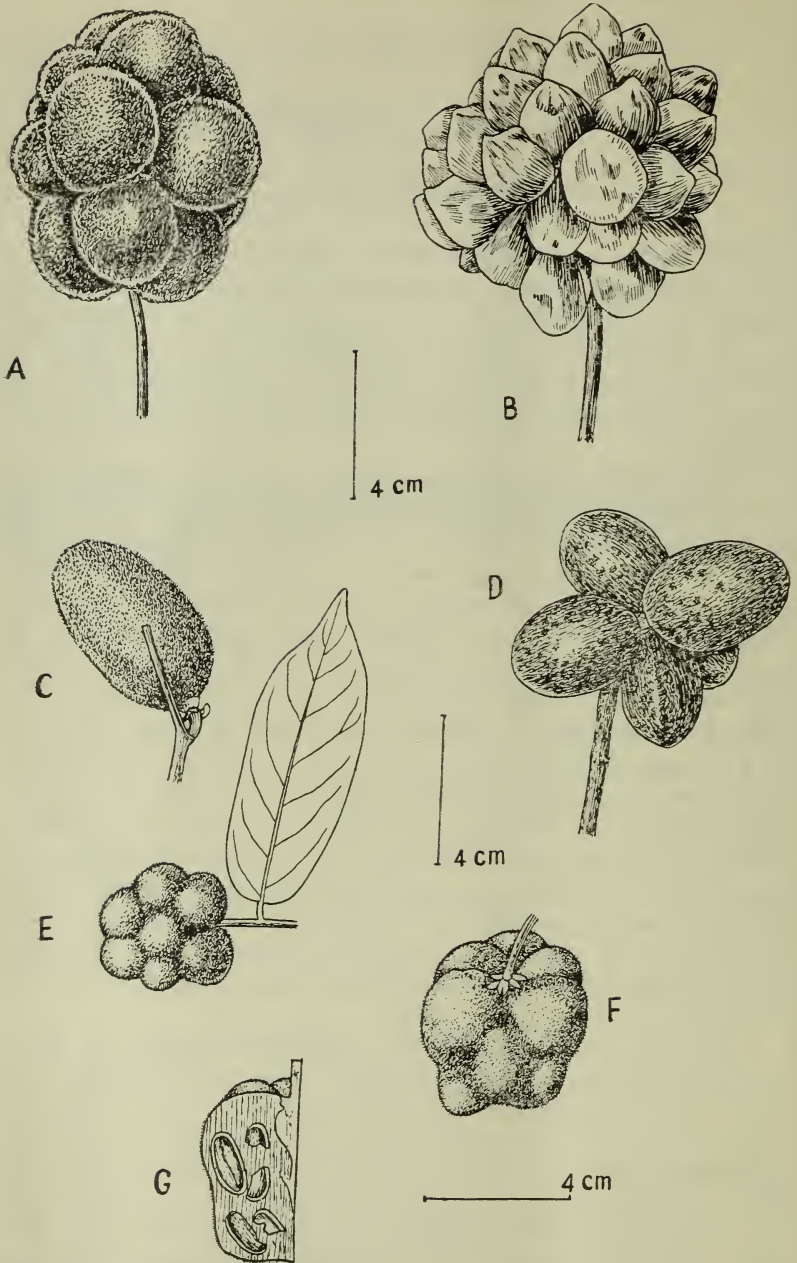


Fig. 1. Some Annonaceae carpels.

A, *Fissistigma lanuginosum*. B, *Goniothalamus ridleyi*. C, *Meiogyne virgata* with a single carpel. D, the same with five carpels. E, F, *Ararocarpus velutinus*. G, the same in longitudinal section. A from Kiah S.F.N. 32199. B from Sinclair, Seletar Forest. C from Henderson S.F.N. 19609. D from Daud & Tachun S.F.N. 35692. E-G copied from Boerlage's figure in Icon. Bog. 1 (1899) Tab. 40.

There are other species of Annonaceae with numerous, sessile or almost sessile carpels clustered together into a ball. Such examples are seen in *Fissistigma lanuginosum*, *Goniothalamus ridleyi* and *Uvaria sphenocarpa*. One might very well expect to find these with fused carpels since there is little room for lateral or basal expansion of the carpels. However, let no more new names be invented for such abnormalities or monstrosities.

Florae Malesianae Precursores—XX

The Genus *Gymnacranthera* (Myristicaceae) in Malaysia

By JAMES SINCLAIR

SUMMARY

THERE ARE six species and four varieties in the genus *Gymnacranthera*. Some taxonomists may prefer to regard the varieties as subspecies since they occupy only certain geographical areas in some reasonable distributional pattern. One of the six species, namely *G. farquhariana* (Hk. f. et Th.) Warb., synonym *G. canarica* (King) Warb., is confined to southern India, while the rest are Malaysian. I have already dealt with the Malay Peninsula species in *Gardens' Bulletin*, Singapore 16 (1958) 434 in which publication will be found descriptions and details of distribution in Malaya.

The distribution of these Malayan species outside Malaya is dealt with now in the present paper but descriptions and other details are not repeated. Descriptions, however, are given for the remaining species which do not occur in the Malay Peninsula. Species on loan from a few herbaria were received after my paper "A Revision of the Malayan Myristicaceae" went to the press so these are briefly enumerated in the present account under Malay Peninsula, extra specimens. These herbaria are BO, LE and NSW. Vernacular names given here are those used outside Malaya. The only common vernacular names for *Gymnacranthera* in Malaya are *pendarah*, *chendarah*, *penarah*, *darahan*, *chendarahan*, *pendarahan* and *penarahan* and these are equally applicable to the other genera of the *Myristicaceae*. It is not necessary therefore, to repeat them under each species.

In this paper the following receive new status:—*G. crassinervis* is reduced to a variety of *G. forbesii* and *G. zippeliana* to a variety of *G. paniculata*. The following are reduced to synonyms of *G. paniculata* var. *paniculata*:—*G. acuminata* and *G. macrobotrys*, while *G. suluensis* is made a synonym of *G. paniculata* var. *zippeliana*.

KEY

a. Leaves larger than in the other species, 20–40 cm. long and 7.5–16.5 cm. broad (leaves from young or vigorous shoots of *G. forbesii* var. *crassinervis* may equal their dimensions but average leaves are smaller), covered beneath with rusty or ashy tomentum which persists for some time; nerves 19–23 pairs. Inflorescence axis rusty-tomentose with hairs 1 mm. long. Flowers rusty-tomentose, larger than those of the other species, 5–6.5 mm. long. Fruit rusty-tomentose, the apex sometimes sharply acute or slightly uncinat

b. Leaves rounded or slightly rounded at the base. Male flowers 5 mm. long and 3 mm. broad

(1) *G. bancana* var. *bancana*

b. Leaves acute at the base. Male flowers slightly larger and broader, 5–6.5 mm. long and 4 mm. broad

(1) *G. bancana* var. *borneensis*

a. Leaves smaller, not over 28 cm. and up to 10 cm. broad; not covered with rusty tomentum; nerves not more than 21 pairs. Inflorescence axis not tomentose but often puberulous to adpressed-pubescent, flowers scarcely tomentose, mostly pubescent, less than 6 mm. long. Fruit scarcely tomentose, mostly glabrous when mature, the apex obtuse or slightly acute

c. Twigs generally stout, 3 mm. thick at the apex and 5 mm. thick 12 cm. down, grey or pale straw-coloured. Leaves 10–28 cm. long and 3.3–10 cm. broad; nerves 13–21 pairs

d. Leaves often acuminate at the apex, the undersurface with a rusty tinge, less often glaucous; nerves usually fine beneath, not forming a distinct double loop. Inflorescence axis rusty-tomentulose, female 1.5 cm. long, the flowers very densely crowded and touching each other. Fruit oblong, rusty-tomentulose, becoming glabrous

(2) *G. contracta*

d. Leaves generally less acuminate, the undersurface more glaucous; nerves more prominent beneath, forming a double loop. Inflorescence axis pubescent, the male less branched, the female 2.5–3 cm. long, the flowers not densely crowded, scarcely touching each other. Fruit ellipsoid or obovoid, with some rusty scurf when young, soon glabrous

e. Leaves 10–22 cm. long and 3.3–9 cm. broad; nerves 13–17 pairs, prominent beneath, 0.3–0.5 mm. thick on the undersurface; midrib 1–1.5 mm. thick at base below

(3) **G. forbesii** var. **forbesii**

e. Leaves more coriaceous, 15–28 cm. long and 4.5–9.5 cm. broad; nerves 14–21 pairs, more prominent, 0.7–1 mm. thick on the undersurface; midrib 2–3 mm. thick at base below

(3) **G. forbesii** var. **crassinervis**

c. Twigs more slender, 1–2 mm. thick at the apex and 3–4 mm. thick 12 cm. down, brownish towards the apex, grey lower down. Leaves smaller, 6–20 cm. long and 1.5–8 cm. broad (sometimes up to 25 cm. long in some of the Celebes specimens of *G. paniculata* var. *zippeiana*); nerves 6–15 pairs

f. Leaves 10–16–(25) cm. long; nerves 8–15 pairs, prominent beneath, often with distinct interarching

g. Leaves lanceolate, 2–5.5 cm. broad; nerves 8–11 pairs. Fruit globose

(4) **G. paniculata** var. **paniculata**

g. Leaves lanceolate to elliptic, 4–8 cm. broad; nerves 10–15 pairs. Fruit oblong

(4) **G. paniculata** var. **zippeiana**

f. Leaves smaller, 6–15 cm. long; nerves 6–9 pairs, less prominent or faint below, the interarching not usually distinct

h. Leaves lanceolate or elliptic-lanceolate. Nerves not raised above, very fine and faint on the lower surface and not raised, cannot be felt by rubbing with the finger. Male flowers 3–4 mm. long. Fruit ovoid-elliptic, 2 cm. long and 1.3–1.5 cm. broad

(5) **G. eugeniifolia** var. **eugeniifolia**

h. Leaves elliptic to obovate. Nerves raised above and below, fine but those below can be felt by rubbing with the finger. Male flowers 4–5 mm. long. Fruit oblong or sub-globose, larger, up to 2.8 cm. long and 2–2.5 cm. broad

(5) **G. eugeniifolia** var. **griffithii**

- (1) **G. bancana** (Miq.) J. Sinclair in Gard. Bull. Sing. 16 (1958) 436 Fig. 53. Pl. XIII A.

Basionym: *Myristica bancana* Miq., Fl. Ind. Bat. Suppl. 1 (1861) 383; Warb., Monog. Myrist. (1897) 518.

Synonyms: *Gymnacranthera murtonii* (Hk. f.) Warb., Monog. Myrist. (1897) 357 T. 20 Figs 1–3; Gamble, Mat. F.M.P. 5, 23 (1912) 223; Ridley, F.M.P. 3 (1924) 61. *Myristica murtonii* Hk. f., Fl. Br. Ind. 5 (1886) 105; King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 297 Pl. 124 ter. *M. ferruginea* King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 298 Pl. 125. *M. amplifolia* Warb., Monog. Myrist. (1897) 517.

var. **bancana**

SUMATRA INDRAGIRI: (Indrag. Bovenlanden) Kuala Belilas, *bb27590* (L); Sungei Akar, *bb28624* (BO, L).

JAMBI: *bb13659* (BO, L).

PALEMBANG: Sine coll. as *No. 16 Medang Simpai* (L) 3 sheets Nos. 2, 22 and 25 type material of *M. amplifolia*; Banjuasin & Kubustreken, *bbE580* (BO, L); *bbE581* (BO, L); *Grashoff 645* (BO, L); Bajunglintjir, Banjuasin, *bb58E, 2P, 697* (BO) and *bb58E, 1P, 630* (BO); Rawas, *Dumas 1575* (BO, L).

BANKA: Gunong Mangkol, *Kostermans & Anta 694* (BO, L, PNH); Rindik, *bb11822* (BO, L); near Jebus, *Teijsmann 3279* (U); Ayer Limau, Muntok, *bb7609* (BO).

MALAY PENINSULA: Johore and Singapore. For list see Gard. Bull. Sing. 16 (1958) 438. Extra specimens:—*Corner S.F.N. 2994,5* (BO); *Kiah S.F.N. 32193* (BO); *Sinclair S.F.N. 39502* (BO); *Wall. Cat. 6803* (LE).

DISTRIBUTION: Sumatra, Banka, Malay Peninsula.

TYPE MATERIAL: *M. bancana* Miq., *Banka, Teijsmann 3279*. *M. amplifolia* Warb., Palembang, *S. coll. No. 16 Medang Simpai*, *M. ferruginea* King, *Wall. Cat. 6803* (BM, G, K, LE); *Ridley Nos. 1835* (BM, CAL, MEL, SING); *4815* (CAL, MEL, SING) and *3364* (CAL, K, SING) all Singapore; *M. murtonii* Hk. f., Singapore, *Murton 13* (K).

VERNACULAR NAMES: Sumatra:—*medang simpai*, *kayu asap*, *punggung kidjang*.

var. **borneensis** (Warb.) J. Sinclair in Gard. Bull. Sing. 16 (1958) 439.

Basionym: *G. murtonii* (Hk. f.) Warb. var. *borneensis* Warb., Monog. Myrist. (1897) 359.

Synonym: *M. murtonii* Hk. f. var. *borneensis* (Warb.) Boerl., Handl. Fl. Ned. Ind. 3, 1 (1900) 88 *nom. alt.*

BORNEO SARAWAK: Kuching, *Beccari Nos. 1211* (A, C, FI, G & Boiss, K, M, P, S) and *3977* (FI, G, K) both as type material of this variety.

This variety is not very much different from the typical form but the leaves are cuneate at the base and the male flowers slightly larger, 5–6.5 mm. long and 4 mm. broad in dried material. Those of var. *bancana* are 5 mm. long in dried material and up to 6 mm. in fresh.

(2) **G. contracta** Warb., Monog. Myrist. (1897) 360 T. 20 Figs 1–4; Sinclair in Gard. Bull. Sing. 16 (1958) 439. Fig. 54.

Synonym: *Myristica contracta* (Warb.) Boerl., Handl. Fl. Ned. Ind. 3, 1 (1900) 88 *nom. alt.*

SUMATRA BILLITON: *van Rossum 63* (BO, L); *sine coll. Herb. Billiton 30* (L).

MALAY PENINSULA: Malacca, Singapore. For list see Gard. Bull. Sing. 16 (1958) 441.

BORNEO SARAWAK: Near Kuching, *Haviland Nos. 1650* (BO, CAL, L, SING); and *2253* (SING); *Haviland & Hose 3308* (CAL, K, L, SAR); *Beccari Nos. 321* (BO, C, FI, G & Boiss., K, M, NY, P, S); *419* (FI, G, K) and *2999* (FI, G, K, P); Sungei Semengoh F.R., *Muas SAR 179* (SING); Gunong Kayangeran, Lawas, *Omar 81* (SING); S. Kenaban, Upper Plieran, *Pickles SAR Nos. 3446* (SING); *3496* (SING); *3526* (L); *3531* (SING).

BRUNEI: Andalau F.R., *Ashton BRUN 568* (SING); Cpt. 5, Andalau F.R., Kuala Belait, *Ashton, Smythies & Wood SAN 17514* (L, SING).

BRITISH N. BORNEO: Mengalong F.R., Sibubu River, 3½ miles S.S.W. of Sipitang, *G.H.S. Wood SAN 15155* (L, SAN, SING); Ulu Moyah, 8 miles S.S.E. of Malaman, Sipitang, *G.H.S. Wood SAN 16266* (BO, SAN, SING); Tambato, Tambunan; *Puasa & Angian 4023* (L); 4 miles from Ranau on path to Poring Hot Springs, *G.H.S. Wood & Charrington SAN 16368* (SAN, SING).

PULAU SEBATIK: *Kostermans 9154* (L, SING).

PULAU
NUNUKAN: Bulungan, *bb Nos. 26195* (BO, L); *29349* (BO, L) and *29364* (BO, L); Simengkadu, *Meijer 2395* (PNH).

PULAU
TARAKAN: Gil-Diola Pannusion, *Meijer 2475* (PNH).

EAST AND
NORTH-EAST
BORNEO: The following all West Kutei:—Sabintulung, *bb15807* (BO); Longbleh, *bb16048* (BO, L); and *bb16146* (BO, L); *S.I. bb16792* (L); *bb16838* (L); Kahala, *bb28356* (BO, L, SING) and Sei Ritan, *bb32494* (BO, L); the following 5 are East Kutei:—*Kostermans 7241* (BO, L, PNH, SING); Sungei Bambang, *Kostermans 6086* (BO, L, PNH); Sungei Sangasanga near Samarinda, *Kostermans 7730* (BO, PNH, SING); Gunong Sekrat, S. of Sangkulirang, *Kostermans 5955* (BO, L); Sungei Boi, *bb14886* (BO); Sungei Wain, Balikpapan, *Achmat bb Nos. 34310* (BO, L) and *34363* (BO, L); Gunong Haping, Riko, Balikpapan, *bb14971* (BO, L); Muan region near Sg. Riko, *Kostermans 4288* (BO, PNH); Berouw, *bb19027* (L) and *bb19088* (BO, L); Beneden Dajak, *bb19456* (BO, L); Puruk, Tjahu, *bb10029* (BO).

SOUTH AND
SOUTH-EAST
BORNEO: Karuing, Sampit, *bb9928* (BO); Tehang, Sampit, *bb10233* (BO).

DISTRIBUTION: Billiton, Malay Peninsula and Borneo.

TYPE MATERIAL: *Gymnacranthera contracta* Warb. *Beccari Nos. 321; 419* and *2999*. *Motley 1284* (K) quoted by Warburg as a syntype is *G. forbesii* var. *crassinervis*.

VERNACULAR NAMES: Billiton:— *salak*, Sarawak:— *Kumpang* (Malay); *badok*, *lahu*, *hungi* (Kayan). N. Borneo:— *lunau* (Dusun Tambato); *lupi* (Kedayan). Indonesian Borneo:— *mandarahan*, *dara-dara*, *tabulah* (at Berouw).

(3) *G. forbesii* (King) Warb., Monog. Myrist. (1897) 363 T. 20 Figs 1–2; Gamble, Mat. F.M.P. 5, 23 (1912) 224; Ridley, F.M.P. 3 (1924) 61; Sinclair in Gard. Bull. Sing. 16 (1958) 441 Fig. 55. Plate XIIIIB.

Basionym: *Myristica forbesii* King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 306 Pl. 137.

var. **forbesii**

SUMATRA WEST COAST: Kampong Sipisang, Agam, *bb2876* (BO).

- EAST COAST: Lumban Ria, Asahan, *Rahmat Si Boeea* 7984 (SING); Aek Kanopan, Lundut Concession, Kualu, *Bartlett* Nos. 7052 (NY) and 7299 (NY).
- INDRAGIRI: Belimbing (Indrag. Bovenlanden), *bb28501* (BO, L); Danau Menkuang, *bb27559* (BO, L); Kuala Belilas, *bb27644* (BO, L); Pagarumbei Tjenako, *bb25783* (L).
- BENKULEN: Suka Radja, *Forbes* Nos. 2976 (A, BM, CAL, K, L, LE) and 3061 (A, BM, CAL, FI, L, LE).
- PALEMBANG: Lematang Ilir, Semangus, *bb32217* (BO, L) and *bbT512* (BO, L); Banjuasin & Kubustreken, *Endert* Nos. 62E.1P.595 (BO, L); 62E.1P.604(L); 62E.1P.606 (L); 62E.1P.610 (BO); 62E.1P.619 (BO, L); 62E.1P.620 (L); 63E.1P.620 (BO, L) and 86E.1P.606 (BO).
- PULAU
SIMALUR: *Achmad* Nos. 1258 (BO, L); 1316 (L); 1376 (L); 1442 (L); 1452 (L) and 1554 (L).
- PULAU
ENGGANO: Near Boea-boea, *Lütjeharms* 4365 (A, BO, L, NY, SING).
- BANKA: Gunung Mangkol, *Kostermans & Anta* 813 (BM, L, PNH); Toboali, *bb1945* (BO); Ayer Limau, Muntok *bb7843* (BO).
- RIOUW AR-
CHIPELAGO: P. Bintang, *Teijsmann s.n.* (BO).
- MALAY PENINSULA: Penang, Province Wellesley, Perak, Trengganu, Pahang, Selangor, Negri Sembilan, Malacca, Johore, Singapore. For list see *Gard. Bull. Sing.* 16 (1958) 443. Extra specimens:—*Corner S.F.* Nos. 28712 (BO); 28970 (BO); 36961 (BO); *King* Nos. 6591 (BO, LE); 6784 (BO); 6973 (BO, LE); 7419 (BO); 8756 (LE); *Ngadiman S.F.N.* 36866 (BO); *Sinclair S.F.N.* 37936 (BO); *Wray* 1429 (LE).
- DISTRIBUTION: Siam, Sumatra, Banka, Riouw, Malay Peninsula.
- TYPE MATERIAL: *Myristica forbesii* King, Penang, *Maingay* 1293 (CAL, K); Malacca, *Maingay* 1295 (K); Singapore, *Ridley* Nos. 6157 (SING) and 6270 (K, SING).
- VERNACULAR NAMES: Sumatra:—*edaran uding, salak*. Banka:—*salak*.

var. *crassinervis* (Warb.) J. Sinclair, *stat. nov.*

Basionym: *G. crassinervis* Warb., *Monog, Myrist.* (1897) 362 T. 20 Figs 1–3.

Synonym: *Myristica crassinervis* (Warb.) Boerl., *Handl. Fl. Ned. Ind.* 3, 1 (1900) 88 *nom. alt.*—**Fig. 1.**

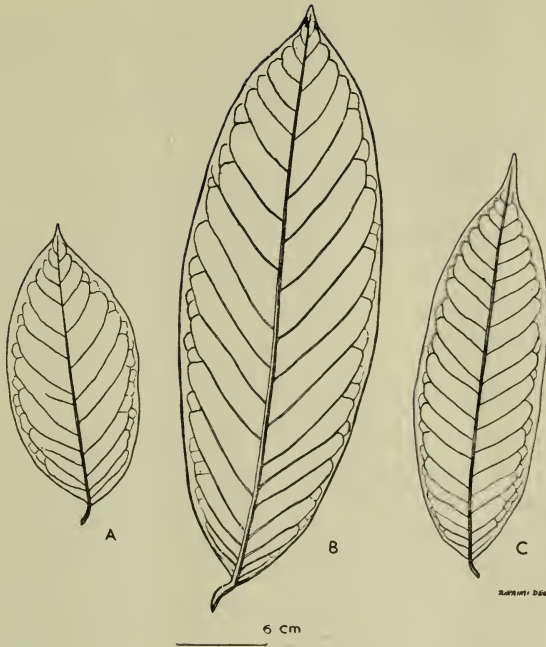


Fig. 1. A, *Gymnacranthera forbesii* (King) Warb. B, *G. forbesii* var. *crassinervis* (Warb.) J. Sinclair. C, *G. forbesii*. A, from Ridley 9464. B, from Sinclair, Kadim & Kapis 9248. C, from Symington 24081 all in Herb. Sing.

Tree 10–20 m. high. Bark greyish brown, slightly rough but not fissured, brittle, inner bark brown; sap red, copious. Leaves coriaceous, dark to medium green above and slightly glossy, glabrous beneath, oblong-elliptic to oblong-lanceolate; nerves 14–21 pairs, very prominent below and there 0.7–1 mm. thick; midrib also prominent, 2–3 mm. thick below at base; length 15–28 cm.; breadth 4.5–9.5 cm.; petiole stout, 1.5–2.5 mm. thick. Inflorescence axis rusty-puberulous. Flowers yellow, male and female more or less as in var. *forbesii*. Fruit as in var. *forbesii*, ellipsoid or slightly obovoid, obtuse at the apex, 2 cm. long and 1.3 cm. broad.

BORNEO SARAWAK:

Kuching, *Beccari 1119* (FI, G, K, LE, P); near Long Kapa, Mount Dulit (Ulu Tinjar), 4th Div., *Richards 2289* (A, K, SING).

BRITISH

N. BORNEO: Sugut, *Fraser 241* (CAL, K); Ulu Moyah, 8 miles S.S.E. of Malaman, Sipitang, *G.H.S. Wood, SAN 16689* (SAN, SING); Gunong Temporangan, Ranau, *Sinclair 9248* (A, B, BM, E, K, L, M, SAN, SING).

- EAST AND
NORTH-EAST
BORNEO: Paru, Thony, Tidungsche Landen, *bb Nos.*
17806 (L); 17837 (BO, L) and 18356
(A, BO, L); Berouw, *bb18463* (BO, L,
SING); Mentawir, Balikpapan, *bb13918*
(B, BO, L, SING).
- SOUTH AND
SOUTH-EAST
BORNEO: Banjarmasin, *Motley 1284* (K); Maram-
pan, *bb11437* (BO).
- WEST BORNEO: Perigi Limus, Gunong Sendjudjuh, Sambas,
B. de Jong bb7045 (BO); Sungei Labai,
Sanggau, *B. de Jong bb7859* (BO).
- DISTRIBUTION: Borneo.
- TYPE MATERIAL: *G. crassinervis* Warb., Syntypes, *Beccari*
1119 and *Fraser 241*.
- VERNACULAR NAMES: Berouw:—*ukut*.

I have to reduce this species to a variety of *Gymnacranthera forbesii*. It is a more magnificent version of *forbesii* with larger, more coriaceous leaves, and thicker nerves, midrib and petiole. The records show that it is confined to Borneo whereas the var. *forbesii* has not been found there.

- (4) *G. paniculata* (A. DC.) Warb., Monog. Myrist. (1897) 370. T. 20; Merrill in Philip. J. Sc. 1 (1906) Suppl. 55 et Enum. Philip. Fl. Plants 2 (1923) 181; Elmer, Leaf. Philip. Bot. 3 (1911) 1059.

Basionym: *Myristica paniculata* A. DC. in Ann. Sci. Nat. Bot. 4, 4 (1855) 31 et Prodr. 14 (1856) 200; F.-Vill. Nov. App. (1880) 177; Vidal, Phan. Cuming. Philip. (1885) 139 et Rev. Pl. Vasc. Filip. (1886) 221.

Synonyms: *Gymnacranthera acuminata* Merr. in Philip. Journ. Sci. Bot. 12 (1917) 265. *G. laxa* Elm., Leaf. Philip. Bot. 8 (1915) 2772. *G. macrobotrys* Merr. in Philip. Journ. Sc. Bot. 13 (1819) 284.

var. *paniculata*—Fig. 2.

Tree 12–30 m. high with lax, horizontally spreading branches. *Bark* rather smooth, yellowish grey; sap red. *Twigs* slender at the apex, reddish brown and 2 mm. thick there, lower down straw-coloured and 3–4 mm. thick. *Leaves* thinly coriaceous, dark green and shining above, glaucous beneath with yellowish green midrib, drying olive green or brownish green above and pale brown or glaucous beneath, lanceolate, base acute, apex acuminate; nerves 8–11 pairs, average 8, faint or indistinct above, fine but prominent beneath, drying chocolate brown, curving and arching near the



Fig. 2. *Gymnacranthera paniculata* (A. DC.) Warb. var. *paniculata*.
A, Leafy twig with male flowers. B, male flowers enlarged. C, fruit. A-B,
from Cuming 901. C, from Borden 669.

margins; reticulations invisible; length 10–16 cm.; breadth 2–5.5 cm.; petiole slender, 1 cm. long. *Male inflorescence* much branched, 4–10 cm. long. *Male flowers* minutely pubescent outside and inside, 3–4 mm. long and 2–3 mm. broad; pedicels 2–4–(5) mm. long, average 3 mm.; column 2 mm. long with 8 anthers. *Female inflorescence* short, 1 cm. long. *Female flowers* not seen. *Fruit* globose or sub-globose, orange outside, pinkish or pinkish orange inside, 2 cm. long and 1.8–2 cm. broad; stalk about 1 cm. long. *Aril* dull pinkish red. *Seed* banded light brown and black.

PHILIPPINES SINE LOC.: *Vidal Nos.* 3552 (K) and 3558 (K).

MINDORO: Baco River, *McGregor* 231 (K, NY); Paluan, *Ramos Nos.* 39587 (A, CAL, NSW, NY) and 39655 (BO, CAL, NSW); Mt. Halcon, *Edaño* 3584 (A); Pinamalayan, *Ramos* 40816 (SING); 40819 (A, SING) and 41102 (A, DD, G, K, UC); Bongabong River, *Merritt* 3663 (K).

BABUYAN

ISLANDS: Calayan Island, *Velasco* 26647 (A, BO, K, NY); *Peñas* 26705 (UC).

LUZON:

Banguí, Prov. Ilocos Norte, *Ramos* 27463 (A, BO); Banguí to Claveria, Prov. Ilocos Norte, *Ramos* 33100 (BM, BO, CAL, L, SING); Burgos, Prov. Ilocos Norte, *Ramos* 32727 (BRI, NSW, SING); *Paraíso* 30242 (NY, UC); Prov. Cagayan, *Bernardo* 13105 (BM, NSW); Pinagsongayan River, Prov. Cagayan, *Edaño* 78564 (BO, K, NY, SING); Prov. Cagayan, *Ramos* 14552 (BM, BO, E, K, L); Prov. Isabella, *Darling* 14843 (BM, NSW); Prov. Nueva Vizcaya, *Cenabre & Porte* 28547 (BM); Lamao River, Prov. Bataan, *Barnes* 174 (K, NSW, NY, SING); *Borden Nos.* 669 (BM, K, NSW, NY, SING); 1138 (UC) and 2940 (NY); Mt. Mariveles, Lamao River, Prov. Bataan, *Williams Nos.* 566 (NY) and 640 (NY); Montalban, Prov. Rizal, *Loher Nos.* 12310 (M, UC) and 13962 (BO); Balabac, Prov. Rizal, *Loher* 14942 (A, BM); Prov. Laguna, *Amarillas Nos.* 24664 (BM, TOFO) and 24940 (BO, UC); Prov. Laguna, *Curran* 19280 (BRI); Los Baños, Mt. Maquiling, Prov. Laguna, *Elmer Nos.* 17606 (A, BM, BO, CAL, G, K, L, NY, PNH, S, UC); 17962 (A, BM, BO, C, G, K, L, NY, PNH, UC) and 18381 (A, BO, G, K, L, NY, UC); *Navarro* 9475 (PNH) and *Perdido* 9476 (PNH); *Sinclair* 9458 (material not yet distributed); Prov. Laguna, *Vidal* 508; Baler, Principe, Prov. Quezon, *Merrill* 1029 (K) and *Quisumbing* 2457 (A, PNH, SING); Casiguran,

Prov. Tayabas, *Ramos & Edaño 45422* (B, BM, BRI, G, MEL, NY, UC); Prov. Camarines, *Ramos 1544* (A, BM, BO, BRI, CAL, G, L, NSW, NY, PNH); Albay, Prov. Sorsogon, *Curran 10606* (BO) Albay Prov., *Cuming 901* (BM, C, G, K, L, LE, M, MEL, NY, UPS); Irosin, Mt. Bulusan, Prov. Sorsogon, *Elmer 15769* (A, BM, BO, G, K, L, NY, UC); Lake Bulusan, *Sinclair 9586* (material not yet distributed).

SIBUYAN: Magallanes (Mt. Giting-giting), *Elmer Nos. 12068* (A, BM, BO, BRSL, CAL, E, FI, G, K, L, LE, NSW, NY) and *12138a* (A, BM, BO, BRSL, CAL, E, FI, G, K, L, LE, NSW, NY).

TICAO: *Clark 1016* (NY).

SAMAR: *Sherfesee, Cenabre & Cortes 21074* (K).

LEYTE: Near Dagami, *Ramos 1171* (BM, BRSL, G, K, L, M).

PANAY: Mt. Macosolon, Prov. Capiz, *Ramos & Edaño 30766* (BM, NSW, SING); Lila-cao, Prov. Capiz, *Ramos & Edaño 31450* (BM, BO, CAL, L); Prov. Capiz, *Hirro 23954* (NY).

SULU

ISLANDS: Tawitawi, Sulu Prov. *Ramos & Edaño Nos. 44047* (LE, NY, UC) and *44284* (A, B, BM, BO, G, K, NY, PNH, SING, UC).

BASILAN: *Miranda 18969* (BO, BRI, C, CAL, E, L); *Reillo Nos. 15460* (BM, BO, L, NSW, NY) and *15489* (BM).

MINDANAO: Santa Maria, Distr. of Zamboanga, *Reillo 16444* (K, L, NY); Cabadbaran, Mt. Urdaneta, Prov. Agusan, *Elmer 13715* (A, BM, BO, E, G, K, L, LE, NSW, NY); Butuan Sub. Prov., *Miranda 20529* (BM); Surigao, *Wenzel Nos. 2672* (A, BO, G, K, M, NY, UC) and *2853* (A, B, BO, G, K, M, NY, SING, UC).

BORNEO BRITISH

N. BORNEO: Bukit Kasiladan, Ranau, *Sinclair 9266* (B, E, K, L, SAN, SING) sterile.

DISTRIBUTION: Philippines and probably North Borneo. Lowland forests.

TYPE MATERIAL: *M. paniculata* A. DC., *Cuming 901*. *G. acuminata* Merr., *Sherfesee, Cenabre & Cortes 21074*. *G. laxa* Elmer, *Elmer 13715*. *G. macrobotrys* Merr., *Ramos 1171*.

VERNACULAR NAMES: *anuping* (Sul.); *batu-batu* (Bik.); *dagang* (Tag.); *dumadaka* (Ilk.); *laguan* (Mang.); *magandau* (Mbo.); *malakapa* (Mang.); *pamitogan* (Ibn.); *yango*, (P. Bis).

Gymnacranthera acuminata, *macrobotrys* and *laxa* are not different species. It is true that there is some variability in size of flowers and length of pedicels in *G. paniculata* and at first sight *laxa* with its loose spreading panicle, may at least appear to be a variety. Specimens of *paniculata* with young unopened flower buds have short pedicels and look very different from those with mature flowers. Such immature specimens, from what I have seen, are more frequent in herbaria than the last-mentioned. The same observations on the compactness and laxity of young and old inflorescences also apply to the var. *zippeliana* and such progressive stages of growth ought not to mislead one. The bark of var. *paniculata* is lighter and more yellowish than that of *eugeniifolia* or any of the Malayan species.

Sinclair 9266 from North Borneo is sterile and is most probably *G. paniculata*. It is quite reasonable that it should occur in North Borneo.

var. ***zippeliana*** (Miq.) J. Sinclair, **stat. nov.**

Basionym: *M. zippeliana* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 50; Scheff., in Ann. Jard. Buit. 1 (1876) 45.

Synonyms: *G. zippeliana* (Miq.) Warb., Monog. Myrist. (1897) 372. *G. suluensis* Warb., Monog. Myrist. (1897) 373; Elmer, Leaf. Philip. Bot. 3 (1911) 1058; Merr., En. Philip. Flowering Plants 2 (1923) 181.—**Fig. 3.**

Tree 10–25 m. high, very similar to var. *paniculata*. Bark greyish or medium brown, slightly striate; sap red. *Leaves* more variable than in var. *paniculata*, generally longer and broader but not always, lanceolate, oblong-lanceolate, elliptic or oblanceolate; nerves 10–15–(17) average 12 pairs; length 10–21 cm. long; breadth 4–8 cm. *Male inflorescence* branched, usually slightly shorter than in var. *paniculata*. *Female inflorescence* 2 cm. long. *Male and female flowers* 3 mm. long, adpressed pubescent inside and outside; pedicels 3 mm. long in the male and 2 mm. long in the female; ovary 2 mm. long, rusty tomentose; flowers of both sexes yellow. *Fruit* oblong, yellowish green, ridged, 2–3 cm. long and 1–1.5 cm. broad. *Seed* dark brown.

PHILIPPINES MINDORO: Lubang Island, *Rosenbluth 12237* (CAL).

BASILAN: *Vidal Nos. 3546* (K) and *3561* (K).

MINDANAO: Surigao Prov., *Ramos & Pascasio 34462* (A, CAL, BRI, K, NSW, NY, SING, UC); Todaya, (Mt. Apo), District of Davao, *Elmer 10941* (A, BM, BO, BRSL, CAL, E, FI, G, K, L, LE, NSW, NY).

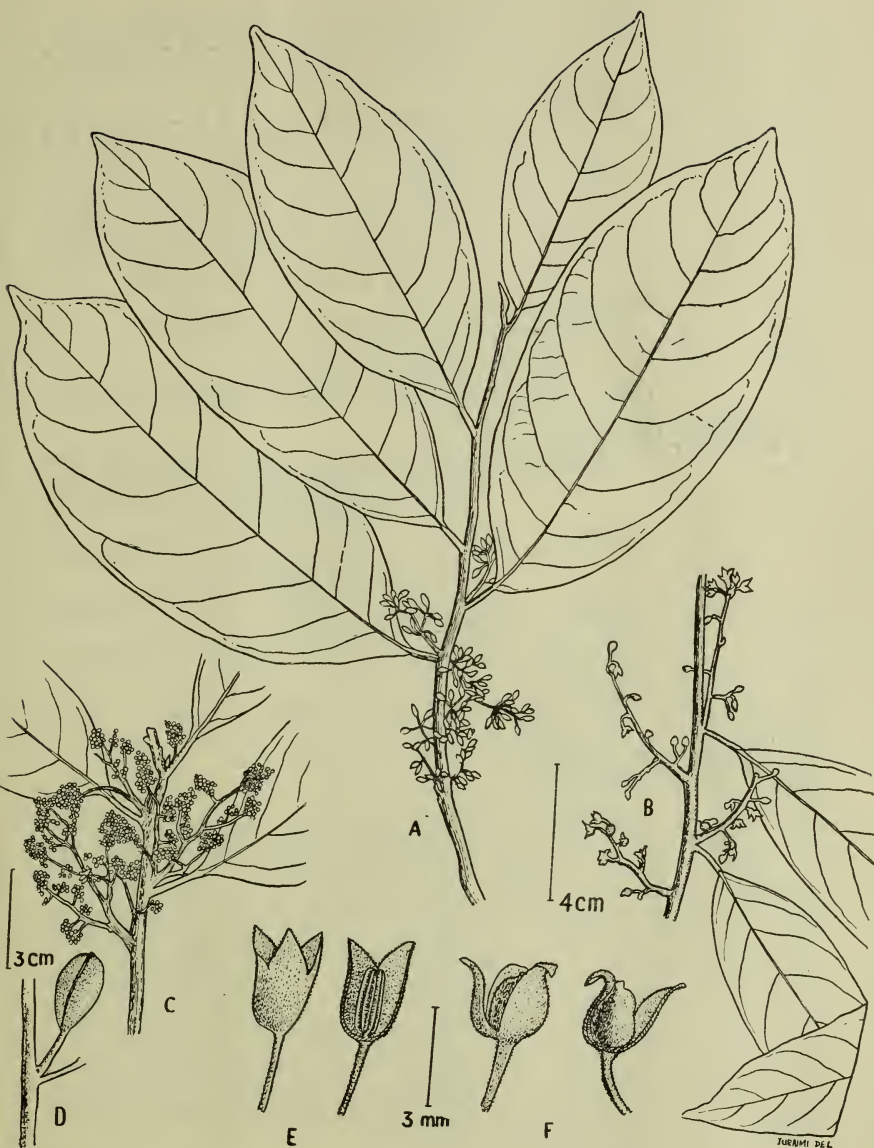


Fig. 3. *Gymnacranthera paniculata* var. *zippeliana* (Miq.) J. Sinclair.

A, Leafy twig with male flowers. B, leafy twig with female flowers. C, male flowers in bud. D, fruit. E, male flowers enlarged. F, female flowers enlarged. A and E, from Forbes 329 (L); B and F, from Carr 16172 (SING). C, from Hoogland 4618 (L); D, from Carr 12064 (SING).

- CELEBES NORTH PENINSULA: Manado, Minahassa, *Koorders Nos. 18147* (BO, L) and *18150* (BO); Bongomeme, Gorontalo, Manado, *bb19416* (BO, L).
- CENTRAL CELEBES: Poso, Lapé, *bb29466* (BO, L); Usu, Malili, *bb Cel/II 303* (BO, L); *bb Cel/II 352* (BO, L) and *bb Cel/II 316* (BO, L); Thawtta, Tole-tole, Kawata, Malili, *bb Cel V/255* (BO, L); La Roua, Malili, *bb1880* (L); Malili, *bb Cel/II 402* (BO, L); Lingkomomo, Malili, *bb8567* (BO); Lobose, Malili, *bb11421* (BO).
- SOUTH-EAST PENINSULA: Sangona, *Kjellberg 950* (BO, S).
- PULAU MUNA: Wakadea, *bb5870* (L).
- PULAU BUTON: Kambowa, *bb6643* (BO) and *bb6645* (BO, L).
- MOLUCCAS TALAUD ISLANDS: S.W. slope of G. Duatu, Karakelong, *Lam 2919* (L, PNH) and *2942* (L); E. slope of G. Piapi, Karakelong, *Lam 3329* (L).
- OBI ISLANDS: Laiwui, *bb23778* (A, BO, L, SING) and *bb23779* (A, BO, L, SING).
- BURU: Balo-balo, *bb25191* (L); Walpangat, *bb22815* (L).
- AMBON: *Robinson 239* (A, BM, BO, K, L, NY).
- KAI ISLANDS: *Jaheri 80* (BO) and *714* (L).
- NEW GUINEA VOGELKOP (DUTCH WEST NEW GUINEA): Sorong, *Beccari 221* (FI); Andai, *Beccari 705* (FI); Pikipik, *bb22252* (BO) and *bb22273* (A, BO, L); Modan, *bb22311* (BO); Manokwari, Dessa, Momi, *bb33490* (A, L, SING) and *Kostermans 300 = bb33490* (A, BO, L, SING); Dossi, Manokwari, *bb15907* (BO); Tainindi, 3 km. from Manokwari, *Kostermans 2975* (A, BO, K, L); McCluer Gulf, *Warburg 20723* (A); P. Aiduma (Aituma) *Zippelius s.n.* (CAL, L); Rauna, *bb22537* (BO); Sennen, Nabire, *Kanehira & Hatusima s.n., 7th March, 1940* (BO); Fakfak, Onakasi, *bb32694* (BO, L).
- DUTCH NORTH NEW GUINEA: Bernard Bivak, Hollandia, *bb25748* (L, BO, SING); Pionier Bivak, Hollandia, *bb31329* (BO).
- DUTCH SOUTH NEW GUINEA: s.l., *Versteeg 1472* (BO, K, L).

PAPUA:

Thu, Vailala River, *Brass 971* (A, BRI, K, SING); Wuroi, Oriomo River, Western Division, *Brass 5903* (A, BRI, BO, NY); Lake Daviumbu, Middle Fly River, *Brass 7897* (A, BM, BO, BRI, L, LE); Kokoda, *Carr Nos. 16141* (SING); *16172* (CANB, L, SING) and *16467* (BO, SING); Koitaki *Carr 12064* (L, SING); Sogerri Region, *Forbes Nos. 236* (A, BM, CAL, FI, K, L, LE, PNH, SING); *329* (A, BM, CAL, E, FI, K, L, LE, PNH, SING); *350* (BO, CAL, E, FI, K, L, LE); *375* (BM, CAL, E, FI, K); *396* (BM, E, FI, L); *646* (BM, CAL, FI, K, L) and *709* (BM, FI, LE); about 1 km. S.E. of Bundi Barracks, Tufi sub-district, Northern Division, *Hoogland 4618* (A, CANB, L, LAE); Vaimuru, Vanapa River, Central Div., *McDonald N.G.F. 8166* (CANB, SING); Yalu, Atzera Range near Lae, *Womersley N.G.F. 3205* (BRI, CANB, LAE).

MANDATED
TERRITORY
OF NEW
GUINEA
(KAISER
WILHELMS-
LAND):

Sepik, *Ledermann Nos. 6551* (SING); *6917* (SING); *7790* (SING); *9659* (L) and *10456* (L); Quembung, Morobe District, *Clemens Nos. 2149* (A, B, SING); and *2189* (A, B, SING); above Gabensis, Morobe District, *Floyd N.G.F. 7251* (BRI, CANB, LAE, NSW, SING); Sattelberg, *Nyman 750* (BRSL); Wobbe, *Schlechter 16338* (A, E, G, K, L, NY, S; SING); Gati Mts., *Schlechter 17186* (A, E, G, K, L, NY, S, SING); Ramu Valley about 5 miles S.E. of Faita Air Strip, Madang sub-division, *Saunders Nos. 208* (CANB, LAE); *229* (CANB, LAE); *236* (CANB, LAE); *247* (CANB, L, LAE); *255* (CANB, L, LAE); *260* (CANB, LAE); *265* (CANB, L, LAE); *293* (CANB, L, LAE); *297* (CANB, L, LAE); *308* (CANB, L, LAE); *338* (CANB, L, LAE); *352* (CANB, L, LAE); *361* (CANB, L, LAE); *378* (CANB, L, LAE); *394* (CANB, LAE); *405* (CANB, L, LAE); *451* (CANB, L, LAE); *477* (L, LAE); *480* (A, CANB, L, LAE); *492* (CANB, LAE); *497* (CANB, L, LAE); *504* (CANB, L); *504A* (LAE); *507* (CANB, LAE); *512* (CANB, L, LAE); *515* (CANB, LAE); *517* (CANB, LAE); *521* (CANB); *522* (CANB, LAE) and *526* (LAE); Bengi, *Lane-Poole 805* (BRI); Dobodura Area, *N.G.F. 2036* (BRI, LAE).

NEW BRITAIN: Keravat, *Coppack N.G.F.* 7036 (BRI, CANB, LAE, SING); *Floyd Nos.* 3449 (CANB, BRI, BO, L, NSW, PNH, SING) and 7009 (BRI, CANB, L, LAE, NSW, PNH, SING); *Womersley N.G.F.* 3409 (BM, BRI, CANB, LAE, NSW, PNH, SING); Vudal Divide, *Womersley N.G.F.* 7929 (BRI, CANB, NSW, SING).

SCHOUTEN

ISLANDS:

P. Biak, *Feuilletau de Bruyn* 446 (BO); *bb Nos.* 30770 (A, BO, L, SING); 30805 (BO, L); 30819 (A, BO, L, SING).

PULAU JAPEN: *Aet & Idjan* 798 (A, BO, K, L); *bb Nos.* 30254 (A, BO, L, SING); 30490 (BO, L, SING); 30493 (A, BO, L, SING); *bb*30528 (A, BO, L); 30532 (A, BO, L, SING); 30536 (A, BO, L, SING) and 30591 (A, BO, L, SING); Serui, *bb*30657 (BO); *Mariarattu, bb. Nos.* 30378 (BO, L, SING); 30396 (A, BO, L); 30420 (A, BO, L); 30427 (BO, L, SING); 30430 (A, BO, L, SING) and 30459 (A, BO, L, SING).

DISTRIBUTION:

Philippines, Celebes, Moluccas, New Guinea.

TYPE MATERIAL:

M. zippeliana Miq., P. Aiduma, *Zippelius s.n.*, *G. suluensis* Warb., Syntypes *Vidal Nos.* 3546 and 3561.

VERNACULAR NAMES: Talaud Islands:— *lahu*. New Guinea:— *saksak, hokol* (Amele); *mobo, gadagod, kini* (Bilia); *gisek, sarenki, gaigihab, dzidzir, minip, bisip* (Dumpu); *gamukua* (Faita); *koreaif* (Onjob); New Britain:— *goma* (Maprik); *kokomo* (Pidgin).

I cannot accept *G. paniculata* and *zippeliana* as two distinct species after having examined the large list of specimens enumerated above. The former has a globose fruit and the latter an oblong one and this seems to be the best character for distinguishing them. The leaves of the variety *zippeliana* are generally larger and broader with more veins, but this is not always the case and one may have to rely on geographical distribution to identify sterile material.

(5) *G. eugeniifolia* (A. DC.) J. Sinclair in *Gard. Bull. Sing.* 16 (1958) 444. Fig. 56. Pl. XIV.

Basionym: *Myristica eugeniifolia* A. DC., *Ann. Sc. Nat.* 4, 4 (1855) 29 et *Prodr.* 14, 1 (1856) 190; *Miq., Fl. Ind. Bat.* 1, 2 (1858) 58; *Hk. f., Fl. Br. Ind.* 5 (1886) 113.

Synonyms: *Gymnacranthera farquhariana* (Hk. f. et Th. sensu King) *Warb., Monog. Myrist.* (1897) 365 T. 22 Figs 1–2;

Gamble, Mat. F.M.P. 5, 23 (1912) 225; Ridley, F.M.P. 3 (1924) 62 [omnino pro parte quoad specimina malayana tantum]. *Myristica farquhariana* Hk. f. et Th. sensu Fl. Br. Ind. 5 (1886) 108 pro parte; King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 305 pro parte [non Hk. f. et Th., Fl. Ind. (1855) 162 sensu stricto = A. DC., Prodr. 14, 1 (1856) 200 et Miq., Fl. Ind. Bat. 1, 2 (1858) 63 = species ex India tantum = Synonym *G. canarica* (King) Warb.]

var. **eugeniifolia**

- SUMATRA TAPANULI: Sibolga, *bb19305* (A, L).
WEST COAST: Painan, Br. Belantai, *bb3995* (L).
EAST COAST: Masihi F.R., Asahan, *Krukoff 4052* (A, BRI, BO, G, L, LE, NY, SING); vicinity of Lumban Ria, Asahan, *Rahmat Si Boeea 8035* (A, S, SING); Ayer Kandis near Rantau Parapat, Bilia, *Rahmat Si Toroes 2407* (A, NY, UC).
INDRAGIRI: (Indrag. Bovenlanden) Sungei Akar, *bb28598* (BO, L, SING); Hutan Pulau Lawas near Taratak Ayer Hitam, Taluk region, *Meijer 4394* (SING).
LINGGA: P. Singkep, *bb5891* (BO).
MALAY PENINSULA: Kedah, Penang, Perak, Selangor, Negri Sembilan, Malacca, Johore, Singapore. For list see Gard. Bull. Sing. 16 (1958) 446. Extra specimens:—*Corner S.F.N. 29955* (BO); *Hervey Aug. 1886*, Malacca (BO); *King Nos. 4640* (BO, LE); *5801* (BO, LE); *6141* (LE); *6620* (BO, LE); *6631* (BO) and *6932* (LE); *Ngadiman S.F.N. 34628* (BO).
DISTRIBUTION: Sumatra, Lingga and Malay Peninsula.
TYPE MATERIAL: *M. eugeniifolia* A. DC., Penang, *Gaudi-chaud 116* (FI, G & Prodr. holotype, P).
VERNACULAR NAMES: Sumatra:—*mandaharan*, *kayu gadjah*.

var. **griffithii** (Warb.) J. Sinclair in Gard. Bull. Sing 16 (1958) 447 Fig. 57.

Basionym: *G. farquhariana* var. *griffithii* (Hk. f.) Warb. Monog. Myrist. (1897) 368; Gamble, Mat. F.M.P. 5, 23 (1912) 226 pro parte; Ridley, F.M.P. 3 (1924) 62.

Synonyms: *Myristica griffithii* Hk. f. Fl. Br. Ind. 5 (1886) 109; King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 304 Pl. 135 excl. *Curtis 2406* and *2458*. *M. farquhariana* Wall. Cat. 6795, sphalmate 6798, *nom. nudum*; Hk. f. et Th., Fl. Ind. (1855) 162; Hk. f., Fl. Br. Ind. 5 (1886) 108; King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 305 Pl. 135 [omnino pro parte]. *G. farquhariana* (Hk. f. et Th.) Warb. sensu Warb., Monog. Myrist.

(1897) 365; Gamble, Mat. F.M.P. 5, 23 (1912) 226; Ridley, F.M.P. 3 (1924) 62. *M. farquhariana* var. *major* King in Ann. Roy. Bot. Gard. Calc. 3 (1891) 306 Pl. 136 Fig. 4. *G. farquhariana* var. *major* (King) Gamble, Mat. F.M.P. 5, 23, (1912) 226; Ridley, F.M.P. (1924) 62. *G. apiculata* Warb., Monog. Myrist. (1897) 359 T. 2o Figs 1–2. *M. apiculata* (Warb.) Boerl., Handl. Fl. Ned. Ind. 3, 1 (1900) 88 *nom alt.*

SUMATRA EAST COAST: Langga Pajung, Sungei Kanan, Kota Pinang, *Rahmat Si Toroës 3425* (A, NY); Gunong Si Papan, Kalubi, Kota Pinang, *Rahmat Si Toroës Nos. 3886* (A, NY) and *3944* (A, NY).

BANKA: Bihang, S. Banka, *bb Nos. 15100* (BO) and *15104* (BO).

MALAY PENINSULA: Perak, Selangor, Malacca, Johore, Singapore. For list see Gard. Bull. Sing. 16 (1958) 447. Extra specimens:—*Corner S.F.N. 29499* (BO); *Griffith 4355* (LE); *Kiah S.F. Nos. 32157* (BO) and *37718* (BO); *King 7928* (BO, LE); Wall. Cat. *6795* (LE); *Ridley 3365* (NSW).

BORNEO SARAWAK: *Beccari 2246* (FI, G, K, LE, S); *Hose* (probably), *June 1906, PNH acc. No. 23664* (PNH); Loba Kubang Protected Forest, *Jara SAR 540* (SAR, SING); *Anderson SAR 2723* (SAR, SING); Baram, *Anderson SAR Nos. 2017* (SAR, SING) and *3251* (SAR, SING); 6th mile F.R., Kuching, *Muas SAR 98* (SING).

BRUNEI: Berakas F.R., *Ashton BRUN 837* (SING); Labu F.R., Temburong, *Ashton, Smythies* and *Wood SAN 17434* (SAN, SING).

BRITISH
N. BORNEO: *Damit River, Md. Tahir 798* (A, NY, SING).

EAST AND
NORTH-EAST
BORNEO: *Sebakis R. region, Kostermans 9301* (L, SING).

DISTRIBUTION: Sumatra, Banka, Malay Peninsula and Borneo.

TYPE MATERIAL: *G. farquhariana* var. *griffithii* (Hk. f.) Warb., Malacca, *Griffith 4356* (A, CAL, K, holotype, P). *M. farquhariana* var. *major* King, Perak, *King Nos. 6548* (CAL, DD, E, FI, K, L); *6622* (BM, CAL, DD, G, K, L, SING); *6736* (CAL, MEL, UPS); *7928* (CAL, FI, G, K, L) and Perak *Wray Nos. 2399* (CAL, K, SING) and *2695* (CAL, FI, K, SING); Malacca, *Griffith 4355* (A, CAL, FI, K, LE, M); *G. apiculata* Warb., Sarawak, *Beccari 2246* (FI, G, K, LE, S).

VERNACULAR NAMES: Sarawak:—*Kumpang* (Malay).

Excluded Species

- Gymnacranthera cryptocaryoides* Elmer = **Knema kunstleri**
(King) Warb.
G. ibutii Holth. = **Horsfieldia macrocoma** (Miq.) Warb.
G. lanceolata Merr. = **Myristica agusanensis** Elmer
G. negrosensis Elmer = **M. cumingii** Warb.
G. stenophylla Warb. = **K. stenophylla** (Warb.) Sinclair
G. sulphurascens Elmer = **M. elliptica** var. **simiarum** (A. DC.)
Sinclair.
G. urdanetensis Elmer = **M. cumingii** Warb.

LIST OF COLLECTORS' NUMBERS

- ACHMAT—1258; 1316; 1376; 1442; 1452 and 1554 forbesii var.
forbesii; bb34310 & bb34363 contracta.
AET & IDJAN—798 paniculata var. zippeliana.
AMARILLAS—24664 & 24940 paniculata var. paniculata.
ANDERSON—SAR Nos. 2017; 2723 & 3251 eugeniifolia var.
griffithii.
ASHTON—BRUN 568 contracta; BRUN 837 eugeniifolia var.
griffithii.
ASHTON, SMYTHIES & WOOD—SAN Nos. 17434 eugeniifolia var.
griffithii; 17514 contracta.
BARNES—174 paniculata var. paniculata.
BARTLETT—7052 & 7299 forbesii var. forbesii.
bb Nos.—1880 paniculata var. zippeliana; 1945 forbesii var.
forbesii; 2252 paniculata var. zippeliana; 2876 forbesii var.
forbesii; 3995 eugeniifolia var. eugeniifolia; 5870 paniculata
var. zippeliana; 5891 eugeniifolia var. eugeniifolia; 6643 &
6645 paniculata var. zippeliana; 7045 forbesii var. crassinervis;
7609 bancana var. bancana; 7843 forbesii var. forbesii;
7859 forbesii var. crassinervis; 8567 paniculata var. zippeliana;
9928 contracta; 10029 & 10233 contracta; 11421 paniculata
var. zippeliana; 11437 forbesii var. crassinervis; 11822
& 13659 bancana var. bancana; 13918 forbesii var. crassinervis;
14886 & 14971 contracta; 15100 & 15104 eugeniifolia
var. griffithii; 15807 contracta; 15907 paniculata var.
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17837; 18356 & 18463 forbesii var. crassinervis; 19027 &
19088 contracta; 19305 eugeniifolia var. eugeniifolia; 19416

paniculata var. zippeliana; 19456 contracta; 22273; 22311; 22537; 22815; 23778; 23779; 25191 & 25748 paniculata var. zippeliana; 25783 forbesii var. forbesii; 26195 contracta; 27559 forbesii var. forbesii; 27590 bancana var. bancana; 27644 forbesii var. forbesii; 28356 contracta; 28501 forbesii var. forbesii; 28598 eugeniifolia var. eugeniifolia; 28624 bancana var. bancana; 29349 & 29364 contracta; 29466 paniculata var. zippeliana; 30254; 30379; 30396; 30420; 30427; 30430; 30459; 30490; 30493; 30528; 30532; 30536; 30591; 30657; 30770; 30805; 30819 & 31329 paniculata var. zippeliana; 32217 forbesii var. forbesii; 32494 contracta; 32694 & 33490 paniculata var. zippeliana; 34310 & 34363 contracta; E580 & E581 bancana var. bancana; T512 forbesii var. forbesii; Cel/II 303; Cel/II 316; Cel/II 352; Cel/II 402; Cel/V 255 paniculata var. zippeliana; 58E 1P630 & 58E 2P697 bancana var. bancana; 62E 1P595; 62E 1P604; 62E 1P606; 62E 1P610; 62E 1P619; 62E 1P620; 63E 1P620; 86E 1P606 forbesii var. forbesii.

BECCARI—119 forbesii var. crassinervis; 221 paniculata var. zippeliana; 299; 321 & 419 contracta; 705 paniculata var. zippeliana; 1211 bancana var. borneensis; 2149 & 2189 paniculata var. zippeliana; 2246 eugeniifolia var. griffithii; 3977 bancana var. borneensis.

BERNARDO—13105 paniculata var. paniculata.

BORDEN—669; 1138 & 2940 paniculata var. paniculata.

BRASS—971; 5903 & 7897 paniculata var. zippeliana.

CARR—12064; 16141; 16172 & 16467 paniculata var. zippeliana.

CENABRE & PORTE—28547 paniculata var. paniculata.

CLARK—1016 paniculata var. paniculata.

CLEMENS—2149 & 2189 paniculata var. zippeliana.

COPPACK—N.G.F. 7036 paniculata var. zippeliana.

CURRAN—10606 & 19280 paniculata var. zippeliana.

DARLING—14843 paniculata var. paniculata.

DUMAS—1575 bancana var. bancana.

EDAÑO—3584 & 78564 paniculata var. paniculata.

ELMER—10941 paniculata var. zippeliana; 12068; 12138a; 13715; 15769; 17606; 17962 & 18381 paniculata var. paniculata.

FEUILLETAU de BRUYN—446 paniculata var. zippeliana.

- FLOYD—N.G.F. Nos. 3449; 7009 & 7251 *paniculata* var. *zippeliana*.
- FORBES—236; 329; 350; 375; 396; 646 & 709 *paniculata* var. *zippeliana*; 2976 & 3061 *forbesii* var. *forbesii*.
- FRASER—241 *forbesii* var. *crassinervis*.
- GRASHOFF—645 *bancana* var. *bancana*.
- HAVILAND—1650 & 2253 *contracta*.
- HAVILAND & HOSE—3308 *contracta*.
- HIRRO—23954 *paniculata* var. *paniculata*.
- HOOGLAND—4618 & 4896 *paniculata* var. *zippeliana*.
- HOSE—June 1906, PNH acc. No. 23664 *eugeniifolia* var. *griffithii*.
- JAHERI—80 & 714 *paniculata* var. *zippeliana*.
- JARA—SAR 540 *eugeniifolia* var. *griffithii*.
- B. de JONG—bb 7045 & bb 7859 *forbesii* var. *crassinervis*.
- KJELLBERG—950 *paniculata* var. *zippeliana*.
- KOORDERS—18147 & 18150 *paniculata* var. *zippeliana*.
- KOSTERMANS—300 & 2975 *paniculata* var. *zippeliana*; 4288; 5955; 6086; 7241; 7730 & 9154 *contracta*; 9301 *eugeniifolia* var. *griffithii*.
- KOSTERMANS & ANTA—694 *bancana* var. *bancana*; 813 *forbesii* var. *forbesii*.
- KRUKOFF—4052 *eugeniifolia* var. *eugeniifolia*.
- LAM—2919; 2942 & 3329 *paniculata* var. *zippeliana*.
- LANE-POOLE—805 *paniculata* var. *zippeliana*.
- LEDERMANN—6551; 6917; 7790; 9659 & 10456 *paniculata* var. *zippeliana*.
- LOHER—12310; 13962 & 14942 *paniculata* var. *paniculata*.
- LÜTJEHARMS—4365 *forbesii* var. *forbesii*.
- MCDONALD—N.G.F. 8166 *paniculata* var. *zippeliana*.
- MC GREGOR—231 *paniculata* var. *paniculata*.
- MD TAHIR—798 *eugeniifolia* var. *griffithii*.
- MEIJER—2395 & 2475 *contracta*; 4394 *eugeniifolia*.
- MERRILL—1029 *paniculata* var. *paniculata*.
- MERRITT—3663 *paniculata* var. *paniculata*.
- MIRANDA—18969 & 20529 *paniculata* var. *paniculata*.

- MOTLEY—1284 *forbesii* var. *crassinervis*.
MUAS—SAR Nos. 98 *eugeniifolia* var. *griffithii*; 179 *contracta*.
NAVARRO—9475 *paniculata* var. *paniculata*.
N.G.F.—2036 *paniculata* var. *zippeliana*.
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PERDIDO—9476 *paniculata* var. *paniculata*.
PEÑAS—26705 *paniculata* var. *paniculata*.
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PUASA & ANGIAN—4023 *contracta*.
QUISUMBING—2457 *paniculata* var. *paniculata*.
RAHMAT SI BOEEA—7984 *forbesii* var. *forbesii*; 8035 *eugeniifolia* var. *eugeniifolia*.
RAHMAT SI TOROES—2407 *eugeniifolia* var. *eugeniifolia*; 3425 & 3944 *eugeniifolia* var. *griffithii*.
RAMOS—1171; 1544; 14552; 27463; 32727; 33100; 39587; 39655; 40816; 40819; 41102 *paniculata* var. *paniculata*.
RAMOS & EDAÑO—30766; 31450; 44047; 44284 & 45422 *paniculata* var. *paniculata*.
RAMOS & PASCASIO—34462 *paniculata* var. *zippeliana*.
REILLO—15460; 15489 & 16444 *paniculata* var. *paniculata*.
RICHARDS—2289 *forbesii* var. *crassinervis*.
ROBINSON—239 *paniculata* var. *zippeliana*.
ROSENBLUTH—12237 *paniculata* var. *zippeliana*.
van ROSSUM—63 *contracta*.
SAUNDERS—208; 229; 236; 247; 255; 260; 265; 293; 297; 308; 338; 352; 361; 378; 394; 405; 451; 477; 480; 492; 497; 504; 504A; 507; 512; 515; 517; 521; 522 & 526 *paniculata* var. *zippeliana*.
SCHLECHTER—16338 & 17186 *paniculata* var. *zippeliana*.
SHERFESEE, CENABRE & CORTES—21074 *paniculata* var. *paniculata*.
SINCLAIR—9248 *forbesii* var. *crassinervis*; 9266, 9458 & 9586 *paniculata* var. *paniculata*.
TEIJSMANN—3279 *bancana* var. *bancana*; s.n. *forbesii* var. *forbesii*.
VELASCO—26647 *paniculata* var. *paniculata*.
VERSTEEG—1472 *paniculata* var. *zippeliana*.

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VIDAL—508 paniculata var. paniculata; 3546 paniculata var. zippeliana; 3552 & 3558 paniculata var. paniculata; 3561 paniculata var. zippeliana.

WARBURG—20723 paniculata var. zippeliana.

WENZEL—2672 & 2858 paniculata var. paniculata.

WILLIAMS—566 & 640 paniculata var. paniculata.

WOMERSLEY—3205 & 7929 paniculata var. zippeliana.

G.H.S. WOOD—SAN Nos. 15155 & 16266 contracta; 16689 forbesii var. crassinervis.

G.H.S. WOOD & CHARRINGTON—SAN 16368 contracta.

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BOOK REVIEW

Common Malayan Plants—(*Selected Drawings with notes*) by H. B. Gilliland, Professor of Botany, University of Malaya. Published by the University of Malaya Press, Singapore 1958—228 pages and 222 line drawings. (Price M\$5).

This handy pocket-size volume consists of line drawings of common Malayan plants most of which are selected from a war-time publication in Japanese by Professor Watanabe of the Chiba University entitled "Illustrations of Useful Plants of the Southern Regions". It is more or less an abridged edition of the Japanese book with short notes in English, while a few new drawings, prepared by 'Che Juraimi bin Samsuri, artist at the Botanic Gardens, Singapore, have been added. The paper is good, of much better quality than that of the original book, and the general set-up of the type is clear. There is an attractive cover.

The purpose of the book is to interest younger students in the plants which grow around them. The pictures should inspire them with a genuine and spontaneous interest in a far better way than text books with difficult words and scientific terms can ever do. Thus drudgery, boredom and tears are avoided and their early interests are not frustrated but fostered. The book ought also to be of some interest to the tourist passing through Malaya, who inevitably sees some strange fruit in the market and wishes to know more about it. Teachers repeatedly visit the Botanic Gardens and ask for simple publications on plants for school lessons. There is a shortage of such and it is hoped that the present one may meet their needs. The choice of plants for illustration is a good basic representation of what is commonly met with round villages and is more likely to interest the layman than a selection of the rare ones or those from the remote jungles.

If the book falls short of anything at all, then perhaps it might be criticized a little by Malay speaking students on the author's choice of Malay names. He has not always selected the commonest Malay name. His choice is often with emphasis on names used in the north. For example, he calls the well-known *bunga tanjong*, *Mimusops elengi*, *mengkula*. *Sesbania grandiflora* is *getih*, but it is far better known as *turi* in Singapore and Johore, the leaves being used as a vegetable. *Paku laut* or *paku hadji* would have been better for *Cycas rumphii* than *bogak hutan* which is probably seldom used. *Saga* is sufficient for *Adenanthera pavonina* without

the epithets *daun tumpul* and likewise *Durio zibethinus* is simply called *durian* and not *durian kampong*. Finally the three species of *Ocimum* namely *basilicum*, *sanctum* and *canum* are often confused on account of their similarity. The name *selaseh* is more correctly applied to *O. sanctum*, the sacred *tulasi* of the Hindus and not to *O. basilicum* which is *selaseh hitam* or *jantan*.

There has been more uniformity and standardization recently in the use of botanical names of plants and most of Professor Gilliland's names are correct and up-to-date according to the rules of botanical nomenclature. The following are the exceptions noted:—*Rhizophora conjugata* should now be *R. apiculata* while *Bruguiera conjugata* becomes *B. gymnorrhiza*. The better known name *Scaevola frutescens* ought now to be changed to *S. sericea* and *Bouea macrophylla* to *B. gandaria*. *Neptunia oleracea* is older than *N. prostrata* while *Lagerstroemia speciosa* takes precedence over *L. flos-reginae*.

The book is almost free from misprints. On page 25 there is *Averrhoa calambola* for *carambola* but here the sound is not really very different and anyway neither the Chinese nor certain English people ever lay much stress on the letter *r*. *Adenostemma lavenia* (*lavenia* a classical Ceylonese name) is misspelt *laevinia*.

The notes accompanying each plate are short but very interesting and there is often information which trained botanists would do well to read. The author states that the flowers of *Dillenia indica* and *Momordica cochinchinensis* are yellow. This is not quite correct as the petals of the former are white but the stamens are yellow. The petals of the latter are white or cream or white with a yellow tinge. Not-with-standing these slight defects the book is quite useful and we hope to see more of its kind at some future date.

J. SINCLAIR.

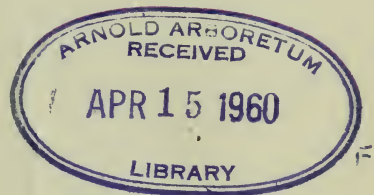
OTHER PUBLICATIONS OF THE BOTANIC GARDENS SINGAPORE

- 1. Annual Reports. 1875*.**
Reports for many years 1886 onward remain available.
Prices variable.
- 2. The Agricultural Bulletin of the Malay Peninsula (Series I).**
Nos. 1-9, 1891-1900.
Only Nos. 3, 5 and 7 available at 20 cents each.
- 3. The Agricultural Bulletin of the Straits and F.M.S. (Series II).**
Vols. 1-10, 1901-12, monthly issues.
All are available except Vol. 1 (6) and 1 (11) at 50 cents each or \$5 per volume.
- 4. The Gardens' Bulletin, Straits Settlements (Series III).**
Vol. 1 (1-5) Jan.-May 1912, issued under title of *Agricultural Bulletin of the Straits and F.M.S.* and Vol. 1 (6-12) Dec. 1913-March 1917 as *The Gardens' Bulletin, S.S.*
Vols. 2-11, July 1918-August 1941.
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- 5. The Gardens' Bulletin, Singapore (Series IV).**
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- 10. A Revised Flora of Malaya, Vol. 2, Ferns by R. E. Holttum.**
Government Printing Office, Singapore 1955. Price \$20.
- 11. Malayan Orchid Hybrids, by M. R. Henderson and G. H. Addison.**
Government Printing Office, Singapore 1956. Price \$21.
- 12. Wayside Trees of Malaya by E. J. H. Corner, 2 Vols.**
Government Printing Office, Singapore. Price \$25.
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An issue to mark the
occasion of the
100th Anniversary
of the founding of the
Botanic Gardens, Singapore

THE
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SINGAPORE

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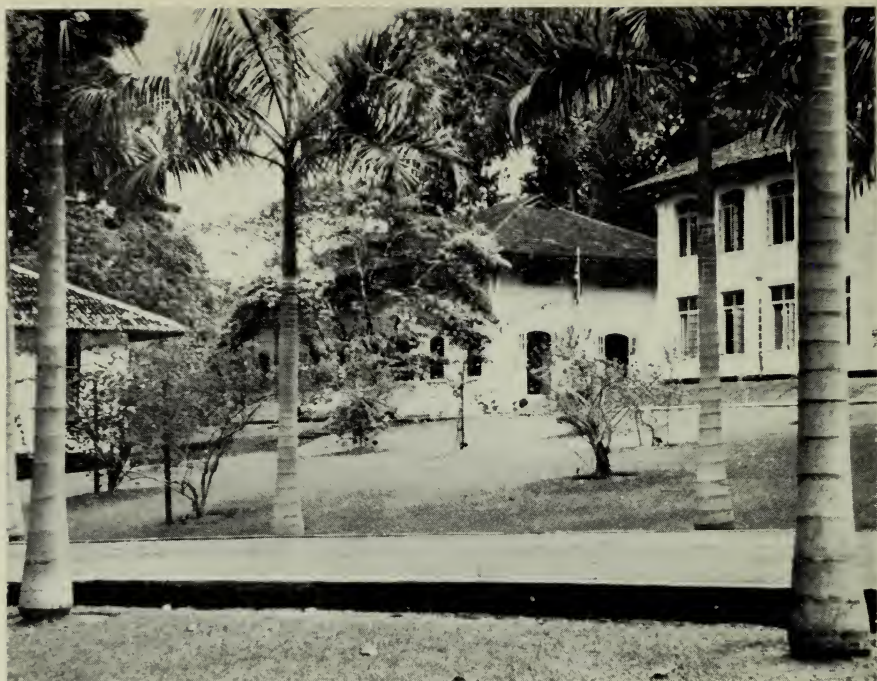
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Botanic Gardens, Office and Herbarium



Palm Valley

THE
GARDENS' BULLETIN
SINGAPORE

AN ISSUE TO MARK THE OCCASION OF THE
HUNDRETH ANNIVERSARY
OF THE FOUNDING OF THE
BOTANIC GARDENS, SINGAPORE
1859 - 1959

*History does not record the exact date.
The nearest one can get is that the
period of formation was between the
first half of November 1859, when a
body of citizens was formed with the
express purpose of establishing a gar-
den, and 1st January, 1860 when the
first subscription became valid.*

History and Functions of Botanic Gardens with Special Reference to Singapore

By J. W. PURSEGLOVE

*Director of the Botanic Gardens,
Singapore (1954-57)*

MANY PEOPLE THINK of botanic gardens as public parks in which to stroll amid pleasant surroundings and admire beautiful and rare flowers. Others consider them a convenient exercising ground for the baby or the dog, a good place for picnic and, in Singapore, somewhere to feed the monkeys.

Definition of Botanic Gardens

Any public park can provide these amenities. Why then go to the expense of maintaining botanic gardens with their staff of botanists, horticulturists and other specialists? The answer is that botanic gardens, to merit the name, are gardens maintained for the scientific study of the plants. As soon as this vital function is neglected botanic gardens change to public parks. This has been the fate of many botanic gardens throughout the tropics, while others have been totally neglected or have disappeared. It is true that they sometimes sell or give away planting material of fruit trees and ornamental plants, but this function can be undertaken by agricultural stations or commercial nurseries.

Botanic or Botanical

Some gardens such as Kew and Singapore are proud of the name Botanic Gardens, all too frequently called Botanical Gardens by the public, while others, especially in America, style themselves Botanical Gardens. Why is this? Botanic is the older form of adjective, but is now mostly superseded by botanical, except in the names of institutions founded long ago. It is advisable to ascertain which adjective is used by any particular gardens in order not to give offence. Some such as the Royal Botanic Garden, Edinburgh, do not use the plural of the noun.

The first Botanic Gardens

The oldest botanic gardens in existence today are those of Pisa in Italy founded in 1543, closely followed by Padua. They were founded by the Universities and were herb gardens in which the

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future physician was taught the medicinal use of herbs and how to recognize them. The Jardin des Plantes was founded by Louis XIII in Paris for this same purpose in 1626, as was the Oxford Botanic Gardens by the University in 1632, and the Chelsea Physic Garden in 1673 by the Apothecaries Society.

Systematic study of plants

In the eighteenth century Linnaeus laid out a garden showing his new system of classification and the plants were labelled in accordance with his binomial nomenclature. Other gardens followed suit and were designed to illustrate a purely scientific concept. Living plants, as well as herbarium specimens, were brought from all over the world for study in temperate countries. Botanists were often attached to voyages of exploration to collect and bring back this material. Many of the famous gardens of Europe, including the Kew Royal Botanic Gardens, founded in 1759, carried out these early taxonomic studies. (The first Botanic Gardens in the United States were not founded until the nineteenth century.) The herbaria and libraries which are so essential for this work were accumulated and the systematic study of plants, sometimes on a local basis, sometimes on a world basis, is still one of the most essential functions of modern botanic gardens.

Founding and work in the early tropical Gardens

As far as I can ascertain the oldest botanic gardens in the tropics are those of Pamplémousses in Mauritius which were established by the French in 1735. Hart's (1919) history of these gardens makes fascinating reading and is typical of many tropical gardens elsewhere. They started as a pleasure garden, although cassava was first introduced as early as 1736. After periods of neglect their principal function was to obtain, grow and distribute seeds of economic plants, particularly of spices, hitherto only cultivated by the Dutch in the Moluccas. Nutmegs were first introduced in 1765, but died. Among the introductions in 1767 were pepper, cinnamon, fruit trees and other plants yielding dyes and varnishes. Expeditions in 1770 and 1772 brought back nutmegs and cloves. The gardens were laid out in a picturesque manner and planted with native, African, Indian, Malayan and Australian plants. They suffered from subsequent periods of neglect, but later played a prominent part in the founding of the Mauritius sugar industry. They were taken over by the newly-formed Agricultural Department in 1913.

The first British tropical botanic gardens are those of St. Vincent founded in 1764 (Chipp, 1920). Bligh was commissioned to obtain bread-fruit for these gardens from Tahiti and his expedition

ended in the famous mutiny of the *Bounty* in 1787; he was more successful in 1791 and brought back bread-fruit plants to the West Indies. These gardens were abandoned for some 60 years later in their history. Among the other early botanic gardens founded in colonial territories are Jamaica in 1774, Calcutta in 1786, the first of the three Penang Botanic Gardens in c.1796, Buitenzorg (now re-named Bogor) in 1817; Trinidad in 1819, Peradeniya (Ceylon) in 1821 and the first Singapore Botanic Gardens in 1822. Typical of all these gardens is the founding of the first botanic gardens in the north American continent when Charles III of Spain sent a scientific expedition to Mexico in 1781, when "one of its objects was to establish a botanic garden in which instruction should be given in botany and in which the native products of the country should be cultivated and preserved" (Rickett, 1956).

In addition to the very important function of collecting, growing and distributing indigenous and exotic economic crops of promise, as well as seedlings of timber trees, and giving advice to the early planting communities on methods of cultivation and the control of pests and diseases, many of these botanic gardens laid a sound foundation of botanical research in the tropics in the nineteenth century. Many of the early directors were men of outstanding ability and industry. First and foremost they were keen botanists and could not help but be interested in the wild plants growing around them, many of which were as yet undescribed. They made arduous collecting trips into little-known country bringing back living plants for trial in their gardens, as well as large numbers of herbarium specimens. These were exchanged with other institutions throughout the world, and as time went on local floras and monographs of particular groups were prepared. The world owes these great pioneers a considerable debt.

By the second decade of the twentieth century most tropical territories had inaugurated independent agricultural and forestry departments, and much of the work on crops and forest products was handed over to them. Many of the botanic gardens were absorbed into the new agricultural departments, often with disastrous results to the research in botany which they had hitherto undertaken. The rôle of botanic gardens in fostering agricultural development in many tropical countries, usually achieved with very small staff and slender financial resources, is now often forgotten.

The movement of crops in the tropics

I have already shown how botanic gardens played a prominent rôle in the distribution of the principal economic crops grown today in the tropics. It is worth examining the subject a little further. It

has always seemed strange to me that many of the world's major tropical plant products are produced largely in countries far removed from their region of origin, e.g. South American rubber in Malaya and Indonesia, South America cocoa in West Africa, South American quinine in the East Indies, African coffee in Brazil, cloves and nutmegs from the Moluccas in Zanzibar and Grenada respectively, sugar, bananas and limes from South-East Asia in the West Indies, and vanilla from Central America in Madagascar. Obviously this cannot be attributed to any one particular reason and many factors are involved, including economics, available land and labour supply, technical skill in processing, suitability of the crop for plantation or peasant agriculture, etc. Nevertheless, one would have expected that a crop was more suited ecologically to its country of origin than to its new home. I suspect that one of the major reasons is that when a new crop has been introduced without many of its normal pests and diseases, it has more chance of flourishing and giving high yields. Many of the crops are introduced as seeds, which limits the number pests and diseases which they can carry with them, and this is further enhanced by the plant quarantine regulations now enforced in many countries. One can only contemplate what would happen to the Malayan rubber industry if the South American Leaf Blight (*Dothidella ulei*) were accidentally introduced.

In this digression I have limited myself to economic crops, but further examples can well be given from food crops, too. Many of the staple crops now grown in parts of tropical Africa are of New World origin, e.g. cassava, sweet potatoes and maize.

The early Penang Botanic Gardens

Ridley (1910a) gives the date of the founding of the first Botanic Gardens, Penang as 1800, although in the same article he states that, soon after the first settlement in Penang in 1786, the East India Company decided to start spice gardens with a view to breaking down the Dutch monopoly of the spice cultivation and trade. A botanist, Christopher Smith, was appointed in 1794 and in 1796 was sent to the Moluccas to collect living plants of nutmegs and cloves. Ridley then adds that by 1800 the Gardens contained 1,300 plants and that they were greatly enlarged in that year, when 15,000 clove and 500 nutmeg trees arrived from Amboina. It thus appears that the first Gardens were begun about 1796 and not in 1800 as is usually stated. Ridley goes on to say that Smith sent in all 71,266 nutmeg plants, 55,264 cloves and large quantities of canary nut, (*Canarium commune*) and Kabong palm, (*Arenga saccharifera*).

This transporting of very large quantities of plants in the tropics was to continue throughout the nineteenth century. Nor was the movement confined to economic crops, as plants of horticultural merit were freely distributed between botanic gardens, while scientific institutions, wealthy patrons, seedsmen and nurseries sent collectors to the far corners of the earth to bring back novelties for their hothouses and for sale. The scale on which the exchanges took place is hardly conceivable today and the expense, difficulty and length of time spent transporting them must have been very considerable.

The first Penang Botanic Gardens were sold in 1806. Raffles founded the second Gardens in Penang in 1820. Ridley states that these existed until 1834, "when Governor Murchison, who took no interest in gardens or agriculture, sold them for 1,250 rupees, because his wife could not get enough vegetables from them to diminish her cook's bill."

HISTORY OF THE SINGAPORE BOTANIC GARDENS

The Singapore Botanic Gardens are the last gardens in the British tropics which function as a separate and self-contained department and have never been under the control of any Agricultural Department, Municipality or University. I now propose to confine my attention to these Gardens and describe some of the work carried out there during their long history.

The first Singapore Botanic Gardens

Shortly after the founding of Singapore in 1819, the founder, Sir Stamford Raffles started the first Botanic Gardens on the Government Hill at Fort Canning in 1822. Nathaniel Wallich, who was visiting Singapore from the Calcutta Botanic Gardens, advised on this project. Raffles introduced nutmegs, cloves and cocoa. These gardens were closed in 1829 on instructions from India to retrench expenditure. They were re-opened later by an Agri-Horticultural Society in 1836, who covered the cost from the sale of nutmegs and cloves growing there. They were finally abandoned about 1846. The principal crops of Singapore at that time were nutmegs and gambier; the former failed because of pests and diseases; the latter was too exhausting to the soil and required large quantities of charcoal for its preparation.

In a recent popular article in a Singapore paper a writer (H.T.S., 1956) says, "When critics carp at British colonialism, they should stop for a moment and ponder on the old circumstance that one of

the first matters which occupied the earnest attention of the founders of Singapore was to find a site for a botanical (*sic*) gardens. No great plan for exploiting the local people was afoot here."

The Second Singapore Botanic Gardens

The First Phase: 1859–1875

In 1859 a new Agri-Horticultural Society was formed in Singapore, the third in the history of the island. The Society was given a grant of some 60 acres of land in Tanglin by the Government on which to found a garden. Convict labour was also provided. Members of the society paid an entrance fee and a monthly subscription, while there were second-class subscribers who might enjoy the use of the gardens by paying a monthly fee. They also raised money by public entertainments. The southern end of the Gardens was probably abandoned gambier land, a haunt of tigers, while the north was still virgin tropical evergreen rain forest, 11 acres of which are still preserved in their original form, a most valuable asset in the centre of a great city. The first object of the committee was to create a pleasure garden with roads, terraces and a band stand, where military bands performed fortnightly, the gardens providing an alternative evening drive to the Esplanade for 'the quality'.

Laurence Niven, who supervised a privately-owned adjoining nutmeg plantation, was employed part-time as Superintendent. He had a fine eye for design and laid out the Gardens much as they are today. As early as 1861, flower shows were organised in the hope of encouraging the local cultivation of vegetables, fruits and flowers. In 1866 the Society purchased a further 25 acres of land and built the present Director's house, as well as constructing the Gardens' lake. This depleted the Society's funds and in 1869 they approached the Government for a further grant, the first being \$50 towards Niven's salary in 1866. The second grant was agreed to on condition that the Society should exhibit in the gardens living economic plants. At the same time a small zoo started. (There has been a menagerie at the Jardins des Plantes in Paris since 1794.) By 1874 the Society was in debt and could carry on no longer. They asked the Government to take over their Gardens and their debts and to maintain the Gardens for the benefit of the people of Singapore. Government agreed to do this and in 1875 the management committee asked Sir Joseph Hooker, the Director of the Royal Botanic Gardens, Kew, to recommend a suitably trained candidate for the post of Superintendent, who "was to be a practical, as well as systematic botanist, and to travel in the Malay Peninsula not a little for the purpose of investigating its vegetation". (Burkill, 1918).

Thus the second Singapore Botanic Gardens, which celebrates its centenary in 1959, originating as a little more than a public park, began the second phase of its history and was changed into a working Botanic Garden.

The Second Phase: 1875–1888

Sir Joseph Hooker sent out James Murton, a Kew trained horticulturist. He was energetic and enthusiastic, but unfortunately was very young and little suited for control. He added greatly to the collection of plants growing in the Gardens, both economic and horticultural, from the principal Botanic Gardens in the East, as well as Kew. Kew sent the first live Para rubber seedlings in 1877 (see below).

Under the Raffles Society Ordinance of 1878 the Gardens were legally taken over by the Government of the Colony and vested in Her Majesty the Queen, her Heirs and Successors. In 1879 the Government allocated a further 102 acres of land, now occupied by the University of Malaya, for the cultivation of economic crops, particularly gutta-percha and rubber-producing trees. Also growing in these Economic Gardens at this time were *Cinchona*, arabica and liberica coffee, *Eucalypti*, *Ipecacuanha*, tea, maize, sugar cane, cola nuts, mahogany, etc. Murton added greatly to the Gardens' menagerie. He collected plants in Singapore and in the Peninsula, but his duplicates in Singapore later disappeared, when he was dismissed in 1880. He died in Bangkok the following year and Burkill (1918) says "his death perhaps hastened by his having burnt the candle at both ends."

Murton was succeeded by Nathaniel Cantley, who was also a Kew trained horticulturist. He had been Assistant Superintendent of the Mauritius Botanic Gardens and was an older man, a great lover of order. He did much planting and named and labelled all the plants in the Gardens. He surveyed the forests of the Straits Settlements and was responsible for gazetting the first forest reserves. He planted large numbers of Malayan and introduced timber trees in the Economic Gardens, and his arboretum was arranged in a botanical sequence on the system of Bentham and Hooker. Cantley was a keen botanist; he collected local plants and started the herbarium. He also experimented with European vegetables. The grounds of Government House Domain were placed under the Botanic Gardens and still remain so today. The Gardens also helped in horticultural work in the city and much of the tree planting in Singapore, which greatly adds to its attraction, was supervised by the Gardens' staff. Cantley, who had never been a very fit man, went on sick leave in December 1887 and died the following year.

The Third Phase: 1888–1912

With the appointment of Henry Nicholas Ridley as Director in 1888 the Gardens entered upon the third stage in their history and a most productive period it was. "Ridley's capability as a research worker and his power to demonstrate by his publications the practical and beneficial effects of photography on plant science in all its aspects . . . succeeded in a surprisingly short time in pushing the Singapore Gardens to the fore as a centre of Malaysian phyto-graphy" (de Wit, 1949). Ridley was a tireless worker and his phenomenal output of work in the natural sciences and his application of this to economic problems is quite remarkable.

He has been rightly named "the father of Malaya's rubber industry". His early experiments on the tapping and preparation of rubber and his constant advocacy of it as a plantation crop, often in the face of opposition, led to the foundation of the present industry upon which so large a share of the wealth of Malaya and the eastern tropics has rested (Purseglove, 1955 a). Nor was his work on economic crops confined to rubber; he carried out experiments with most of the actual and potential crops known. As early as 1889 he reported that cacao would probably be profitable on the better Malayan soils, while in 1907 he directed attention to the possibility of oil palm as a plantation crop. The local planting community was largely dependent upon the Economic Gardens for planting material and seeds of economic crops were distributed to all parts of the tropics. In the case of rubber alone, over seven million seeds were distributed from the Singapore Botanic Gardens, as well as many seedlings. The Gardens obtained a considerable income from the sale of these, as well as the rubber produced, thus allowing them to be maintained without any increase in Government vote. Visitors from all over the world visited the Economic Gardens, while Ridley and his three assistants in Singapore, Malacca and Penang, were the only trained men whom the planting community could approach for technical advice and help. It was Ridley who was responsible for and then administered, the *Coconut Trees Preservation Ordinance* of 1890 for the control of the rhinoceros beetle. In addition to being Director of the Botanic Gardens, Ridley was also Director of Forests, Straits Settlements and was responsible for gazetting additional forest reserves. He produced the first published accounts of Malayan timbers, vegetables, fruits, fibres, dyes and drug plants, while his book on *Spices* (1912) is the standard work.

Ridley's work as a field botanist is equally remarkable. He travelled far and wide in the Malay Peninsula, often in remote regions,

as well as visiting Cocos and Christmas Islands, Borneo, Java and Sumatra. On all these expeditions he studied the vegetation and brought back vast numbers of herbarium specimens, as well as many living plants for trial in the Gardens. In all he collected many thousands of specimens, of which a large number were unknown to science. These specimens are now in our herbarium, but duplicates were sent to Kew and other botanical institutions. He named and described for the first time a few thousand plant species and a surprising number are still only known from his original gatherings. Specimens were sent to experts on certain groups elsewhere and many new species were named in his honour. Ridley realised very early in his career that the flora of a country cannot be studied *in vacuo* and that it is essential to take into account plants from neighbouring territories as well. After his retirement he wrote his five-volume *Flora of the Malay Peninsula* (1922–25).

Nor was Ridley's attention confined to plants, of which he collected in all groups. He belongs to that great pre-specialised age of scientific natural history and he collected and studied many animals, as well as distributing specimens and writing about them. Ridley's work as a naturalist has been more fully described elsewhere (Purseglove, 1955 b). He took a keen interest in the Gardens' menagerie, which was disbanded in 1904–5, much to Ridley's obvious regret.

In addition to publishing in many scientific journals in Singapore and overseas, Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891, so that he could supply the planting community and others with information resulting from his many investigations. In all he published over 500 papers, articles and books, totalling over 10,000 printed pages, so that the work of the Singapore Botanic Gardens became widely known throughout the world. Details of his publications and other work will be found in *Gardens' Bulletin*, Vol. IX, 1935, which was dedicated to him on his 80th birthday. Attention should be drawn, however, to his encyclopaedic volume, *The Dispersal of Plants throughout the World*, published in 1930, which still contains much of value for the botanist and the agriculturist.

Few people have accomplished so much in twenty-three years of tropical service as Ridley did—he retired in 1912—nor have completed their work after retirement as he had done. He was elected a Fellow of the Royal Society in 1907 and, apart from the honour of C.M.G. in 1911, he received comparatively little public recognition, until his hundredth birthday, which was celebrated on the 10th December, 1955. On this occasion he wrote "It is a great delight to me to have lived to see the Gardens, the best tropical

Gardens in the world," and that "my hundredth birthday was one of the most enjoyable days of my life". It is with regret that I record the death of Mr. Ridley on the 24th October, 1956.

The founding of Malaya's rubber industry

Accounts of the transfer of Para rubber from Brazil to the eastern tropics have often been given, but frequently they are inaccurate in detail. As the Singapore Botanic Gardens played such an important part in this introduction, it is worthwhile recording briefly the facts at this juncture.

Sir Clement Markham of the India Office, who had been responsible for bringing *Cinchona* from South America to the east in 1865, pointed out in 1870 that there was a danger of exhausting the Indo-Malaysian supply of wild rubber and recommended that plantations should be put down in the east. James Collins, who was Government Economic Botanist and Librarian in Singapore, was asked to collect all the available information about rubber-producing plants and his report was published in 1872. Through Markham's efforts and those of Sir Joseph Hooker, the Director of Royal Botanic Gardens, Kew, a few seeds were collected and sent to Kew in 1873, when a dozen plants were raised. Six of these were sent to the Calcutta Botanic Gardens and were later propagated and sent to Sikkim, where they were a failure, the climate being unsuitable. A consignment of seeds was sent to India in 1875 and failed to germinate.

Markham then arranged for Robert Cross to collect rubber seeds in South America, while Hooker obtained the services of H. A. Wickham, later Sir Henry, who was then on the Amazon. Wickham collected 70,000 seeds. He did not smuggle the seeds out as is often suggested; it is now known that they were brought out with the goodwill and co-operation of the Brazilian Government. Wickham chartered a ship and the seeds arrived at Kew on 15th June, 1876, where they were planted immediately. Less than 4 per cent germinated and some 2,800 seedlings were raised at Kew. Many large tropical oily seeds retain their germination powers for short periods only and it was Ridley who later discovered that they could easily be transported in damp powdered charcoal. On 9th August, 1876 Kew sent 1,919 plants to Ceylon in 38 Wardian cases. Two days later 50 plants were sent direct from Kew to Singapore. Thiselton-Dyer (1878), and later quoted by Ridley (1910b), states that "owing to the delay in payment of freight (in Singapore) these plants all perished". Burkill (1935) says that Murton reported that "five plants were alive when the cases were received at the Gardens", although they appeared to have perished subsequently.

On 10th June, 1877 Kew sent a further 22 plants direct to Singapore and these thrived. They were not sent from Ceylon as is often published.

In the meantime Cross returned to England with a consignment of plants in November, 1876. Burkill (1935) states that "not one of Cross's plants collected in Para is known to have survived the seedling stage or to have reached the east". This was good fortune in disguise as the east was stocked from Wickham's seeds, which were collected in the central valley of the Amazon, where the trees are now known to have been of better quality than those nearer the mouth. Murton planted eleven of the rubber plants near our present nursery and then Fox in 1879 transferred them to swampy ground in the new Economic Gardens, as it was thought that this was the natural habitat of the tree. He took nine of his seedlings to Perak in October 1877 and these were planted at the Residency at Kuala Kangsar. Most of the rubber in Malaya has come from this original introduction, although some seeds were received from Ceylon at a later date.

The Singapore trees first fruited in 1881. When Ridley arrived in 1888, there were 9 trees of the original introduction, some 50 trees 2-4 years old and over 1,000 young seedlings. He quickly planted more. The subsequent exploitation and establishment of rubber as a plantation crop in Malaya was due almost entirely to Ridley. Within four months of his arrival in Singapore he drew the Government's attention to this possibility. With great perseverance, little encouragement or help and slender financial resources, he set to work. He has since recalled how he was "carpeted by the Governor, Sir Frank Swettenham, who admonished him to waste less time on an uneconomic product such as rubber." He experimented with various rubber-producing trees and found that *Hevea* was superior to all others. Starting with a mallet and chisel, and later using a modified farrier's knife, he developed the tapping technique which has been but little changed since. He discovered wound response, which he terms "calling the rubber", and he also demonstrated that the bark regenerated and could be tapped again. He exhibited coagulated rubber in Singapore in 1890 and the following year sent specimens to England which were well reported on.

Having shown that rubber was a commercial proposition, Ridley then tried to persuade the reluctant planters to give the new crop a trial, but at first met with little success, as coffee was considered to be the only important crop in Malaya. For his efforts he was known as "Mad Ridley". In 1893 he distributed the plants and seeds to Residents and District Officers in the Federated Malay States to plant near their houses. It was fortunate for Malaya that

when rubber planting began in earnest—coffee prices had slumped and the trees had been attacked by diseases and pests—that there was at the Singapore Botanic Gardens a good supply of planting material and Ridley, the expert, with the latest 'know-how' to advise and to help planters. Ridley stayed long enough in Singapore to see the great rubber boom in 1910 and for Malaya to reach a predominant position in world rubber production, which it has never lost.

The Fourth Phase: 1912–41.

During Ridley's term of office the Gardens established for themselves an international reputation, which was adequately maintained during the next stage in its history. With the forming of the new Agricultural Department in 1904, much of the work on the economic crops passed from the Gardens and the Economic Gardens were finally closed in 1925. Gradually during the period more staff were recruited, especially botanists, so that the work on taxonomy could be extended. Some work was done on the lower plants, particularly the Fungi. In the horticultural field the hybridising of orchid and other cultigens was undertaken.

I. H. Burkill, who had been on the staff of the Calcutta Botanic Gardens and had collaborated with Watt on the study of the economic products of India, was appointed Director in Singapore in 1912. During World War I the Gardens were understaffed and there was little time for expeditions and collecting. Anderson's *Catalogue of Plants growing in the Gardens* was published in 1912 and lists 1739 species, which included 276 orchids, 261 ferns and 245 palms. T. F. Chipp was appointed Assistant Director in 1915, a new post having been created, but he did not take up his duties until 1919. He was transferred to West Africa at the end of 1920, in which year he published his *List of the Fungi of the Malay Peninsula*. Until the Economic Gardens were taken over by Raffles College, now the University of Malaya, in 1924–25, they continued to play an important role in the distribution of economic plants. In 1916 two hundred species were listed as available for sale at the Gardens. The loss of the Economic Gardens was a grievous blow, as the land available for planting was more than halved.

Burkill continued his interest in medicinal and economic plants generally and collected much information on these in Malaya. He continued this work for 10 years after retirement and published in 1935 his large two-volume *Dictionary of the Economic Products of the Malay Peninsula*, a work of great scholarship, "a masterpiece of synthesis", and a model for all works of this type. It is of great value to the botanist and the agriculturist, not only in Malaya, but

throughout the tropics. Unfortunately it is now out of print, but I hope that it may be reprinted soon. Burkill also made a detailed study of the genus *Dioscorea* (yams), a genus on which he is still working.

The Gardens Committee ceased to have their own banking account in 1919 and their balance was paid into the Treasury. Thereafter the Government increased the Gardens' vote, which was provided under several separate heads, where formerly a lump sum had been given.

R. E. Holtum was appointed Assistant Director in 1922. He was promoted Director in 1925 and continued in this post until 1949, when he became the first Professor of Botany in the University of Malaya. Holtum's principal interest were ferns and monocotyledons and he added greatly to our knowledge of these plants, describing many new species. He showed that wild orchids may hybridise and produce 'species' which had hitherto never been suspected to be of hybrid origin (de Wit, 1949). He began work in 1928 on the production of spectacular new free flowering hybrids of cultivated orchids and this work is still being continued at the Gardens.

C. X. Furtado joined the staff in 1923 and is still Botanist here. During this period he has become an acknowledged authority of the International Rules of Botanical Nomenclature and on Malaysian palms and aroids.

M. R. Henderson was appointed Curator of Herbarium in 1924 and held this post until he was appointed Assistant Director in 1946 and Director in 1949. He worked on Malayan flowering plants generally, his special interest being limestone plants and the family Myrtaceae.

E. J. H. Corner arrived in Singapore in 1929 as Assistant Director, the post which he held until 1946. He specialised in Fungi and trees and carried out research on the morphological and ecological aspects of the vegetation. Corner trained *berok* or pig-tailed monkeys (*Macacus nemestrina*) to collect botanical specimens, thus partly solving the problem of obtaining specimens from tall trees and climbers otherwise inaccessible. Corner states that one of these monkeys knew the meaning of 18 words of Malay and was able to find at the tree tops fruits and flowers which had been shown to him on the ground. It has been said that these botanical monkeys were "the first apes to enter Government Service". Corner's two-volume *Wayside Trees of Malaya* was published in 1940, a work full of out-of-the-way information and original observations and is one of the most fascinating books ever produced on the trees of

any country. Corner, now Lecturer at Cambridge University, is continuing his study of the genus *Ficus* in Malaysia.

Mention must also be made of C. E. Carr, a Malayan planter, who worked in conjunction with the Gardens, and added greatly to our knowledge of Malaysian orchids. He died in New Guinea in 1936 when returning from a collecting expedition.

From 1923 to World War II the senior staff of the Gardens consisted of Director, Assistant Director, Curator of the Herbarium and Assistant Botanist, all actively engaged on botanical research and three horticulturists as Curators, two in Singapore and one in Penang. In Singapore one Curator supervised the horticultural work at the Gardens and the other looked after Government House Domain and the outside commitments in the City.

The Gardens' collection of living plants and the herbarium were added to greatly during this period.

The Fifth Phase: The Japanese Interregnum: 1942-46

During the early years of the World War II before the Japanese attacked Malaya at the end of 1941, most of the senior Garden staff were seconded for at least part of their time to the Department of Food Control and Information. The Gardens maintained demonstration plots of vegetables to encourage local production. J. C. Nauen and G. H. Addison, Curators at Penang and Singapore, were mobilised with the local defence force and were later taken prisoners and sent to work on the Siam-Burma railway, where Nauen lost his life. Holttum, Corner and Furtado remained in Singapore during the occupation and were permitted to carry on with their botanical research. Immediately following the capture of Singapore Island, Professor Tanakadate, of Tohoku University, took over the control of the Gardens, and took care that they were not despoiled by the Japanese military forces. Holttum remained in executive charge until the appointment of Professor Kwan Koriba, of Kyoto University, as Director of Gardens in December 1942.* During his stay in Singapore Koriba undertook research on the growth-behaviour of some Malayan trees. It was particularly fortunate for the Singapore Botanic Gardens that the Japanese scientific officers and the British staff who remained were able to preserve the herbarium and the library as part of the cultural heritage of Malaya and that no loss whatsoever was suffered in them, except for a few specimens which were on loan in Germany. Losses did occur, however, among the living collection and garden work deteriorated generally, as more than half of the out-door staff (49 men)

* An obituary of Professor Kwan Koriba is published in this Bulletin.
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were sent to work on the Siam-Burma Railway, where 22 of them lost their lives. There was comparatively little damage in the Gardens, although the Director's house received a direct hit from a shell, but, even so, the damage was not serious.

From September 1945 to March 1946 the Gardens came under the British Military Administration.

The Sixth Phase: 1946-56

After the war the staff was gradually re-assembled, but did not reach its full compliment until the end of 1954, M. R. Henderson was appointed Assistant Director and later Director (1949-54). J. Sinclair arrived in 1948 as Curator of the Herbarium, the title later being changed to Keeper. J. W. Ewart, Horticultural Curator, served as Agricultural Officer, Singapore, as well as carrying out his duties at the Gardens. Henderson retired in 1954 and J. W. Purseglove was appointed Director, while H. M. Burkill (son of I. H.), was appointed Assistant Director in December of that year.

Gradually during this period the Gardens were brought back to their former good condition, the living collection of plants was increased and collecting in Malaya and Borneo was resumed. The first two volumes by R. E. Holttum of the *Revised Flora of Malaya* were published. Burkill has begun a study of Malayan seaweeds.

On the 10th December, 1955, the Gardens celebrated the hundredth birthday anniversary of H. N. Ridley, with an exhibition of Ridleyana and current work, while the Gardens were floodlit for one week. A special brochure for private circulation was produced for the occasion (Purseglove, 1955c).

Early in 1955 a scheme was drawn up in conjunction with the University of Malaya with the aim of attracting research workers from Britain and elsewhere to Singapore for one or two years to carry out the botanical research in their specialised fields. By this means the output of research would be increased and knowledge would be obtained which would be of great value to the tropics as a whole. Furthermore, workers from temperate countries would become familiar with tropical botany and their interest in our problems would be stimulated. In 1955 P. B. Tomlinson of Leeds University was awarded an Agricultural Research Council Scholarship and spent one year here studying the anatomy of palms. T. C. Whitmore, a Ph.D. student of Cambridge University, arrived in December 1956 to spend a year working on the anatomy of Diptero-carp barks in relation to taxonomy. He is receiving a Colonial Development and Welfare grant. It is hoped that more research workers may come in the future.

[In order to bring this paper up-to-date as a history of the first hundred years of the Botanic Gardens, the footnote below headed: **The Seventh Phase: 1957 and on**, has been added to the original paper in concurrence with the author.—EDITOR.]

Waterfall Garden, Penang

The third Botanic Gardens in Penang were founded by Charles Curtis in 1884 as "a nursery for the planting of colony products", and were under the charge of the Gardens and Forest Departments Straits Settlements, with its headquarters at the Singapore Botanic Gardens. Curtis, who had been employed as Messrs. Veitch's plant collector in Mauritius, Madagascar and Malaysia, was appointed Superintendent and remained there until his retirement in 1903. Holttum (1934) records that Curtis "was an enthusiastic plant-lover and a born gardener, and the development of the Waterfall Garden is a monument of his energy and skill". Curtis also made large collections of herbarium specimens in Northern Malaya. The Penang herbarium was later incorporated with that at Singapore.

The Seventh Phase: 1957 and on.

The penultimate constitutional step in the introduction of full internal autonomy of Singapore (effected in May 1959) was operative from April 1955. As befits a country in charge of its own affairs, the Singapore Government adopted a policy of "malayanisation" of the public service from January 1st, 1957. J. W. Ewart retired in March 1957 in accordance with this policy, and A. G. Alphonso, who had returned in 1956 from a two year course of training in horticulture at the Royal Botanic Gardens, Kew, England, was promoted Curator. J. W. Purseglove retired voluntarily in March 1957, and H. M. Burkill became Director. G. H. Addison retired in February 1959. Chew Wee Lek was appointed Botanist in 1956 and went to Cambridge, England, in 1957 for three years to study for a higher degree. Lam Hin Cheng was appointed Horticultural Assistant in July 1957 and went to the Royal Botanic Gardens, Kew, for a two year course in horticulture. The new post of Librarian was eventually filled in April 1958, and Tan Kim Ho went to Melbourne, Australia, in 1959 for training in library management on an Australian Government award under the Colombo Aid Programme. Attempts to fill the post of Assistant Director were unavailing, and finally Miss Chang Kiaw Lan was appointed Botanist (vice Assistant Director) to take up a study of mycology. In 1958 Bajuri bin Sappan, Laboratory Assistant, was sent to various institutions in England for one year to study plant breeding techniques with a view to furthering the Department's plant breeding work.

The last three years, 1957 to this centenary year of 1959 have been a period of transition characterised by an acute shortage of senior personnel through loss of qualified staff and temporary loss of the services of officers sent overseas for training. The most severe effects of this will be over by the end of 1959, when only one officer remains overseas, and he will be back in 1960. Thus will close a century of expatriate know-how in the senior botanical and horticultural posts, and there will open the second century of the Gardens' history, every bit as promising in the comity of international botany as the first has been successful, with the majority of the senior posts held by Malayan personnel. *H.M.B.*

In 1910 it was decided to convert the Gardens into a reservoir, but fortunately this did not materialise. With the formation of the Malayan Union in 1945, later renamed the Federation of Malaya, and the separation of Singapore as an individual colony, the control of the Waterfall Gardens passed from the Singapore Botanic Gardens to the Federation Agricultural Department. This was a great loss to the Singapore Gardens as the climate of Penang is more seasonal than that of Singapore and was therefore better suited for the growth of certain plants, which flower and fruit there, but will not do so in Singapore. Furthermore, the Penang Gardens lost the stimulus of direct contact with the parent institution where botanical research is carried out.

THE WORK OF BOTANIC GARDENS

The principal work carried out by botanic gardens can be divided under three broad heads, namely, botanical, horticultural and educational, although inevitably there is some overlapping between them. In addition to these functions most botanic gardens are opened to the public and thus provide the facilities of a public park. For this purpose they should be laid out as attractively as it is possible to make them, without jeopardising the work of the scientific study of plants. The Singapore Botanic Gardens are opened to the public from 6 a.m. until 7 p.m. daily; no charge is made and the popularity of the Gardens can be gauged from the very large number of visitors to them. Most tourists visiting Singapore also come to see the Gardens.

I now propose to give a more detailed account of the work under the various heads given above, illustrating this from the Singapore Botanic Gardens.

BOTANICAL WORK

The living collection

A botanic gardens should have as large a collection of living plants as it is possible to grow, without sacrificing an attractive layout. In fact a Gardens should be a great museum of living plants. All the plants should be correctly labelled with their scientific name and family, together with the country of origin. If there is a common English or vernacular name, this may be added, but this is often difficult when various languages are spoken as in Singapore. Care should be taken to keep the names up-to-date according to the latest nomenclature changes. As many different groups of plants as possible should be represented. Inevitably, certain gardens specialise in certain groups, particularly those on which specialists have

been working. Thus in Singapore our collection of palms, orchids and ferns are particularly good. Inevitably many plants of botanical interest, but of little value horticulturally, must be included in a botanic gardens, and they are not always as colourful as the layman expects. It is desirable that closely related species or even groups, should be planted near each other, which is very useful for comparative purpose, but this should not be carried to the extreme, as it results in a deterioration in the lay-out. Herbs and woody plants of varying stature, although belonging to the same family, are often difficult to grow together and to maintain and are unsightly when so planted. A lot of plants can be grown in pots. For this a burnt earth-compost mixture has proved to be the most suitable for our conditions for many plants. This method is described by Holtum (1953 a).

The Singapore Botanic Gardens have some 3,000 perennial species growing in them at present and this does not include hybrids. Even so, there is a limit to the number of plants that can be grown in our eighty-five acres and there is little room for further planting, particularly of large trees. The work of labelling such a large collection presents difficulties and label printers are constantly at work repainting old labels and preparing new ones. The majority of our labels are made of wood or metal, 6" × 4", with an iron prong 8" long for sticking in the ground. They are painted black with the plant name clearly printed in white. For pots and small species printed aluminium labels are used. These are also attached to trees in the Gardens' jungle, but unfortunately they are often removed by monkeys.

The Herbarium

In addition to the living collection, a botanic garden should have a *hortus siccus*—the herbarium, or at least one reasonably accessible to it. In this, dried mounted specimens are preserved. The Singapore Herbarium is situated in the Gardens and has over 400,000 sheets. The specimens are mainly confined to plants of the Malaysian region, which extends from Sumatra and Malaya to New Guinea, but there are a few from surrounding countries. Our oldest specimens are over 150 years old and are still in a good state of preservation, despite the fact that they are housed in wooden cupboards and the building is not air-conditioned, although the latter is preferred if possible. The collection is arranged according to the Bentham and Hooker system, and, within the species folders, according to the various Malay states, Malay islands and exotics. There is also a smaller and separate Gardens' Herbarium of cultivated plants.

In addition to being in constant use by the botanists, both at the Gardens and the University, the specimens are sent on loan to botanical institutions elsewhere for study. In 1956 a total of 4,525 sheets were sent on loan, mainly to Leiden, Bogor and Kew, to authors of the *Flora Malesiana*, while 4,903 sheets were sent on loan in 1955. The value of the specimens is enhanced considerably when the sheets are returned correctly annotated. Inevitably some mixing occurs in folders until the genus has been currently revised, but this is not peculiar to Singapore.

There is also a good collection of spirit material, particularly of orchids, and this is invaluable for detailed study.

Collecting, naming and distribution of specimens

Both the living and dead collections of plants at the Botanic Gardens are added to constantly by collection, donations and exchange. Plants do not recognize political boundaries and in studying the plants of a country such as Malaya, it is essential to study the plants of surrounding countries, if one is to understand the variation and distribution of the local species. Thus botanists from the Singapore Botanic Gardens, although the bulk of their collection has been made in Malaya, have also collected extensively in Borneo and to a lesser extent elsewhere, where the flora shows regional affinities. We also try to collect as many duplicates as possible of each gathering, so that these may be distributed to other institutions elsewhere. In these uncertain days spacial separation of duplicates is very desirable, so that if one or more sets are destroyed, as happened in Berlin and the Philippines during the war, others are available elsewhere. 5,397 duplicates were distributed from Singapore in 1956, many of which were plants collected by the writer in Sarawak. 6,768 duplicates were received, of which a large portion came from the Forestry Departments of Sarawak, Brunei and British North Borneo. Many of these were unnamed and have since been determined by the staff. Private collectors are also encouraged to send in specimens.

The importance of adequate field data on all specimens cannot be over-stressed. Each specimen should be given a serial number and notes are made of the place of collection, habitat, altitude, relative abundance, as well as information on habit, colour of flowers, etc., which cannot be ascertained from the dried specimens. Special herbarium labels are provided for listing this data. In the past this type of information, which can be of very great value to the taxonomist, was frequently neglected. Sterile material is often of doubtful value.

With the aid of a good modern flora, a botanist should be able to determine most of his specimens in the field—but unfortunately how many tropical countries have complete up-to-date floras! Even when they are available, certainty can only be reached by comparison with authentic named material. Agricultural and forestry departments, teachers, students, planters and others from Malaya, Borneo and elsewhere send us specimens for determination. Small plant fragments are sometimes sent for identification in connection with police investigations, medical enquiries, etc. We receive frequent requests for information on certain plants. Thus we provide an important service, which cannot be obtained elsewhere in Malaya.

Taxonomic studies

A very important function of any botanic gardens is research in systematic botany. This critical and highly specialised work involves detailed revisions of genera and families and is an essential preliminary to the publication of any flora. Previously named species are critically examined, questions of synonymy are finalised, and new species are described. Furthermore such work can never be completely perfected, as a critical study of the great amount of material collected during the past 40 years reveals large numbers of undescribed species, as well as new information on distribution and variability, while future collecting will yield yet more. It is necessary that the names and descriptions of Malayan plants should be brought into line with those of neighbouring countries. I am convinced that a study of Malaysian plants as a whole is an essential preliminary in the preparation of the local flora. Consequently, the staff of the Singapore Botanic Gardens is now collaborating in the production of the *Flora Malesiana*, edited by C. G. G. J. van Steenis of Leiden University and financed by the Indonesian Government.* This major work will occupy many botanists from many countries for many years.

So much new material and new knowledge has accumulated since the publication of Ridley's *Flora of the Malay Peninsula* in 1922–25, that it is now out-of-date and a *Revised Flora of Malaya* is being prepared. Two volumes have been published so far, both by R. E. Holttum, namely, *Orchids of Malaya* (1953) and *Ferns of Malaya* (1955). This work is designed to be of use to the field

* From 1st January, 1958 funds from this source have ceased. The *Flora Malesiana* Foundation is currently sponsored by the Netherlands Organisation for Pure Scientific Research "Z.W.O." with contributions from British Government and Commonwealth sources, including Singapore.

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naturalist and the gardener, as well as the specialist, and includes introduced, as well as indigenous plants.

The great complexity of the Malaysian flora, which is one of the richest in the world, makes the task of the taxonomist a very formidable one. Some idea of this can be obtained if one realises that the island of Singapore, with an area of 225 square miles and a population of one and a quarter million, has some 2,000 indigenous species of plants, a total which is greater than that of the British Isles; the Malay Peninsula has about 10,000 species, while the estimate for the Malaysian region as a whole is 30,000 species.

The taxonomist working in the region whose flora he is describing has the great advantage of being able to study many of the plants in his group living in their natural habitat, which is an invaluable aid to his study of herbarium material. Some of the plants may also be growing in the local botanic gardens. For modern taxonomic study it is essential for the worker to see as many as possible of all the collections that have ever been made of the species he is studying. Thus most herbaria are willing to lend their specimens to experts wherever the latter may be working.

The importance of taxonomic research

The great Linnaeus has said "Science, and in the first place botany, is the only reliable basis of private as well as national economy." Many people would regard this statement as too sweeping; nevertheless taxonomic research is of vital importance to the agriculturist, the forester and other applied scientists, as well as all those who wish to assess and develop the natural resources of a country. Many people fail to realise the importance of giving plants their correct scientific names, so that their results can be understood in all countries regardless of the language used. Their research would often be of greater value if they took the trouble to ascertain the correct names of the plants they are working with, and, in the case of plants not widely known, would lodge authentic specimens at some recognized institution for reference purposes. Anthropologists and others frequently write of plants used by indigenous people as food and medicine and in magic, etc., and are content to give the vernacular names only, thus rendering their work nearly worthless for the botanist, chemist and others, who might well follow it up had they taken the trouble to collect specimens and get them properly identified. I have long felt that there is far too little active collaboration between the agriculturist and the botanist to their mutual disadvantage.

The knowledge of the correct names of plants is essential for the ecologist. I would like to see the collecting numbers of plants

quoted in ecological papers, so that future workers have access to the specimens of which authors have based their results. Some ecological studies have been carried out by the staff of the Singapore Botanic Gardens in the past and I would like to see this extended. I believe that ecological studies in the widest sense provide the only sound basis for the preparation of rational plans of land utilisation.

Botanists from their collections and research discover plants which are closely related to those in cultivation and thus can provide material of great value to the plant breeder. An Indian sugarcane breeder visited Singapore in 1956 and found in our herbarium one sheet of a variety of *Saccharum spontaneum*, which had been collected by Ridley in 1891 in a remote area of Pahang. Travelling by plane, car and boat he was able to obtain planting material of the variety and returned to Singapore within four days.

This section could be extended considerably. I hope I have said enough to convince the Philistines that the plant collecting and taxonomic research carried out by the staff of the botanic gardens has a wider application than is often realised.

HORTICULTURAL WORK

Exchange of Planting material

Most botanic gardens produce an annual *Index Seminum*, or seeds list, which they distribute to other botanic gardens for favour of exchange. As the number of species of which seed is available in Singapore varies but little from year to year, our list is produced at irregular intervals for distribution and is also available on request. We receive lists from all over the world, including most communist countries. In this way a free exchange of planting material is effected, thus enriching the living collection of plants in all countries. In 1955 the Singapore Botanic Gardens sent out 515 packets of seeds and 113 plants on an exchange basis and received 362 packets of seeds and 371 plants, including gifts. 368 packets of seeds and 87 plants were despatched in 1956, while 575 packets of seeds and 185 plants were received. Only a small proportion of the introductions may be really successful in Singapore; nevertheless, our collection of plants is being added to constantly and new plants of horticultural value are available for the country as a whole.

The immediate supply of seeds from the Singapore list cannot be guaranteed as many local seeds are viable for short periods only and stocks cannot be kept in good condition, while many species fruit at irregular or long intervals. Every effort is made to meet requests, however, and lists are kept of requirements and the seeds



Top—Formal Garden.
Lawn J

Below—Sun Rockery
and Director's Quarters
in background



are collected and despatched at the earliest opportunity as they become available. Our current list gives 864 species, some of which are grown in the Gardens, while others are collected in the natural vegetation on the island. Many of the larger seeds of short viability are sent out in damp powdered charcoal or damp coir dust. Germination begins during transit and we receive very favourable reports on palms and other seeds sent out in this way.

In addition to this normal exchange of seeds between botanical institutions, many requests are received for living plants, as well as spirit and fixed material, from specialists elsewhere. Wherever possible it is provided, except for unreasonable requests which would require a major expedition to fulfil or take up too much time. In all this exchange care is taken to see that only authentic material is sent out.

During the past few years a collection of over 400 species of cacti and other succulents has been built up. These grow surprisingly well in Singapore, provided they are sheltered from the rain and receive plenty of sun. They are grown in open-sided houses with glass roofs. Succulents are becoming very popular among local growers.

Members of the staff on collecting expeditions bring back local plants of horticultural value for trial in the Gardens, while friends and correspondents send in similar material. Living material is usually packed in polythene bags, in which it remains fresh for a considerable period. One of the most successful introductions in recent years has been the New Guinea Creeper (*Mucuna bennettii*), which produces hundreds of large spectacular trusses of brilliant flame-coloured flowers several times a year.

Although most of the work on economic plants has been taken over by the Agricultural and Forestry Departments, there is still a good collection in the Singapore Botanic Gardens and new ones of special interest, such as *Rauwolfia* spp., are introduced for trial.

Breeding of Orchids and Other Plants

The seasonless climate of Singapore, with an average annual rainfall of 105 inches per year, a mean temperate of about 80°F. with little diurnal change and a mean relative humidity of 82 per cent, makes it difficult to find plants which will flower regularly and provide colour in the Gardens. The aspect of the natural vegetation is varying shades of green and offers little in the way of good horticultural plants. Consequently, most of the garden plants grown in Singapore have originated in countries other than Malaya and where there are distinct cold or dry seasons. Under our conditions there is no special season of flowering or leaf-fall and individual

plants of the same species adjust themselves quite differently. Consequently, we never get the spectacular bursts of flowering of such trees as *Delonix regia* or *Jacaranda* as can be seen in India or East Africa.

One of the solutions to this problem is the breeding of new varieties of plants suited to local conditions and this work has been actively pursued at the Singapore Botanic Gardens for many years. Although hybridisation has been done in various groups such as *Bougainvillea*, *Cannas*, etc., by far the most attention has been devoted to orchids. This work was begun in 1929 and has produced very successful and spectacular results. The aim is two-fold, namely, to produce hybrids of horticultural merit and commercial worth and to investigate the relationship between the various groups of orchids. Malaya has some 800 species of indigenous orchids, but only a few of these are suitable for garden plants. By hybridising these, together with imported species from Burma, Java, the Moluccas, New Guinea and the Philippines, a very wide range of free-flowering and beautiful hybrids have and are being produced.

The principal genera used in crossing are: *Arachnis*, *Dendrobium*, *Renanthera*, *Spathoglottis* and *Vanda*. The first Singapore hybrid was *Vanda* Miss Joaquim raised in 1893, but the bulk of the hybrids now grown have been produced in the last 30 years and many of these since the war. Some 2,800 crosses have been made to date and every year new hybrids are coming into bloom. Local growers also make crosses and bring their seeds for raising at the Gardens, while a few have now mastered the technique and raise them themselves.

The seedlings are first grown in conical flasks under sterile conditions. The medium used in Singapore is agar-agar with Vacin's solution and 2 per cent sugar, at a pH of about 5.2. Full details of the method are given by Holtum (1953b). In 1956 experiments were begun using coconut milk (the water inside the mature nut) in the medium and this is giving a considerable stimulus to the early growth of the seedlings. The mature orchids are grown in the open or with slight shade, either in pots or in beds, depending on the type, and details of the cultivation can be found in Holtum (1953b) and Henderson and Addison (1956).

Mention can only be made of one or two of the hybrids raised in Singapore. A fuller account of the principal hybrids, except for the very recent ones, with photographs of a spray and individual flower of each hybrid, has recently been published in Henderson's and Addison's *Malayan Orchid Hybrids* (1956). *Vanda* Tan Chay

Yan, which first flowered in 1952, was awarded a First Class Certificate of the Royal Horticultural Society at the Chelsea Flower Show in 1954 and is considered to be one of the best *Vanda* hybrids bred anywhere in the world. *Arachnis* Maggie Oei, now one of the principal cut flowers in Singapore, flowers continuously, whereas its larger parent *A. flosaeris* flowers but twice a year. Among the inter-generic hybrids bred in Singapore are *Aranda* (*Arachnis* × *Vanda*), *Aranthera* (*Arachnis* × *Renanthera*) *Renantanda* (*Renanthera* × *Vanda*), while our first tri-generic hybrid flowered in 1956 and has been named *Ridleyara Fascad*, in honour of H. N. Ridley. Mr. Ridley was informed of this shortly before his death.

There are a large number of enthusiastic orchid growers in Singapore and the Federation and there is a considerable demand for plants and seedlings grown in the Gardens. The sale of cut orchids, both local and for export, is rapidly increasing. An experienced cytogeneticist is expected to visit Singapore shortly to work on problems of orchid hybridization.

Sale of Plants

Although the sale of plants is not an essential function of a botanic gardens, it is desirable in those countries where there are few nurseries. The Singapore Botanic Gardens sells plants daily, but limits the sales to those plants which are not readily available in the local nurseries. The revenue from the sale of plants in 1956 was \$27,245 (Straits), of which the major share came from the sale of 3,446 orchid plants and seedlings, while 26,092 other plants were also sold.

Advisory Work

The horticultural staff of the Singapore Botanic Gardens advise and assist various government departments in planning the lay-out and planting of roadsides, open spaces, school compounds, etc., and usually supply free material for this purpose. They also maintain close contact with the City Council Parks Department and many requests for advice are also received from private firms and individuals. Thus the Gardens play a large part in beautifying the city and island.

Men from the Rehabilitation Centre of the Labour Department are accepted for training as gardeners. The Director of the Singapore Botanic Gardens is the Imperial War Graves Commissioner's representative in Singapore and the staff of the Gardens take charge of the care and maintenance of the Kranji War Cemetery.

EDUCATIONAL WORK

General

The maintenance of a large, named and labelled collection of local and introduced plants attractively laid-out in the Botanic Gardens enables all visitors, who are interested, to increase their knowledge of plants. Parties of school children and students, both from Singapore and the Federation pay regular visits to the Gardens and occasionally parties are taken round by members of the staff. Special exhibits are arranged from time to time. One which proved popular with teachers and students was an exhibit of seven common plants which were changed weekly. The plants were labelled with their scientific, English and Malay names and family and brief notes were appended. Members of the staff are often requested to give lectures to local societies, a valuable method of educating the public in our work.

The staff of the Gardens co-operates fully with the staff of the University of Malaya's Department of Botany. The University is adjacent to the Gardens and so the latter are very handy for lecturers and students who wish to use them, while much material is provided for class work and research.

Singapore Gardening Society

The staff of the Singapore Botanic Gardens was largely responsible for the founding of the local Gardening Society, which at present has about 250 members. An active interest is taken in its work, as well as that of the Malayan Orchid Society. Some monthly meetings are held at the Gardens and emphasis is usually placed on practical demonstrations. A very successful annual flower show is held and the standard of blooms and plants exhibited is high. In these ways, the interest of local horticulturists is stimulated and the standard of gardening is raised.

PUBLICATIONS AND LIBRARY

It is very desirable that botanic gardens carrying out research should have their own journal for the publication of their results. Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891. The title was changed to the *Agricultural Bulletin of the Straits and Federated Malay States* in 1900 and it was then issued monthly. This journal was largely devoted to work on economic plants. Ridley published many taxonomic papers in the journal of the *Royal Asiatic Society, Straits Branch*, of which he was editor from 1889 to 1911, as well as being secretary of the Society. The title of the *Agricultural Bulletin* was changed in 1913 to the *Gardens' Bulletin, Straits Settlement* and in 1947 to the *Gardens'*

Vol. XVII. (1958).

Bulletin, Singapore. This is published at irregular intervals and an attempt is now made to produce a volume per year. It is largely devoted to papers on local taxonomy. It is distributed to the major botanical institutions in the world and exchange arrangements now exist with 160 scientific bodies. It can also be purchased direct from the Botanic Gardens, Singapore. In exchange we receive valuable periodicals and reprints, which are so essential for our work, and which we would not be able to purchase from our slender library vote. The *Annual Report* is also printed and distributed.

In addition to these and other publications already referred to in this article, the Gardens staff prepares from time to time more popular works which are of general interest to the amateur. Such a work is Henderson's *Malayan Wild Flowers* (1949-54) published by the Malayan Nature Society. A series of small illustrated pamphlets, each containing drawings and brief descriptions of ten *Malayan Garden Plants* are also produced. Popular horticultural articles are submitted regularly to the *Malayan Agri-Horticultural Journal* and the *Malayan Orchid Journal*. Names and descriptions of our new orchid hybrids are published in the latter.

Adequate library facilities are essential for the research workers at botanic gardens. The taxonomist must consult original publications for the names and descriptions of the plants on which he is working, and for this the older, as well as modern literature is required. The Singapore Botanic Gardens are particularly fortunate in that they have one of the finest collections of old botanical books in South-East Asia, many of which are of considerable value and rarity. In all, the library contains some 8,000 bound volumes, as well as many periodicals.

Since 1890 there has always been an artist on the Gardens' staff, who prepares drawings and paintings for the specialist staff. The paintings done by James and Charles de Alwis between 1890 and 1908 are of outstanding beauty and accuracy and are among the treasured possessions of the Singapore Botanic Gardens. Over the years a large and valuable collection of plant drawings and paintings has been built up.

NATURE RESERVES

I have already shown how Cantley and Ridley were responsible for gazetting and maintaining the first forest reserves in the Straits Settlement. These were later taken over by the Forest Department. The Singapore forest reserves reverted to the control of the Botanic Gardens in 1937 and have since been maintained as nature reserves. Under the *Nature Reserves Ordinance* of 1951, some 8,000

acres in Singapore were "set aside for the purpose of the propagation, protection and preservation of the indigenous fauna and flora of the Colony", as well as "providing, under suitable conditions and control, facilities for the study of and research into matters relating into the fauna and flora and the physical conditions in which they live". The reserves are administered by a statutory board of management of six nominated trustees, with the Director of the Botanic Gardens as *ex-officio* chairman. The day-to-day administration is carried out by the staff of the Singapore Botanic Gardens.

Inevitably, with the spread of the rapidly increasing population, plants and animals, which were known to have occurred in Singapore, have disappeared completely. Every effort is being made to preserve the remnants which are left for present and future generations to study and enjoy. Only a comparatively small area of the nature reserves consists of primary vegetation. The most important is undoubtedly the Bukit Timah Reserve covering 163 acres on the highest hill on the island. It has been a botanical collecting ground for more than a century, and it is the type locality of many Malayan plants. It consists of primary tropical evergreen rain forest, with many trees 50–70 m. high, and for the greater part it has not been cut over nor damaged. There are also important areas of mangrove on the south coast preserved as a nature reserve.

Thus the Botanic Gardens have guarded jealously this heritage of the people, which might so easily have been lost for ever.

THE FUTURE

And what of the future? Singapore is shortly to receive independence. Already the Government has embarked upon a programme of rapid Malayanisation of its staff, although it is not likely that this will be fully achieved at the Gardens as rapidly as in some other departments. A local man has returned from training as a horticulturist at the Royal Botanic Gardens, Kew, while botanists and others are to be sent overseas for further training and on their return will take over from the expatriate officers. Much will depend on these new recruits to maintain the Gardens and collections and to carry on the tradition of research which has been built up during the past hundred years. It is hoped that the scheme recently devised to attract research workers from Britain and elsewhere to Singapore to carry out botanical research in their specialised fields will be continued and extended.

The Gardens are financed entirely by the Singapore Government and now come under the Ministry of the Chief Secretary.* In the

* In 1959 the Gardens came under the newly formed Ministry of National Development.

1957 estimates a total of \$546,780 (=£63,791) is voted to the Gardens and this includes the votes for the upkeep of Government House Domain and the Nature Reserves. If they are to survive, it will be necessary to convince the politicians and the general public that the Gardens are fulfilling a worthwhile rôle, not only as a public park, but also that the research carried out is of value to the economy and prestige of Singapore. As Commelijn said in 1701 (de Wit, 1949) "It is certain, however, that this Science, like all Sciences, flourishes sometimes more and sometimes less, all in accord with the inclination of Rulers and the Favour of Government."

A recent distinguished visitor wrote in my visitor's book "The Singapore Botanic Gardens are unique. Civilisation would be the poorer if they were not maintained." In discussing the history of botanic gardens in the tropics, I have shown how many of them were neglected or abandoned and failed in their primary function, which is the scientific study of plants. New botanic gardens are being founded at some of the new tropical universities and university colleges, but it will take them many, many years to build up the type of collection of living and herbarium specimens which is now available in Singapore. It is my fervent hope that the Singapore Botanic Gardens may be fully maintained for many long years to come and to continue as a leading centre of tropical botany and a worthy memorial to Ridley and those other members of the staff who have helped to raise them to their present position.

I have shown how in these uncertain and unsettled days there still exists much goodwill and active co-operation between botanic gardens, wherever they may be situated. As Baas Beeking says in the Preface to *Flora Malesiana* "as long as sentiment, politics, greed and bigotry rule this world, a purely scientific endeavour may become a binding force between individual groups, and maybe, even between nations". If the aims and ideals which motivate the work of botanic gardens could be extended to certain other fields of human endeavour we could make this planet a better place on which to live.

ACKNOWLEDGEMENTS

In addition to the works quoted in the bibliography, reference has been made to all the published *Annual Reports* of the Botanic Gardens Department, Singapore from 1875 to the present day, as well as unpublished data in the files of the Department.

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Kew and Singapore

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*"The gift of a useful plant seems to me more precious than
the discovery of a gold-mine"*—BERNARDIN DE ST. PIERRE
(translated)*

IT IS A pleasing thing that the Botanic Gardens at Singapore and the Royal Botanic Gardens at Kew should be celebrating in the same year, the one honouring 100 years of existence on the present site, the other commemorating the 200th anniversary of its founding. As we congratulate each other on the happy occasion and wish each other well for the future, it is also fitting that we recall the close bonds which have been woven between Kew and Singapore during their common life. In order to understand how these bonds came to be fashioned, it may be helpful to retrace some part of the history of the gardens at Kew.

The Royal Garden of Princess Augusta

Two hundred years ago Kew House, situated near the River Thames 7 or 8 miles above Westminster, was the residence of Augusta, Princess of Wales and daughter-in-law of King George II. Here this German princess had been brought by her husband, the Prince of Wales, soon after their marriage, and here she continued to live after his early death. In 1759 she decided on making improvements to the place. She engaged a prominent architect, Sir William Chambers, to re-design the grounds, and employed a skilled gardener, William Aiton, to make a garden of exotic plants or botanic garden. Chambers laid out the grounds in the fashionable mode of the day, building a handsome Orangery, a Great Stove (the largest heated greenhouse then in existence), a Pagoda, and various Temples; and some of his buildings are features of the gardens still. Aiton was no less industrious, and, in seeking plants for the botanic garden, Princess Augusta was greatly helped by the third Earl of Bute, whose influence was exerted to secure plants from many distant lands. Soon the garden became famed throughout Europe for the unrivalled variety of its plants.

* From the inscription on a memorial erected in 1860 in the Botanic Gardens of Pamplémousses, Mauritius.

New Functions for the Royal Gardens

It may be noted that, at the start, no more was desired of the garden than that it should provide pleasure and interest to its royal owner and her friends. In 1772 when Princess Augusta died, the garden was taken over by her eldest son who, by this time, had succeeded to the throne as King George III, and he increased the area of the property by addition of adjoining lands. For guidance in the care of the garden the King sought the advice of Sir Joseph Banks, a man of outstanding ability and scientific knowledge, who was to exercise a directing influence on its activities over a period of many years. His view was that the royal garden should become a place where the plant-resources of the world would be studied and made known, and where men might be trained who would go abroad to seek and collect new plants. These proposals, being approved by the King, set the Gardens on a course which has been followed to the present day. There have been times when the policy wavered, and indeed a bad period followed the death of Banks and George III when the closure of the Botanic Gardens was under consideration. But this, causing an outcry from a number of people who appreciated their value, led in 1838 to the appointment of a Commission to advise on the future of Kew. This Commission not only recommended the continuance of Kew as a State institution, but urged a more vigorous direction of its activities, in particular the study of plants and their uses, and the supplying of useful plants to territories overseas. To make effective these recommendations the first Director, William Hooker, was appointed in 1841.

In the years since then under successive directors, the study of the world's plants has been the main task of Kew. Here in the course of years, has been built up an unrivalled collection of plants, some in living state in the gardens and glasshouses, but many more in dried state in the Herbarium, providing a rich store of material for study of the identification and affinities of plants, their distribution over the world's surface, and the uses to which they can be put. Amongst this collection the flora of Singapore and of the neighbouring territories is well represented, thanks to the efforts of past collectors, and as a result Kew is able to be of assistance in the compiling of the great *Flora Malesiana* now being undertaken.

Kew Collectors

But it is in Kew's other functions, the sending out of men trained in the knowledge and care of plants, and the supplying of plants of economic use, that the strong links between Kew and Singapore have been forged. As early as 1772 men trained at Kew were being

sent abroad, the first, Francis Masson, being appointed by Banks to go to South Africa there to travel and collect seeds and plants for Kew. Masson proved a diligent collector sending back to England many plants hitherto unknown, of which some have since become garden-favourites. He subsequently made expeditions in Europe, the West Indies, and Canada, with such good results that Banks was encouraged to send out others.

Such a one was David Nelson who went as botanist in 1776 on the third voyage which Captain Cook made to the South Seas, and collected plants at many places where the ship called. Returning safely from this voyage, he was then appointed to Captain Bligh's ship H.M.S. *Bounty* sailing for Tahiti. At this place breadfruit plants were to be taken on board and Nelson's job was to see that they were properly stowed and tended during their voyage to the West Indies. The story of that ill-fated voyage and its mutiny is well known. Loyal to his captain, Nelson shared the privations of the open boat during the long journey to Timor, only to die a few days after reaching this haven, commended by Captain Bligh for his "manly fortitude in our late disastrous circumstances."

To retrieve this disaster a second voyage was made by Captain Bligh in 1791. On this occasion two Kew men accompanied the expedition, which was completely successful in conveying a large supply of breadfruit trees to the West Indies where they were established without difficulty. One of these men, Christopher Smith, deserves mention here as being probably the first man trained at Kew to give his service, if not to Singapore, at least to Malaya. In 1794 Smith was appointed botanist of the Honourable East India Company at Calcutta and, three years later, he was sent to the Molucca Islands to collect plants. These islands were then the centre of the spice trade which had been held as a strict monopoly first by the Portuguese and latterly by the Dutch. In 1797, through fortunes of war, Britain had access to the spice islands and Christopher Smith's commission was to obtain planting-material of valuable spice-trees for growing in the East India Company's territory. In this he was extremely successful, obtaining no less than 70,000 nutmeg trees and 55,000 clove trees of which the bulk went to Penang whence someone was able to write "we are now become masters of every kind of spice plant valuable or uncommon." Smith himself went to Penang to supervise their cultivation and died there in 1806. Doubtless from some of his trees were descended the nutmegs and cloves introduced in 1819 into the Gardens of the Agri-Horticultural Society in Singapore, which provided a useful source of revenue to the Society for many years.

About this time, botanic gardens were being opened up in many British colonial possessions. The first were in West Indies, at St. Vincent in 1764 and Jamaica a few years later. Then came gardens of the East India Company, at Calcutta in 1786 and Madras soon after, the spice garden at Penang about 1800, and the garden of Peradeniya, Ceylon in 1821. These places looked to Kew to provide men trained in horticulture, and Kew men soon filled a majority of posts in the colonial gardens and were responsible for starting horticultural work in many new territories. These men commonly remained in touch with Kew and there was often a frequent exchange of plants, Kew sending out plants of economic or ornamental value for the new gardens and receiving in return specimens of the indigenous vegetation.

Kew Men in Singapore

Singapore was added to the botanic gardens served by men of Kew in 1875, when the Director of Kew was asked to supply a practised botanist for the post of Superintendent. He chose Henry James Murton, a young man for the job, but a skilled and keen horticulturist. The Gardens at Singapore up to this time had served chiefly as a pleasure-park, and Murton deserves recognition for altering its character, for improving the collection of plants, seeing to their naming, and making trials of new economic plants. This work was continued from 1880 by another Kew man, Nathaniel Cantley, a great believer in system and orderliness, whose notable contribution to the Gardens was cut short by his early death. Both these men had the assistance of a third trained at Kew, Walter Fox, whose service in Singapore and Penang extended over 31 years. These three did much to set the Botanic Gardens on the right lines and prepare for the progressive development which followed under H. N. Ridley and his successors. In more recent times men trained at Kew have continued to be appointed to Singapore and, amongst them, we would pay tribute to a splendid horticulturist J. C. Nauen, whose service to his fellows and gallant death as a prisoner-of-war are remembered at Kew, as doubtless at Singapore.

It must not be suggested, however, that movement between Kew and Singapore has been all one way, for it was to the vicinity of Kew that Ridley came on retiring from Service in Singapore and, so long as he remained in active health, he visited the Gardens at Kew almost daily. Another former Director from Singapore, R. E. Holttum, is also a neighbour at Kew, and both I. H. Burkill and E. J. H. Corner are sufficiently near to be occasional and welcome visitors. It is a happy occurrence that in this year of celebration the Kew Guild, the association of present and past members of the

Kew Staff should have as its President F. Flippance, a Kew man whose long experience in the East has included service in the Singapore Botanic Gardens. Moreover at Kew we have been glad to welcome as student-gardeners young men from the Gardens at Singapore who, after a period of training at Kew, return east with a widened knowledge of plants and of horticultural skill. These too, it may be hoped, will help to strengthen the bonds between the two Gardens.

New Plants for the East

For these are the strong links between Kew and Singapore, the men such as have been mentioned whose skill and loyal service have been shared by both places. Nor must we forget the plants distributed from Kew which have formed so useful a link with other gardens.

Reference has been made to co-operation between the Honourable East India Company and the Royal Botanic Gardens, and this had as one of its most productive results the introduction of quinine into the Far East. A century ago, while the effectiveness of quinine against malaria was well known, the drug itself was scarce and not generally available, since the only source was the wild growth of *Cinchona* trees in the Andes. An expedition to South America in 1860 was successful in obtaining seed of several species, and the seedlings, raised at Kew, were sent to India, Ceylon, and other places. In India particularly the plants were readily established and plantations were made on a large scale with the result that quinine was soon obtainable throughout the East at low cost. The influence this introduction had on general health and well-being can hardly be estimated.

So encouraging was the outcome of this venture that it was followed by a second, an expedition to Brazil to collect seed of the Para rubber-tree. A supply of seed was sent to Kew in 1876 and gave rise to seedlings which, as soon as they were large enough, were distributed to countries where it was thought they might suitably be grown. A case of these plants sent to Singapore in 1877 came into the hands of H. J. Murton, and 12 plants survived to be planted in the Gardens at Singapore and 9 at Kuala Kangsar in Perak. From these plants, and others which came subsequently from Ceylon, was built up the great rubber industry of Malaya, which brought a new commodity into every civilised home and made possible a new era in road-transport.

It may seem idle to conjecture what the history of Singapore would have been if *Hevea* had not arrived when it did, if the threatened closure of Kew in 1838 had in fact taken place, if the

Gardens at Singapore had not been in running order with a Murton and a Ridley to take charge. Such thoughts are not altogether vain if they bring home to us what great service these botanic gardens have rendered through the exchange and development of useful plants. Nor must this be regarded as their only, or even their chief, function, which, as has been shown, is the study of plants and plant-resources in its widest sense.

Botanic gardens have not been without their critics, who, at different times and places, have pointed out how much money is spent and how little comes back as revenue, urging that they be closed or their activities trimmed in the interest of economy. Looking back 100 years, and 200 years, we can clearly see how time has fully justified the men of vision, men like Banks, the Hookers, and Ridley, whose faith in botanic gardens led them, not to close them down, but to develop and shape them to serve the community to best effect. Having viewed the splendid record of the past, we can look to the future of these Gardens with confidence, believing that the skill and devoted service, which have already achieved so much, may have no less a contribution to make in years to come.

Singapore and Flora Malesiana

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IN MY TRIBUTE to the healthy centenarian, the Singapore Botanic Gardens, I feel that the intimate relation which has grown in the past years between the Singapore Botanic Gardens and the *Flora Malesiana* requires an introduction and an explanation. Many of the Singapore citizens will know this work only by name but not by personal experience.

Let me first explain this *Flora Malesiana*. It intends to be a modern critical inventory of the native, introduced, and major cultivated plants of the entire Malaysian region. This is the whole archipelago between the Asiatic and Australian continents including also Singapore and the Malay Peninsula up to about the isthmus of Kra where the flora rather abruptly changes into that of continental South-East Asia. It wants to give critical data on the ecology and distribution of all the plants, of the altitude at which they occur, the soils which they can stand or prefer, the climates which they tolerate, their mode and period of flowering and fruiting, the manner in which they are pollinated, the mode of dispersal and germination of their seeds, etc.

The knowledge to be accumulated must be carefully collected by qualified, scientific botanical specialists and we are happy to put on record that many prominent persons all over the world have been persuaded to add to the effort. Malaysia is botanically one of the richest countries of the tropics, it can boast of probably not far from 25,000 different species of flowering plants in all, from the tiny herbaceous up to the colossal tualang and the majestic jelutong, unique creations of tropical nature beside which man feels his smallness.

The exact knowledge of this vegetable wealth has grown slowly and gradually, in former times largely from curiosity of disinterested scientists, local and overseas, but it appears more and more in modern time that this knowledge is intimately connected with far-going aspects of human welfare, land-use, economy, and industry. The fast-growing world population, with its increasing needs and its stupendously developing techniques, is steadily asking more information about the three kingdoms of nature, the earth, the animals, and the plants. Among these kingdoms the

plants play an enormous role by their bulk and by the easy way in which man can manage them. But before man can use them efficiently he must know their identity, their name. The critical name of a plant species is the alpha of botanical knowledge, it is the key to our knowledge of it. And that is what we intend to accomplish with the *Flora Malesiana*. Following this trend of thought it will also be clear that, though elaborated by disinterested research, the *Flora Malesiana* is automatically becoming a most useful tool for humanity in the East.

How is it then, the readers will ask: have we not already a Flora of Malaya? This is admittedly true, there are even three with a start of a fourth. The flora of Malaya was in the past century incorporated in the *Flora of British India*. Shortly afterwards it was the subject of the excellent work by King & Gamble, *Materials towards a Flora of the Malay Peninsula*, and finally there is the more recent *Flora of the Malay Peninsula* by Ridley.

The first two treatments are good but more than half a century old and naturally very incomplete. The third one unfortunately does not come up to the required standard of accuracy. All of them suffer from two inadequacies, viz the lack of correlation with plants described from other parts of Malaysia and the lack of general data, on uses, distribution, and ecology of the species. The second desideratum was to be filled in the *Revised* (fourth) *Flora of Malaya* initiated a few years ago of which two volumes were issued, viz on the orchids and ferns, by Professor R. E. Holttum. Admirable as these volumes are, there is still the lack of correlation notwithstanding their author's speciality on these two groups.

A large plant geographical study has revealed that Malaya, Sumatra, Borneo, the Philippines, Java, the Moluccas, and New Guinea form for plants one unbreakable whole. Plants do not keep to political boundaries, they have a distribution of their own and attained their area through the geological ages of the past. This means that for an adequate knowledge of their identity they should be pursued throughout that area.

We should strive then first towards a general Flora of the entire Malaysian province, as Nature made it, before giving an account of a politically defined part of it, a so-called local Flora.

A few days ago I was struck again by the truth of this basic principle, in trying to arrange the species of a rather important timber genus *Camposperma*, těrěntang or sěrěntang as it is known by its vernacular name; it is common in the lowland and swamp forests of Malaya. Mr. Corner, who in 1939 made a study of it on the basis of material from Malaya only, concluded that there was an undescribed new species, těrěntang jantan of Johore, which

he called *Campnosperma minor* and which would be unique to Malaya. But revising the genus over the whole of Malaysia a few weeks ago, it appeared to two of us that this same new species had already been described from the swamp forest of Borneo, under the name *Campnosperma squamata* by Ridley in 1933, but occurred also in the Moluccas and New Guinea and from there had been described still earlier as *Campnosperma montana* by Lauterbach in 1920. The latter is obviously the oldest and correct name for it. Once that is known we can properly proceed to judge its ecology and uses over its entire range and we know where we are.

This example is no exception, unfortunately it is the rule as soon as groups are revised regionally. The background of this rule is the fact that in the past the study of the flora of the Malaysian region has been approached by local work, in Malaya, in Java and other parts of Indonesia, in the Philippines, in West New Guinea, and in Papua, instead of by regional attempts covering the entire archipelago. This serious lack of correlation we try to remedy by the Flora Malesiana attempt, from which all separate states and territories will have the same benefit. In this whole, Malaya, with its very rich flora, forms an essential integral part.

The senior leaders of Malayan botany, who were or are directors or staff members of the Singapore Botanic Gardens, have in the past decade realized the scientific necessity to give priority to a regional flora over a local flora, large as it may be, and Flora Malesiana is happy to have their authoritative collaboration. Mr. Burkill Sr., the author of the standard work on the *Economic Products of the Malay Peninsula*, revised the yam family (Dioscoreaceae), Mr. Corner is doing the colossal job of tackling the fig family (Moraceae), Mr. Sinclair revised the nutmeg family (Myristicaceae) and intends later to work on the kenanga family (Annonaceae). Mr. Furtado has also, in his studies on aroids and palms, felt the need to step far beyond the borders of Malaya. Last not least, Prof. Holtum is organising the Pteridophytes, a lofty attempt; it will take him at least ten years to come to achieve this, his final magnum opus.

One might query: but what is the use for Malaya to know all about the floras of the other islands, even as far as Papua? This question has already partly been answered by the example of *Campnosperma* given above. It is curious and possibly of interest to Malayan readers to know that the closest relative of the genus *Hevea*, to which the pararubber tree belongs, is a tree native in Papua, *Annesijoa novoguineensis*. In wider scope this question is part of the general issue: what is the potential use of plants?

Frankly, no botanist is capable to say which plant can be of what special service to man and which not. It is certainly not determined by size: most humble annual plants like flax have shown their importance whilst woody giants are sometimes of hardly more value than as firewood. Use depends on the needs of man and that varies with place and time. The tuba plant (*Derris*) was until the twenties only locally used as a fish-poison until it appeared that this fish-poison contained a powerful insecticide harmless to man. Then it became at once an industrial plant from which money could be made. Nowadays interest in the plant has waned as during the war other, artificial insecticides have superseded it. When in the thirties it appeared necessary to have pararubber latex shipped in bulk, without coagulating the milk, the tuber of a fetid aroid containing a special kind of starch which could do that trick, but to which no use had ever been ascribed, came into great demand.

Some other Malaysian plants have never reached the industrial phase, possibly because they have never been given a trial, such as the bark-cloth yielding figs and champedaks. Nothing is yet known about possible industrial qualities of these fibres.

Timber and wood-pulp are naturally of basic value, but it is not certain that Malayan trees used for that purpose are the most economical that grow on Malayan soils; possibly the Papuan eucalypt (*Eucalyptus deglupta*), a rain-forest species, is superior.

Useful plants for specialized purposes, specially for medicinal use, are still hidden among the native flora, sometimes even in Malaya itself and the vivid interest in *Strophanthus*, *Rauwolfia*, *Kopsia*, and other alkaloid-containing plants are contemporary examples. But the phytochemist cannot work with anonymous material: he must know the exact name of the plant which he is analyzing, under what conditions it can grow, and where it occurs. That information he will ultimately find compiled in the *Flora Malesiana*.

This seems enough to demonstrate to non-botanists the value of that scientific basis for applied work in botany: *Flora Malesiana*.

I have alluded to above to the heart-warming fact that all former and recent systematists of the Singapore Botanic Gardens participate in this great work and that through the farsighted policy of its director, Mr. H. M. Burkill, it figures on the official programme of the Gardens. It is evident that for its completion we will need at least another twenty-five or even more years, depending on money and manpower of specialists. Though in the past ten years three thick volumes have appeared the major part of the work still remains to be done and our sincere hope is that not only retired

officers of the Singapore Botanic Gardens will collaborate in an honorary function, but that the number of active staff members will be increased for this purpose and brought at least to pre-war strength.

The eastern tropics have always been much better provided with botanic gardens than Africa and South America. Unfortunately the Calcutta Gardens, the oldest, have since long lost their standing as a scientific botanical research centre and the same can be said of Peradeniya. In the past few years the Bogor Botanic Gardens have almost been deprived of scientific personnel and no qualified systematist is any longer on the staff of the Herbarium, to the great regret of its director. The Singapore Gardens suffer in less degree from the same evil of having several vacant posts. I trust that this situation will be improved in the near future, as whatever high qualification can be given to a Garden in the way of collections of living plants, herbarium, buildings, space, and library, its scientific activity which is decisive for its importance depends on the quality and size of the scientific staff; first brains, then books, then bricks.

It is this scientific activity which is of the highest importance in the world of today, and upon which progress depends more than ever.

With the occasion of a centenary one is apt to look backward; there we see a dignified growth of an outstanding botanical centre in the East; gradually as a matter of fact, but all good things grow slowly.

But we have also to look forward, in the future. There we see a vista of intensified and extended scientific research to be achieved for future generations, for their education and welfare, for adequate use of the land, appropriate utilization of plants and their products, made possible by critical knowledge and study of them.

The *Flora Malesiana* is a useful tool towards that aim intended for the future generations of the eastern peoples. The sooner it will be completed and be available the more profit it will yield. I trust that the Administration, convinced of this profit, will find ways and means to increase Singapore's contributions towards this goal and be proud of it.

A tale of two cities: Singapore and Leiden

By H. J. LAM

*Director, Rijksherbarium, Leiden and
Professor of Systematic Botany of the Government University*

I FEEL BOTH pleased and honoured to find myself amongst those who were invited to contribute towards the Centenary number of this Bulletin, because "Singapore" (meaning the Botanic Garden) is one of the important centres of botanical research in insular Asia. There is, and was, a marked parallel relationship in that Singapore was, in a way, an affiliation of Kew and Bogor of Leiden. In addition, there were close bonds between Singapore and Bogor in the Far East and between Kew and Leiden in Europe.

When speaking of these four places it must be stated that the relationships between them were, in more recent times, principally maintained by the respective herbaria, all of which are younger than the botanical gardens they belong to or are connected with. And since the present commemoration actually deals with the garden it may be stated first that in this respect Leiden is the senior institution, since its botanical garden was created shortly after the establishment of the University (1575), viz. in 1587. Followed Kew in 1759 (as a Royal Garden; 1841 as National Gardens), Bogor (Buitenzorg) in 1817, and Singapore in 1859.

From times immemorial botanical gardens were institutions with a prevaillingly practical aim, viz. the study of medicinal plants. As far as means of conveyance permitted there was an ever increasing exchange of material and many gardens organised collecting trips in order to augment their assortment. In this way a great number of useful plants, medicinal and otherwise, became known or better known and in the nineteenth century quite a number of large tropical crops owed their origin and extension to being first studied in botanic gardens, e.g. pararubber (*Hevea*), quinquina (*Cinchona*), coffee (*Coffea*), tea (*Thea*) and numerous others.

In later years when experimental gardens and stations were created, the original aims of botanical gardens gradually shifted to these specialised institutions, and while the study of the flora was transmitted to the herbaria which naturally grew out of collections of dried specimens of the local flora in and around the gardens proper, the latter more and more served as open air (and hothouse) museums of the wealth of plant forms with both decorative and

RIJKSHERBARIUM
LEIDEN



General herbarium to left of entrance and working rooms to right



The Dutch Herbarium and Cryptogamic Herbarium
An annexe to the General Herbarium

scientific purposes; decorative so as to indulge in the growing demand of recreation by town-dwelling people and their natural craving to admire the wonders of plant life; scientific so as to meet the increasing necessity of developing sciences such as plant physiology, biochemistry, experimental taxonomy, and the like.

As a matter of course the aims and purposes of the temperate gardens and tropical ones soon diverged. The first-named ones, *in casu* Kew and Leiden, grew next to indigens such plants from as many different vegetational and floristic areas as they could lay hands on, and various artificial habitats were created for these according to their ecological preferences and exigencies. The tropical gardens, i.e. Singapore and Bogor, naturally showed first of all a display of the surrounding vegetational riches and furthermore strove for the cultivation of tropical plants other than their own.

In the meantime, as we said, herbaria came into operation. Old collections of dry plant specimens, some of these as old or even older than the garden whose property they were or became, were assembled and arranged. Much new material was added, more and more intentionally and methodically, as collectors or expeditions were sent out, and gradually a worldwide system of exchange of duplicates as well as of borrowing and lending on behalf of monographic work was brought about.

Whereas thus a wealth of information was obtained, catalogued, and systematically published, it soon appeared that the floras of all countries and particularly those of tropical areas whose study had been tackled at a much later date than that of temperate ones, was unbelievably richer in every respect than had been long anticipated. It is now recognized that our knowledge of the more intimate details of the vegetable kingdom is still in its infancy. Again the temperate situation differs from the tropical one. In temperate countries the higher plants are generally fairly well known specifically although much work has still to be done on variability, specific and infra-specific limits, and nomenclature. The study of lower plants (Thallophyta), however, which started little over one hundred years ago when the microscope got its first modern construction, is now well under way and shows an unexpected and bewildering wealth of forms and products, particularly in the fungi.

The tropical countries are, also in this respect, still very much "underdeveloped". The causes of this are not only that western science started its investigation there at a relatively late date, but that their flora appeared to be infinitely more diversified than that of e.g. N.W. Europe (which, among its temperate sisters, is particularly poor as a consequence of the comparatively recent glacial periods). It has taken some considerable time to arrive at the

recognition that on studying life phenomena, biologists should have started in the tropics with their optimal environmental conditions rather than in any temperate climate. Unfortunately at the time when western science consciously penetrated in those areas, the basis of many sciences and their terminology had already been laid and this has been the cause of the fact that all too long tropical life has been considered a special case of temperate phenomena, instead of the reverse.

Today, our knowledge of tropical plants is still scanty. That of higher plants, though tolerably good in and near cultural centres such as in S. Malaya, W. Java, and S. Luzon, is very much inadequate regarding such large areas as central Borneo, New Guinea and a number of remote smaller islands. Practically every explorer in those parts collects numerous unknown species and is even likely to discover new genera.

As to the lower plants such as fungi and algae (including kelps), our knowledge is entirely haphazard and we still have to find our way in this enormous *terra incognita*. Everybody knows how much the life of tropical peoples depends on their surrounding plant world. But even though their very intimate daily contact with that plant world is the outcome of an association of tens of thousands of years, it should not be believed that nothing in it can be improved and that nothing is to be added. On the contrary. Already science has revealed many useful particulars of plants so far unrecognized. A striking example is that of the unpretentious shrub *Rauwolfia*, practically unknown only a few years ago, now of extensive fame as a producer of a very effective remedy against high blood pressure. Numerous other plants containing substances which are surmised to be of potential value to men are still unknown phytochemically, numerous others doubtless are still to be discovered and native plantlore may serve as a guide where to look for them.

But also among the lower plants untold riches and possibilities are undoubtedly stored away. Already certain fungi play a very important part in native food stuffs but our knowledge of their processes is extremely scanty and many of them are waiting to be accurately investigated, cultivated, hybridized and segregated in order to give them their optimal efficiency.

For all this the botanic garden, its affiliations and its incorporated institutes, including the herbaria, are there to serve as an indispensable tool and medium to be used for the benefit of the people.

At present, the relationships between the four botanic gardens is rather more platonic than practical, though I do not underrate the value of occasional exchanges. But the emphasis of the co-operation clearly lies on the work of the herbaria. Of these again

Leiden is leading as far as the date of origin is concerned. The Rijksherbarium as it is called—or national herbarium—was founded in 1829 in Brussels and it was moved to Leiden in 1830. Kew, now by far the largest herbarium in the world, followed in 1841, Bogor in 1844 (the date of 1817 mentioned in *Index Herbariorum* is that of the garden, not of the herbarium), and Singapore in 1875. Naturally Kew got the best opportunity for a rapid extension of its collections from all over the British Empire. The Dutch national herbarium in its modern form was based on the extensive collection made by BLUME and some others in western Java after the Dutch had retaken supremacy from the British interregnum in Napoleonic times. To these some older garden collections were added, some even older than the university.

During the whole of the nineteenth century numerous collections were added from the Malay Archipelago as well as from many other parts of the world, notably the West Indies. Around the secular turn the study of the West Indian flora was taken over by the Utrecht School, founded by PULLE, but the Rijksherbarium received more and more acquisitions from the Malaysian area, as a consequence of a very close co-operation between Buitenzorg (now Bogor) and Leiden. Bogor has grown to be a very important tropical herbarium and it must be stated with great satisfaction that in spite of unfortunate political misunderstandings the mutual institutional and personal relations with Leiden have remained excellent, thanks to our colleagues KUSNOTO and DILMY.

After the second world war the Rijksherbarium has again increased rapidly. Next to Bogor it is the recognized world centre for the study of the Malaysian flora, particularly important because of the great many types, especially older ones. In addition, after Berlin had lost its leading position regarding the flora of New Guinea, Leiden has taken over here, and a new scientific co-operation has arisen between Lae, Canberra and Leiden. The total average yearly acquisitions now amount to some 40,000 specimens.

The activity of the Leiden herbarium has greatly increased as the staff grew to the present number of 17 full-time botanists and 6 honorary fellows. Of the former 8 devote their time to the study of the Malaysian flora and 4 of them, now still in the service of the Flora Malesiana Foundation of which VAN STEENIS gives an account elsewhere in this Bulletin, will possibly be taken over gradually by the Rijksherbarium now that the Bogor staff, temporarily I trust, has been curtailed in a most lamentable way.

Naturally the co-operation between the two tropical and the two temperate institutions has been mutual. Either party would be greatly hampered in its activities without the assistance of the other.

The older collections and types are preserved and best represented in Europe, more recent ones in the tropics, though duplicates have been liberally ceded. The indispensable literature is generally more copiously available in Europe (though Bogor can boast of a remarkably rich library). Living specimens, on the other hand, can only be studied in the tropics and the same is true for all characters which lose their value on the plants being dried.

As has been stated above Singapore has ever maintained a similar bond with Kew as that which exists between Bogor and Leiden. Yet the direct relationship between Singapore and Leiden has by no means been negligible. The exchange of duplicates from 1948 (inclusive) to May 1959 amounts to 2,600 from Leiden and 6,700 from Singapore, material on loan in the same period to 1,300 from Leiden and 21,000 from Singapore. These figures are significant: on the one hand they show the main source of the material, and on the other the place where it is mainly investigated.

Thus, the Singapore Gardens and their valuable herbarium represent a rich source of important information and the Rijksherbarium is proud to be allowed to co-operate with its staff. We on our side participate in this work out of pure scientific interest in the overwhelmingly rich tropical flora and vegetation with its countless and inexhaustible scientific problems. Our tropical friends on the other end of the line, who daily enjoy the inspiring neighbourhood of their flora, know that ultimately they work to the profit of their country. To both parties co-operation is a living necessity, for better and for worse.

On offering the Singapore Gardens our hearty congratulations on their first centenary, I venture to express the hope that our co-operation will hold, nay, be intensified for many years to come, to the benefit of science and the welfare and happiness of the human race.

A Note on the Gardens' Jungle

By I. H. BURKILL

Director, Botanic Gardens, 1912-25

THIS IS AN INCIDENT of 35 years ago at which time search was being made for a site that could be used for the proposed University buildings in Singapore, and the Economic Garden has been mentioned. On one afternoon I met in the Economic Garden a friend from Johore who was taking the opportunity of a visit to Singapore to form an independent opinion. So we walked round the Economic Garden together and discussed the subject. It was not difficult to agree that the site, having become surrounded by houses was now a town site with a value greater than that to which it was put as a nursery. But when we returned to the Botanic Garden he dropped a remark which was astounding,—pointing to the Gardens' jungle he recommended that it should be used for houses. It was useless, I found, to point to the beauty of the trees: he could not see it. He grudgingly consented that these as trees added certain species to the display in the Gardens; but could they not be seen in plenty in the forests of the Peninsula? It was quite beyond him to think of one tree helping another to live; are they not competitors; he claimed. At this I gave up my pleading.

Those beautiful trees, mainly of three species of *Shorea*, when they were but seedlings grew in the shade of others and as they surmounted the ground-vegetation of their habitat gradually fitted themselves for drier air and stronger light. Now they are the means of preventing the death of various tender companions and more than that they are the front line in the preservation of the humidity not only of the soil under them, but of the air necessary for the healthy growth of the palms in the Palm Valley.

The Dell at the head of the Gardens' Lake furnishes another illustration of interaction between different items of maintenance within the Gardens' boundaries; or the humidity maintained by the Lake makes the display of the Dell possible.

Any interference with either source of humidity could do more damage than the man in the street can realize.

The Singapore Botanic Gardens and Forestry in Malaya

By J. WYATT-SMITH

Forest Department, Federation of Malaya

ALTHOUGH Singapore and the Federation of Malaya are today two separate countries, and the Singapore Botanic Gardens and the Malayan Forest Department two entirely separate organisations, it is, perhaps, not realised except by a few that the first forest department in Malaya was that of the Straits Settlements and that it was formed in 1883 under Cantley, the then Superintendent of the Botanic Gardens, Singapore. It remained under the Botanic Gardens until 1901 when the administration of forests was handed over to the Land office. It may also not be realised by many that it is mainly due to Ridley who became Director of the Botanic Gardens and Forests in 1888 that Malaya owes the survival of many of the existing forests in Malacca, Penang, and the Dindings.

During this period the forests of Negri Sembilan, Pahang, Perak, and Selangor, the former Federated Malay States, were under the charge of the Land Officers, but in 1895 a full-time Forest Officer was appointed in Perak. Forestry in Malaya owes another debt to the Singapore Botanic Gardens when a year later Ridley, in a report on the forests of Selangor, recommended the establishment of a properly organised forest department under a forestry trained officer for the four Federated Malay States. This was unfortunately not acted on, though special officers were appointed for Selangor and Negri Sembilan. Four years later in 1900 Hill of the Indian Forest Service was commissioned to advise on the forest administration of the Straits Settlements and Federated Malay States, and a year later Burn-Murdoch was transferred from Burma to form a department.

One of the early duties of any forest department is to obtain a census of the forest resources available both in existing forest reserves and on State Land, a census not only of the species that occur, but of their distribution, frequency, size class distribution, and subsequently of their ecological characteristics. Such a census or stock taking is, however, of very reduced value if the identity of the material is not known and if it is uncertain whether any material collected is composed of many or a single species. Plant collecting and the setting up of a small forest herbarium are therefore logical developments, and in 1918 F. W. Foxworthy, a botanist

and wood technologist of international repute who had spent many years' service in the Philippines, was engaged as Forest Research Officer. Determinations were naturally, however, still largely sought from botanists working in the established herbaria of the world that were concerned with plants of this region, and particularly those at Kew and Singapore. The establishment of the Forest Research Institute at Kepong in 1929 with increased research staff saw the growth of the departmental herbarium with particular attention being paid botanically to this region's important timber family, the *Dipterocarpaceae*. The Institute, however, was still dependent on other herbaria and particularly Singapore for assistance with determinations; and, in the case of Singapore, which is near at hand, for reference to their excellent library. It is frequently not realised by the layman how important these old works are to taxonomists and also how important it is to have easy access to type sheets or authentic material. Adequate collections and distribution of duplicate material to many of the well-known general herbaria in the world and to those specialising on the flora of the area are undoubtedly the means of overcoming this, as is readily done today. But there is no such solution for old plant collections nor for many of the old books or journals published which, even if they do appear periodically on the market, are usually so expensive that they are completely beyond the means of any new herbarium. It might almost be stated that existing and long established herbaria such as the Botanic Gardens Singapore, in view of their old collections and their libraries, have an obligation to the scientific world and particularly to their region to maintain their activities, since no newly formed institution can ever hope to obtain the same essential foundations. And this obligation, we are pleased to say, is fully accepted and met by the Singapore Gardens.

The herbarium at the Forest Research Institute has naturally specialised in woody species and is really no more than a reference herbarium for the Forest Department. Up to World War II interest was focussed particularly on the dipterocarps, and a collection has been built up, mainly through the efforts of Symington, which apart from early material and types is possibly the best in the region. Since World War II the emphasis has been on the other important timber producing families and on many of the smaller woody plants, the latter being required in connection with ecological studies of rain forest. Many of the final determinations and all the preliminary determinations are being done at the Institute, but continued reference is still made to the herbarium and assistance required from the qualified staff of the Singapore Botanic Gardens. It is certainly not

envisaged that the Forest Research Institute with its present botanical facilities can ever dispense with the resources of the Botanic Gardens, Singapore, and it is earnestly hoped that it will be found possible to maintain the herbarium, library, and staff of the Gardens at the highest level for the next hundred years as has been so well done during the past century.

Apart from the early guidance in direct administration of the forests of the former Straits Settlements, the subsequent assistance with determinations and permission to use the library and herbarium, the Forest Department has also benefitted in the extreme interest shown by these early and subsequent botanists in the local flora and the large number of publications concerning trees and forest produce that they have published. Works that immediately spring to mind and with which all Malayan forest officers are acquainted are Ridley's *Flora of the Malay Peninsula* which was based on King and Gamble's *Materials for a Flora of the Malay Peninsula*; Burkill's *Dictionary of the Economic Products of the Malay Peninsula*; Corner's *Wayside Trees of Malaya*; Holtum's works on orchids and on ferns which form Volumes I and II of the new *Flora of Malaya*; many articles in the *Gardens' Bulletin* including Holtum's works on bamboos and gingers, Furtado's work on the rattans and canes, Sinclair's on the two tree families *Annonaceae* and *Myristicaceae*, Henderson's on the important timber genera *Calophyllum* and *Eugenia*; and Henderson's *Malayan Wild Flowers* published by the Malayan Nature Society. In addition numerous vegetational papers by members of the Botanic Gardens' staff have appeared in such Journals as that of the Royal Asiatic Society and the Federated Malay States Museum, papers which are of great interest and value to forest officers. We may mention here that the traffic has not been all one way, for Departmental botanists, particularly Symington in connection with dipterocarps, have contributed to the Bulletin of the Singapore Gardens. And some of the series of *Malayan Forest Records* are valuable items in the botanical literature of Malaya.

The Singapore Botanic Gardens and Rubber in Malaya

By P. R. WYCHERLEY

*Botanical Division
Rubber Research Institute of Malaya*

NATURAL RUBBER PRODUCTION in Malaya and other tropical Asian countries depends upon the cultivation of *Hevea brasiliensis*. This tree was introduced into the East and its exploitation developed through the agency of various botanical institutions and, as will be shown below, the part played by staff of the Singapore Botanic Gardens has proved exceptionally important.

The changing fortunes of the rubber producing industry have reflected the trends of world economic history during the first half of the twentieth century. Although during times of trade depression the plantation industry has done little more than provide a survival existence for its many employees, on balance natural rubber production has made one of the greatest contributions to prosperity in Malaya. This has been achieved in the first place by the attraction of capital and latterly because the industry has become the largest single source of employment and revenue in the Federation of Malaya. At present rubber plantation employees number over a quarter of million and it is estimated that nearly 400,000 smallholders are supported wholly or partly by rubber cultivation. Direct taxation of rubber exports has provided about 15 per cent of the total Federal revenue during the last five years. This figure was swelled by taxes on company profits and by other less direct means.

This enterprise, which has given a livelihood to a large section of the population representative of all races in Malaya and provided wealth for the country's development, owes its origin mainly to the Singapore Botanic Gardens.

The Introduction of *Hevea* to the East and Establishment in Malaya

The distribution of potential crop plants to enhance the utilisation of natural resources was a conspicuous feature of the work of the Royal Botanic Gardens, Kew, and its daughter institutes while Joseph Hooker was Director. He was knighted in 1877 and in 1897 honoured for his editorship of the Flora of British India.

Mr. James Collins had reviewed the rubber producing species of plants at the request of Sir Clements Markham of the India Office, the latter recommended the collection of *Hevea* from Brazil and its despatch to oriental territories, and Hooker implemented this recommendation.

Although several attempts were made under Hooker's guidance or by the India Office, only one—the famous Wickham collection—succeeded. The others failed either because the seed did not germinate or owing to the selection of unfavourable reception sites such as Calcutta and Sikkim where the plants died.

The success of the Wickham collection owed much to the expeditious handling of the material. Joseph Hooker commissioned Mr. H. A. Wickham (later Sir Henry) to collect seed, which he did in the area between the Tapajos and Madeira rivers of the Central Amazon basin. Wickham chartered a cargoless ship to rush his 70,000 seeds to England. At the expense of digression from the main theme the charge against Wickham of smuggling should be refuted here. Although he may have disbursed hospitality to speed official clearance of his perishable cargo, there is no evidence that he resorted to corrupt evasion of the law; in fact the shipment of seeds of *Hevea* from Brazil was not prohibited at that time and an official statement—*Borracha no Brasil*, Rio de Janeiro, 1913—reported that Wickham's and other exports were made with the goodwill and co-operation of the Brazilian government.

The seed reached Kew on 14th June, 1876 and Hooker ensured careful treatment; he obtained about 4 per cent germination, which was good considering the long journey and that it was unknown how the seed should be packed or treated. The bulk of the seedlings were despatched in Wardian cases (miniature greenhouses) to Ceylon, where extensive nurseries had been prepared at Henaratgoda on the orders of the India Office. Further shipments from Kew in 1876 were 18 plants to Java and 50 to Singapore, but the latter arrived at the Gardens in poor condition and the five survivors appear to have died subsequently. The following year 22 plants were sent from Kew to Singapore and successfully established by Mr. J. H. Murton, Superintendent of the Gardens.

The distribution of these plants is not fully known. Murton went plant collecting in Perak during October to December 1877, when he planted nine *Hevea* seedlings at Kuala Kangsar behind the old Residency on the bank of the Perak River. The Resident was Mr. (later Sir) Hugh Low, who, like Sir Stamford Raffles, was an active naturalist and very interested in economic botany. Murton is reported to have planted one of the 'Wickham' seedlings with other rubber bearing plants at Durian Sabatang. This may have been the

Durian Sabatang near Telok Anson, but his itinerary did not include Lower Perak unless he made an unrecorded call during the sea voyages between Singapore and Penang. He passed near the Durian Sabatang about twenty miles south of Matang and Taiping. Both these places together with Telok Anson have been quoted as sites for one or more of the first introductions, probably all referring to the single plant, which appears to have been soon lost for no traces could be found by Low in 1878. At least nine seedlings were retained at Singapore. The important point is that Murton established *Hevea brasiliensis* in two centres where the trees could be tended and observed, namely, at the Singapore Botanic Gardens and under Low's good care at Kuala Kangsar.

The plants at Singapore were multiplied to a limited extent by cuttings. However, Murton found, as has been confirmed repeatedly since, that only cuttings from young seedlings rooted easily. Thus there was a limit to the amount of material which could be propagated by this means. Nevertheless it is interesting and to Murton's credit that he was alive to the potentialities of the method and investigated its possibilities. The most suitable site was sought by Murton, his successor, Mr. N. Cantley and Mr. W. Fox, and, after two transplantings, the *Hevea* collection found a home in the newly acquired Economic Garden in 1879. Unfortunately the Government provided no funds for the upkeep of the Economic Garden and scrub invaded; thus by 1885 the trees were in a poor state of upkeep. The numbers were reinforced from 1884 onwards with the progeny of the originals and new imports from Ceylon. This was most important as these provided the material for the classic experiments by Ridley and Derry.

Meanwhile the trees at Kuala Kangsar had flowered in March 1880 and set seed the following year. Mr. (later Sir) Frank Swettenham, acting for Low in 1884, planted out about 200 seedlings on the banks of the Perak River and on the hill behind, where the new Residency was built. A group of seedlings was planted around the grave of British soldiers killed in the Perak expedition of 1876. These proved a valuable source of seed in later years.

The Search for a Means of Exploitation

The first tapping in Malaya was on the Kuala Kangsar trees by aborigines; they used an unsuccessful incision method probably similar to that employed to extract poisonous sap from the Ipoh tree. It is not clear when this was done, as some of the early literature is contradictory and includes evident typographic errors in the dates. Low is reported to have sent rubber samples to London

in 1884, which were not received favourably, but these may have been Ceara Scrap (from *Manihot glaziovii*, which was also planted at Kuala Kangsar); at any rate the confusion did not enhance the reputation of cultivated rubber. Swettenham may have directed an attempt in 1886 and—or—Low an attempt in 1888.

Another attempt was made in 1889 when Swettenham had succeeded Low and the results were again disappointing. Swettenham, having decided that there was no future for *Hevea* in Malaya, ordered the destruction of several of the original Kuala Kangsar trees and discouraged further interest. This remained the view in government circles for some years.

The year 1888 marked the arrival in Singapore of Mr. H. N. Ridley as Director of the Botanic Gardens. He shared Hooker's faith in natural rubber production by *Hevea* cultivation and, despite government opposition and lack of funds, set about rehabilitation of the Economic Gardens and experimented to find a practical means of extracting latex. As early as 1889, while Swettenham made his gloomy predictions, Ridley made his first basic discovery.

Hitherto virtually all forms of and attempts at tapping *Hevea* for latex were incision methods, by which a cut was made through the bark but no bark was removed. (We use bark here in the popular sense to denote all tissues outside the wood). Incisions tend to close, there is no proper channel for the trickle of latex to flow along into a receptacle and it is hard to judge the depth of the cut—the result is much wounding of the tree.

The *excision* method invented by Ridley involved removal of a paring of bark from the cut, which in the first place overcame the main defects of incision noted above, but led to the further discovery that by repeated paring away of bark from the one cut at intervals a greater flow of latex could be stimulated. Rubber obtained by this method was exhibited at the Singapore Agricultural Exhibition in 1890 and samples were sent to London the next year, where they were pronounced excellent. Other members of the Gardens staff joined in the tapping experiments, C. Curtis in 1896 at Penang, L. Wray in 1897 at Taiping and R. Derry in 1898 at Kuala Kangsar, whence rubber was sold in 1899; the various botanic gardens in Malaya were then all under the direction of Singapore.

In 1904 Derry joined Ridley in Singapore and together they conducted a series of experiments, which established a number of principles and carried the technique far towards that currently employed. Mr. A. D. Machado and Mr. C. Boden Kloss assisted in the experiments and yield recording during some years. Only the main trends are described here to illustrate the progress made.

The first tapping was done with a pruning knife, chisel and mallet but these were superseded by a modified farrier's knife or gouge, a form of which was adopted on one of the first plantations—Jebong Estate—and the “Jebong” is still among the most useful tapping implements. The advantage of morning over afternoon tapping was first established at Singapore. The relative performance of wide- and close-planted trees was investigated; the conclusion was reached that a relatively wide spacing giving a stand of 150 trees per acre would give more economic tapping and a longer useful life than much denser plantings.

The arrangement of the cuts fell into two patterns: (i) herring bones, in which sloping lateral cuts branched upwards from a central vertical channel and (ii) spirals encircling the tree several times. The Singapore workers soon abandoned the more fanciful systems, and although they do not seem to have reached the ultimate simplifications, i.e. neither reduction of a double fishbone to a single V-cut and of a half fishbone to a single half spiral, nor restriction of the number of turns in a helical cut to one full or half circumference cut as now, their conclusions were moving in that direction.

At first there was much apprehension that if tapping were continued too long, the bark would not renew over the ever extending area of excision. Ridley and Derry grew bolder as their experience confirmed that continuous tapping—indefinitely repeated excision at regular intervals—was possible, the bark renewed and moreover greater yields were induced. The simplification of the original herring bone was largely to allow adequate time (four years was at first thought sufficient) for bark renewal before one cut encroached on the next under continuous tapping. They compared daily and alternate daily tapping and expressed a preference for the latter.

Changing Interests and the First Plantations

The tapping experiments described above continued until 1909 and we must revert to the period immediately after Ridley's discovery of a practical method of exploitation to carry on the general history of the subject. The depredations of disease were rapidly making coffee cultivation uneconomic and the owner-managers of the first estates were looking for alternative crops. At first Ridley was still a voice crying in the wilderness as far as rubber was concerned, some of his critics referring to him openly as ‘mad’ Ridley. Although some planters such as Mr. Hislop Hill and the Kindersley brothers continued to plant scattered trees of *Hevea* for observation and to provide seed should the crop realise its potentialities,

the first plantation development was the planting of 40 acres of *Hevea* by Mr. Tan Chay Yan at Bukit Lintang. There is some confusion about the date of this. Ridley has stated 1896 but some later authors quote 1898. One of the Kindersley ventures in 1895 is reputed to have been virtually a plantation of *Hevea*. Mr. Tan exhibited rubber in 1898, presumably prepared from his older parent trees and not from the 40-acre block. At any rate this was the turning point; there had been little interest before but now Mr. Tan went ahead with a larger planting at Bukit Asahan and many other planters followed suit.

The decline of coffee cultivation, the increasing demand for and price of rubber on the world market were important factors: nevertheless Ridley's discovery of excision tapping and persistent propaganda were essential contributions.

We must note here that Murton's choice of two sites, Singapore and Kuala Kangsar, for the first introductions had several important results relating to the rapid expansion of plantations. Mr. Cross, who made an unsuccessful shipment of seed from Brazil to the East, had stated that damp, swamp soils were the best for *Hevea*, especially land subject to flooding. Wickham had in fact collected his seed from an undulating plateau probably with a well drained soil, which he confirmed in 1902. However, unsuitable water-logged sites would probably have been chosen for many years if Murton had not established the Kuala Kangsar trees on what would now be recognised as a typical soil for *Hevea*, i.e. moist but well-drained. Thus the range and suitability of habitats for *Hevea* in Malaya was demonstrated by this and subsequent early plantings at Kuala Kangsar, Taiping and elsewhere by Low, Swettenham and Hill.

Furthermore these trees provided a local source of seed for North Malaya, some of which were planted by Hill in Negri Sembilan, and in 1893 he had seed available in quantity. Seed was despatched to the many new plantations in Malaya and other territories; Ridley had found that the best packing for long distance travel was damp charcoal in sealed biscuit tins.

Research and Advice

The new development raised many problems, first in cultivation and later in processing of the crop—in other words there was a need for research and advice. This had been anticipated by Ridley and his assistants, who had devised means of coagulating latex for shipment and studied conditions of tree growth and many diseased specimens.

As early as 1891 the first Agricultural Bulletin had been published; but owing to lack of funds and delays at the Government Printing Office this did not appear regularly until 1901. When Ridley was preparing to depart in 1911 and it appeared that publication might cease, the Planters' Association of Malaya pleaded that his successor should continue it, remarking that 'Ridley's contributions have been highly valued by the Planting Community and it would be a distinct loss if the Bulletin were discontinued.' Feeling towards 'mad' Ridley and the other rubber enthusiasts among his colleagues had changed considerably over twenty years. When leaving Malaya Ridley left pleas in the Agricultural Bulletin and Greniers Rubber News for an expansion of research and advisory services.

By this time the Department of Agriculture F.M.S. (founded 1905) had assumed responsibility for investigations on rubber, although there had been a transition period during which the experience and current experiments of the Gardens' staff were available until the new Agricultural staff were conversant with the problems. For instance the Singapore Botanic Gardens was for many years among the few institutions with an adequate number of trees in tapping for experiments on the preparation of rubber from latex; Ridley had made the first 'biscuits' of rubber coagulated in shallow plates and Derry continued for many years to make improvements in processing, including coagulation, sheet and crepe manufacture.

We will review here only the contributions made by the Gardens' staff—in particular Ridley's. There was activity along parallel lines elsewhere, particularly in Ceylon and Java, the importance of which we do not wish to ignore or gainsay; moreover the Gardens enjoyed the collaboration of Mr. P. J. Burgess, the Government Analyst, who made several contributions on tapping, coagulation and processing. Nevertheless the extent of activities and number of first records by the Gardens' Staff adequately illustrate their pre-eminence in this field.

Pests and diseases are always among of the first difficulties encountered in new crop culture. Termites were the first insects to trouble *Hevea* in Malaya; apart from 'plantation hygiene'—which was only partly helpful—Ridley was unable to solve this problem. However, the full control of termites has had to await the discovery of modern insecticides. Crickets and mites appeared in due course; for the latter Ridley and Derry recommended sulphur dusting.

The white and brown root diseases of rubber were first described in 1904 and 1909, respectively, by Ridley who advocated detection

and destruction of sources of infection. He reported on 'pink' disease of the stem and branches in 1905 and advised destruction of diseased tissue and treatment with copper sulphate and lime. Birds eye spot was recorded as an ephemeral disease of young seedlings in 1906. The present-day planter will be struck by the small changes in the principles of disease control recommended today and those suggested by Ridley.

The first report on the deleterious effects of applying lime to *Hevea* was made by Ridley in 1903, when he conducted a manurial trial.

Prophecies and Warnings

The early planters were, almost without exception, keen advocates of clean weeding; the majority would not tolerate any catch crop which might deter from the main crop nor any cover crop for soil protection. During the first decade of the century many planters had adopted the practice of eradicating all plant growth by spraying sodium arsenite repeatedly. Ridley saw further and especially in his last editorials addressed serious warnings on the risks of soil erosion to the plantation managers. He suggested chillis, pineapples, bananas and bowstring hemp (an agave) as possible catch crops, which—except the last—can all be seen put to good use on small properties today especially by Chinese. Tapioca, the catch crop favoured by the minority group of 'maximum exploitation—minimum time and effort' planters, was considered by Ridley to be liable to exhaust the soil and to spread root disease; therefore he advised caution and experiment before using tapioca as a catch crop, which attitude has been amply justified. In 1910 Ridley prophesied that contour terraces would be necessary to control erosion on slopes and that cover crops such as the local wild *Crotalaria* would be needed for soil protection and enrichment. He realised that not all lands were suitable for rubber cultivation and condemned planting *Hevea* on deep peat soils.

We note too that Ridley advised against cutting out coconuts in order to plant rubber, stating explicitly that neither individual estates nor the country should rely exclusively upon one crop. He was one of the first to suggest the oil palm as a plantation crop and distributed over 3,000 seeds.

There have been and there are—as there should be—critics of the unbalanced state of Malayan agriculture, meaning in particular the predominance of and dependence on rubber. Critics of the plantation industry have pointed to clean weeding and other bad practices of the early planters, whose rapacious exploitation of the

soil has bequeathed us many problems in its rehabilitation. Nevertheless, these critics should realise that the practical founder and advocate of the rubber plantation industry—Ridley—warned against these errors; indeed the slump of 1913 came as an early reminder of the risks involved in dependence on one crop, but neither the sound business men nor officialdom took much heed. Ridley was ably assisted and—perhaps to greater extent than we realise—guided by a team of Gardens' staff in Singapore and throughout Malaya, who were all devoted to the study of plants and fully appreciative of their value in preserving and developing the resources of the land they had come to serve.

We come now to the close of the period during which the Singapore Botanic Gardens were directly responsible for the development of the rubber industry in Malaya. Mr. I. H. Burkill became Director in succession to Ridley in 1912. Rubber development had then become entirely the responsibility of the Department of Agriculture. Yet Burkill maintained tapping of the *Hevea* at Singapore and yield recording of the individual trees, so that the most productive could be selected as seed parents for future improvement of planting material.

The Present Situation

In 1926 the Rubber Research Institute of Malaya was created by enactment and in turn took over responsibility for rubber. The Botanic Gardens have continued with the basic studies of systematic research into the Malayan flora and the nature of the vegetational formations in the region. It might seem that we have gone our separate paths and the Botanic Gardens are of no further service to the rubber industry, but such a view ignores one of the greatest problems still lacking a solution. We need the help of the fundamental botanist, who is found in institutions such as the Botanic Gardens, which we wish well—not for sentimental reasons because of the great contributions of the past—but in expectation of further assistance in the future.

Malaya and most of the other countries where *Hevea* is cultivated lie in the region of the tropical rain forest. This type of vegetation is very complex; frequently over one hundred different tree species are found in a single acre of Malayan jungle with even more species amongst the epiphytes, lianes and ground flora. The rain forest has developed and perpetuated itself for millenia, but the whole formation is now rapidly disappearing under the pressure of man's advance before he has discovered how it functions.

This state of affairs has been frequently acknowledged recently, for instance at the Ninth Pacific Science Congress, Bangkok, 1957, at the Centenary and Bicentenary Congress, University of Malaya, Singapore, 1958, and at the UNESCO Symposium on Humid Tropics Vegetation, Bogor, 1958. Every appreciation of the situation emphasises that the effects of rain and insolation on exposed tropical soils can lead to rapid impoverishment and erosion. Phosphate availability in most Malayan soils is notoriously low and other nutrients are easily leached out of disturbed soil; there are indications that these can be alleviated or prevented by a suitable vegetational cover which maintains the organic content of the top soil. Such vegetation controls physical erosion and through its many members circulates nutrients also.

Copious rainfall, constant warmth and generous irradiation with sunlight are all factors which contribute both to rapid plant growth and to rapid soil degradation. The success of the tropical rain forest derives from its ability to use the benefits of these factors to provide a luxuriant vegetation on generally poor soils, despite the deleterious potentialities due to these same factors. The object of agriculture in the tropics is to produce a luxuriant crop without soil degradation.

Although the agriculturalist can apply fertilisers to make good losses and deficiencies and can use physical means such as terraces and water channels to control erosion and water distribution, basically he has to solve the same problems which the forest has surmounted. This will probably be achieved most effectively and economically by the same means as those which are successful in nature; it is unlikely that totally different principles will succeed where we must contend with tropical climate, poor soil and undulating terrain.

A single crop culture, even in association with a cover crop which is often limited to a narrow spectrum in floristic composition and growth form, is unlikely to perform all the functions carried out by the natural forest vegetation. Plantation crops such as rubber will continue to be grown in stands of one crop because this enables more economic cultivation and harvesting. Nevertheless there is a need to enrich the ecological association of these crops by introducing into the cover further elements which can fulfil the processes of soil conservation. Currently we are approaching this problem by growing various plants in association with the main crop and endeavouring to assess their effects upon the main crop and upon the soil. However, we would be better guided in our choice of plants and factors to study if we knew how the natural tropical rain forest functions.

The Future

It is often stated that the future of the natural rubber industry depends upon reducing the cost of production; nevertheless if the existing advances, especially in the selection of planting material of improved yield, are exploited fully, as is attempted in the current replanting programme, a production cost competitive with synthetic rubber can be achieved. Further research will be necessary to keep the cost of production down to this level despite rising wage trends and possible cheaper synthetic production. In the preceding section we envisaged an ideal tropical agriculture harnessing the natural processes of the forest; such a system for rubber cultivation would doubtless form a valuable contribution towards the long term reduction of production costs, but would moreover preserve the fundamental asset—the soil itself. Investigations on the functioning of the tropical rain forest have scarcely been essayed, yet this is a most important field both for its scientific interest and in order to evolve a rational form of agriculture for land utilisation in the tropics. The scientific manpower available is limited but the destruction of the forest is continuing apace. No one institute can tackle this problem alone, because the facilities built up over long periods such as herbaria, experimental gardens and forest reserves of known history and laboratories proper to different institutes are all needed. Moreover scientists trained in various disciplines who have experience in institutes devoted to every branch must cooperate in this undertaking.

The Departments of Forestry and Agriculture in the Federation of Malaya are daughters of the Singapore Botanic Gardens and the Rubber Research Institute is in effect a grandchild. Within this family there is scope to tackle the fundamental problems of tropical ecology; may the centenary of the Singapore Botanic Gardens be marked by revived interest in this subject. The difficulties which we have inherited and the problems we may bequeath owing to poor land management will be best solved and prevented by this means.

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The Contribution to Agriculture in Malaya by the Singapore Botanic Gardens

By a Malayan Agriculturist

A GARDEN: A piece of ground where flowers, etc. are cultivated.
A pleasant spot. (*Chambers's Dictionary*).

THE SINGAPORE BOTANIC GARDENS are a very pleasant spot indeed and a good place to relax. So much so, that the casual visitor would have no idea of their importance to Malayan agriculture and the valuable scientific research that is carried on there.

It has been said* that the experimental and scientific work in a botanic garden "cannot by its very nature be directly remunerative but may indirectly repay its cost many times by establishing new industries, by saving old ones from losses by disease or otherwise, introducing new and improved methods and so on". The validity of this statement is well demonstrated by development of the rubber industry in Malaya, but even if this were not so, even if rubber had failed to grow here at all, the Botanic Gardens have made many other less spectacular but nevertheless notable contributions to Malayan Agriculture.

In the first place it should be recalled that when the Gardens were taken over by Government in 1875, it was intended that they should be concerned with agriculture and the economic development of the Straits Settlements and not merely a pleasure garden or a base for collecting material for the Botanic Gardens at Kew in England. The Director of the Gardens was also the Director of the Forest Department and regarded, by the Government at least, as the pre-eminent authority in Malaya on anything whatever concerned with plants.

Starting in 1891 a Bulletin dealing with Agri-Horticulture, and other cognate subjects, was published by the Gardens and this was issued as a monthly journal from 1901 to 1911. (*Agricultural Bulletin of the Straits and Federated Malay States*), Opening Volume I of this Journal at random one may find articles on rubber cultivation, a series on the Timbers of the Malay Peninsula, Trade and Market Reports and, among the correspondence, a letter from Mr. Carey claiming that coconuts will yield well on the coastal clay soils of the West Coast. Even today, the scientific reports are of

* J. C. Willis, 1907.

value and although the price of opium (11s. 6 d. per lb., spot) and Mr. Carey's well justified optimism are only of historical interest, one can appreciate how this Journal must have made up for the lack of communications and expert advice to which we are now accustomed.

The Bulletin continued to be published even after a Department of Agriculture for the Federated Malay States was set up in 1905, but its name was changed to the *Gardens Bulletin* in 1912 when the F.M.S. started to produce its own agricultural magazine. In 1919, the Department of Agriculture, F.M.S., also took over the responsibility for agriculture in the Straits Settlements, and the *Gardens Bulletin* gradually began to put less emphasis on practical agriculture until 1924 when this aspect of the Garden's work finally came to an end.

This is not to say that the Gardens' staff were no longer interested in agriculture. The Economic Gardens of 102 acres had been opened in 1879 and used as a preliminary trial area for numerous local and introduced plants which were considered to have some potential value. In addition to rubber, it is worth noting that the first oil palms in Malaya were planted there about 1875 and an excellent review of the possible value of these palms in Malaya was published in the *Bulletin* in 1907. The Economic Gardens were unfortunately closed in 1925, but despite this I. H. Burkill was able to publish his *Dictionary of the Economic Products of the Malay Peninsula*, which is still in every-day use as a reference book at the Department of Agriculture in Kuala Lumpur and all over the world. Other books which have been invaluable to agricultural research and have an international reputation include the floras by Ridley, Holttum and Henderson and the well illustrated two volumes on *Wayside Trees of Malaya* by Corner.

It is our good fortune that the work of the Gardens has been so well documented but no library, however comprehensive, could replace the collection of living and preserved material which is available there. The value of these specimens to the teacher, the student and amateur gardener need not be mentioned here, but to the scientist from tropical and sub-tropical countries, the herbarium type specimens and the easily accessible living material, form an invaluable point of reference. For instance, when the Department of Agriculture was recently anxious to learn the types and distribution of citrus trees growing in Malaya in order to prepare a scheme to improve the planting material of this crop, the Plant Breeder first visited the herbarium at the Gardens and was not only able to gather much of the information he required but was also able to clear up some difficulties over citrus taxonomy in general.

Difficulties are, in fact, quite frequently encountered by anyone concerned with taxonomy and since this is a science in itself there is a small traffic of specimens from Kuala Lumpur to the Gardens for identification.

It would perhaps be appropriate to emphasise here how useful it is for the agriculturist to know the correct botanical name for a plant he is growing. It would be useless for anyone wanting oil palm seed to write to West Africa asking for seed of "kelapa bali" or "kelapa sawit" but if the palm were given its accepted botanical name, *Elaeis guineensis*, the type of seed required would be clearly understood. Similarly root-disease of fruit may be due to a number of causes, but if the plant pathologist can isolate and identify, say, the fungus *Phytophthora citrophthora* from the diseased roots, he can at once be almost certain that he has found the cause of the trouble, and can consult the literature describing methods for controlling this same fungus in other parts of the world.

Until, perhaps, electronic translating machines are invented, it is too much to hope that scientists throughout the world will publish all their works in a universal language. For the moment we must be thankful that Linnaeus invented his binomial system for naming plants and animals. Without this system, and the support of institutions such as the Singapore Botanic Gardens, which are mainly responsible for its propagation, there is no doubt that agriculture would be immeasurably the poorer.

Orchids, Gingers and Bamboos: Pioneer work at the Singapore Botanic Gardens and its significance for Botany and Horticulture

By R. E. HOLTUM

Director, Botanic Gardens, Singapore 1925-1949

A BOTANIC GARDEN is essentially a museum of living plants maintained for botanical study. Out of that study comes new knowledge of various kinds, much of which can find an application in horticulture.

The maintenance of any garden involves thought about horticultural technique; and the maintenance of the great variety of plants in a botanic garden should result in experiment in techniques and in new understanding of the diverse cultural needs of the many plants concerned. Thus in a botanic garden there is a two-way traffic of knowledge and its application; new botanical knowledge finding applications in horticulture, new horticultural techniques aiding the cultivation of plants for botanical study.

A botanic garden may serve also as a park, but that is not its primary function. It should be the source and storehouse of new knowledge, both horticultural and botanical, which can find its application in parks and in private gardens; and without that constant pursuit of new knowledge the parks and gardens lose the impetus to progress.

Botanical study possible in botanic gardens may be divided broadly into two aspects: study of the structure and classification of plants, and experimental work of various kinds. The study of classification is basic to all other, and I would regard it as the primary function of a botanic garden. Such study may seem very theoretical; but it has immediate application in plant breeding and also in other ways. Plant breeding is one kind of experimental work which may be undertaken at a botanic garden; it can provide new kinds of plants for horticultural use. Other kinds of experimental work are concerned with the physiology of plants, and such may result in new knowledge useful in horticultural techniques.

The orchid family is the largest plant family (in number of species) in the Malayan region, and includes many beautiful plants which are valued horticulturally. Botanically, the great variety and complexity of floral structure presents very intricate problems to

the classifier. The botanist who explores the forests of Malaya for orchids (or other plants) cannot make a final study of them as he finds them; he needs to take them away for more detailed examination at leisure. He may either preserve them as herbarium specimens, or he may take living plants for cultivation. The herbarium at the Botanic Gardens, Singapore, is thus a vast storehouse of information, much of which has still not been thoroughly investigated. For orchids it is much more satisfactory to have living plants in cultivation, and to examine the fresh flowers, as dried ones lose some of their characteristic shape as well as their colours.

Mr. H. N. Ridley, who was Director of the Gardens from 1888 to 1912, had made a special study of the orchid family before his arrival in Singapore, and during his many travels of botanical exploration he brought to the Gardens a large number of orchid plants, many of which he described as new species, preserving also specimens of them. He also had the services of an excellent artist (Charles de Alwis) who made accurate coloured drawings of the plants and their flowers. Thus the records of Mr. Ridley's study of native Malayan orchids are preserved in Singapore in the form of specimens, illustrations and descriptions. Upon these records depends stability in the use of names; if a name is to be useful it must always mean the same thing.

Similar work on orchids was carried out in neighbouring countries (India, Siam and Indo-China to the north, and in Indonesia). In order that there shall not be confusion and duplication in the use of names, it is necessary to correlate study of plants in Malaya with those in the surrounding countries (where many of the same species occur, along with others). This has been achieved by the accumulation in Singapore of a valuable botanical library and by exchange of specimens.

The most important later collector and describer of new orchids in Malaya was Mr. C. E. Carr, a rubber planter who made this work his chief recreation. He used the herbarium and library at the Botanic Gardens, Singapore, and contributed specimens which he had gathered. After his death, his many manuscript notes and drawings were also acquired for the Gardens, and are a most valuable record of his work.

In this kind of way a great body of records concerning the native orchids in Malaya and neighbouring countries was built up. Much of this recorded knowledge became of great importance when the breedings of new orchids, for use as garden plants and for their cut flowers, was begun about the year 1928. It is true that only a

small proportion of orchid species are useful for exploitation in this way; but for a proper appreciation of the possibilities, the full survey is necessary, showing the more useful plants in perspective as parts of a whole, and thus showing their own inter-relations. Such a survey also shows what other plants exist, not yet in cultivation, which might be valuable for breeding purposes.

The impetus to orchid breeding was provided by Mr. John Laycock, who imported to Singapore many species from neighbouring countries, thus providing valuable breeding stock, and by a visit from Prof. H. Burgeff, a pioneer of the study of orchid seedlings. Up to that time, no orchid seedlings had been raised in Singapore by modern methods of pure culture which ensure a high percentage of germination; and nobody had any experience of the behaviour and cultural needs of young orchid seedlings newly removed from culture tubes. As a result of trials and errors, methods of dealing with these plants were gradually discovered, and the first seedlings flowered in 1931 (*Spathoglottis* × *Primrose*). A succession of new hybrids followed, and at the time of the Japanese occupation of Singapore some 4,000 seedlings were in pots at various stages of development, in addition to those in flasks and to larger plants. A considerable proportion of these plants was maintained during the occupation period, though there were many losses, and some new crosses were made. Methods of raising seedlings on agar-agar prepared directly from seaweeds were developed. Progress after the war was rapid, and today the production and culture of fine new orchids has become of considerable commercial importance, as well as a recreation for a large number of people.

The significance of this development is that nature provides comparatively few kinds of orchids well suited to the local climate in vigour of growth, and in freedom of flowering, which have also the qualities of floral form and durability required for horticultural purposes. The production of large numbers of new kinds of plants by crossing, by new seedling techniques, and by selection of the best, has resulted in a complete transformation of Singapore gardens, and in the production of a wealth of cut flowers throughout the year in considerable variety, and of kinds previously unknown. It is an example of the kind of change which is possible also with other families of plants.

The Ginger family provides a rather different story. There are about 150 known species of the family in Malaya, most of them wild in the forests, a few others being cultivated in villages for flavouring food or for medicine. Nearly all plants in the family have aromatic properties, and more of them are potentially useful

than are yet in use. Little or no breeding or selection, even of the kinds now in use, has yet been undertaken. The family has its main centre of distribution in Malaysia, and the only full botanical monograph upon it was prepared fifty years ago, in Europe, from imperfect material. This monograph is very unsatisfactory, and a careful study of native Malayan species, made in recent years at Singapore, led the way to revised concepts of basic classification. This study was possible through field and garden work similar to that undertaken for orchids, as above described. The flowers of the ginger family are delicate and short-lived, and also complex in structure, so that dried specimens are difficult to interpret; one needs to see either fresh flowers or specimens preserved in alcohol. The revised survey of the family in Malaya gives a full statement on classification as well as detailed descriptions of all species known to occur in the country. It was in part based on pioneer studies made of some allied species in Java; and in its turn the Malayan survey has helped in the understanding of other Indonesian members of the family. This study, made in Singapore through a combination of botanical and horticultural activities (especially the collections of plants and specimens made by Mr. E. J. H. Corner) is basic to any future exploitation of this family, which contains so many useful plants.

Bamboos are used daily, for many purposes, by almost all people in Malaya; there are no other plants which have such varied uses. But until recently no descriptive account of the various kinds of Malayan bamboos had been published. The reason is that there are many peculiar difficulties in the botanical study of bamboos. In the first place, botanical classification must be based on floral structure, and most bamboos flower rarely (one plant from northern Malaya, in cultivation in Singapore for fifty years, has never been known to flower). Thus it is obviously necessary also to study other parts of the plants, so that recognizable descriptions, based on the non-flowering parts, may be drawn up. In practice, such descriptions are not easy to make, and no real attempt to make them was tried in Malaya until quite recent years. This attempt was only possible because from time to time native Malayan bamboos of various kinds, and also species from India and elsewhere outside Malaya, had been brought into cultivation in the Botanic Gardens, Singapore. These plants were available for detailed study at leisure, and their flowering could be observed when it occurred. As a result of such study, further field work could be effectively carried out, and resulted in more plants being brought into cultivation, as well as in specimens and in recorded observations on plants found in various parts of Malaya.

The results of this first survey of Malayan bamboos, made possible by the cultivation of plants in the Botanic Gardens, Singapore, have now been published. It is hoped that this publication may be made the basis for a comparative study of the useful characters of Malayan bamboos. In the north of Malaya there are many kinds of native bamboos which have never been brought into cultivation, and there have been no experiments to test the usefulness of particular kinds of bamboos for different purposes, or to select the best kinds for propagation and wider use. Here is a subject which touches the daily lives of all people living in the rural parts of Malaya, basic work on which has been carried out at the Botanic Gardens, Singapore, and which awaits that further investigation which is outside the scope of the Botanic Gardens.

Singapore's Contribution to the Study of Palms

By C. X. FURTADO

Botanic Gardens, Singapore

BOTANICALLY PALMS are considered as the "Princes" of the vegetable kingdom, but they are also important economically. In some cases like the coconut palm it is possible not only to make a boat out of the timber but also to provide it with ropes, sails, cloth, flour, oil, sugar, wine, vinegar, spoons, brushes, brooms, drinking vessels, etc. all derived from the palm itself, showing thereby a variety of uses some palms have. Others like the *Nibung* made the Malaysian civilisation possible since its timber was needed not only for the boats but also for the houses, for no other cheap timber was available that could stand salt water and also resist the attack of termites and other destructive organisms. Similarly were it not for the leaflets of the two palms *Nipah* and *Rumbia* (Sagu), Malaysians would have experienced great difficulties to find for their houses and boats suitable attaps that would resist weather and the destructive action of white ants and other insects. Much of the sugar that was available to the original Malaysians in lowlands was derived from coconut and Kabong palms, since sugar cane could not be grown without being protected against the ravages of wild animals. The "dragon-blood" which was formerly exported to Europe and elsewhere for medicinal and other uses, was derived from some species of climbing palms known as rattans or rotang, a group of palms that provide what is commercially known as the Malacca cane used for making walking sticks, wicker chairs and other articles.

Now every species of a particular genus of plants has different properties and uses. This is one of the reasons why systematic botanists keep themselves busy in studying the characters by which different species and varieties of plants might be recognized. Systematic studies help to correlate the results of research workers in different branches of science or knowledge. Thus a dietician or nutritional chemist will want to classify the results on the different vegetable products used in the diets of the people, the pharmacist to know the plants used as medicines by the aborigines or the rural people; the police to know the plant poisons used in murders, suicides and other crimes; the veterinary officers to know the different kinds of plants used to feed, to poison, and to cure the animals; the fisherman to know the small plants that help the fishes

in pisciculture; the malaria controllers to know the plants that encourage or hinder the propagation of the mosquitoes; the silviculturists, the trees that yield the timbers suitable for different purposes, and so on. The systematic botanist is therefore an indispensable person for research workers and commercial men who have anything to do with plants or their products.

To classify plants that are not microscopic a large collection of dried specimens to illustrate the leaves, flowers and fruits as well as the natural variation between these is necessary, for only with a carefully preserved material in herbarium can a systematic botanist concentrate to detect the characters that distinguish one species or variety of plant from another. The need for such a collection is easily satisfied in case of plants which have fairly small twigs, leaves and fruits. But in the case of palms the difficulty is often a formidable one, both for the field botanist who collects the specimens in the field and for the systematist who arranges and studies the material in the herbarium. Many palms have large leaves and their stems are very bulky too. If one were to collect only one leaf and flowering branch of a large palm, they would form a great load for a person, whereas within the time and labour several dozens of specimens could have been made of large trees having small twigs, leaves, flowers and fruits.

Palms also show a good deal of difference in age. The leaves produced when the plants are young and not flowering are often completely different from those produced by a flowering stem. Further an inflorescence might appear completely male at one stage and completely female at another stage. Moreover in the early stages of flowering of a palm that produces both male and female flowers on the same spadices, often no female flowers are produced so as to make one imagine that the sexes are distributed on different plants.

In case of rattan palms, additional difficulties occur often in the better varieties that produce long climbing stems. The long, hooked whips which enable the plant to climb can entangle a collector tearing his clothes and wounding his skin in a way that it may be difficult to extricate him unless armed with a sharp knife. Since such climbing rattans produce flowers and fruits only when they reach to a great height on the trees which they climb, it becomes impossible to get fertile specimens essential for the herbarium except by cutting the rattan; but since the rattan does not climb straight and since the hooked whips are sometimes 15 ft. long or more and the hooks are reversed, it is not possible to pull such a rattan down even with a force of 10 to 15 men. Several times 1

have had to fell 7 to 8 trees and treelets before getting the specimens of one rattan. Further all rattans have thorny sheaths on the leafy stem and the leaves themselves are also armed with hooks. This means that one has to use leather gloves and handle the whole material with care lest it injures the hands and fingers.

Now having obtained a rattan plant, how is one to make the specimens since each leaf or spadix is very large? In the early days when forest officers knew little about collecting palms, the Berlin palm specialist wrote to a forest officer in New Guinea to send him a good specimen of a palm that looked to be a new species though well known to the aborigines. The silviculturist immediately got his men active. He cut a palm with 30–50 ft. tall trunk and 18 inches thick, and had his men transport it to the nearest port whence the plant was shipped to Germany. On its arrival in Hamburg special arrangements had to be made in order to transport it to Berlin, and it was kept in the Museum for the benefit of the school children. But since during the transport the flowers and fruits were lost, the specimen was useless for a botanical study, though several hundreds of dollars were spent in getting the specimen from the jungles of New Guinea to the Botanical Museum of Berlin!

This digression will help to emphasize the need for the botanists to study the palms in living state in order to decide what parts are essential to enable him to distinguish the one species or variety of rattan from another, that is, the specimens that will not burden unnecessarily the collector and that, without occupying unnecessary space in the herbarium, will provide the necessary distinctive clues to the systematist. In this regard the observations made by the botanists in the field as well as on the plants grown in the Botanic Gardens of Bogor and Singapore have provided useful clues for making satisfactory specimens. And as far as the Malayan rattans are concerned, the Botanic Gardens of Singapore may be given the credit of having played the major role in the classification of the rattans, having secured in the initial stages the help of the great palm expert, the late Dr. O. Beccari of Florence, Italy, who had also studied the palms in the forests of Borneo and New Guinea and those collected by the staff of the Botanic Gardens of Bogor and Singapore.

In the course of these studies the status of several doubtful ones has been cleared, some passing under two or more names because of some variation due to age or ecological conditions have been merged into one, several new species and varieties have been described and the generic distinctions have become better understood. In 1907, for instance, Ridley who, as said above, had enlisted

the help of Professor Beccari of Florence, described in his *Materials* 86 species of rattans under 6 genera, of which 16 species were new, that is, in addition to those new species described by Beccari from the specimens collected by the Singapore Gardens' Department. Later in his *Flora of the Malay Peninsula V* (1925) Ridley described 94 species of rattans (with 5 new species) under 7 genera. In 1951-56, Furtado described and illustrated in the *Gardens' Bulletin*, Singapore, 127 species of Malayan rattans under 10 genera, of which one was a new genus and 28 new species and several varieties and new records of species previously known only from non-Malayan regions.

However the study of the Malayan palms is not yet complete. A proper field survey of all the palms is needed in order to build up an adequate herbarium in Singapore, and in this the co-operation of the Forest Officers is valuable, since they make frequent trips to the jungles and can make valuable collections whenever a coupe is felled for timber. If a comparative systematic study were made of the palms from the Malaysian region including Assam, Burma, Lower Siam, Malaya, Sumatra, Java and the neighbouring islands, it should yield much valuable knowledge of the palm genera and species occurring in this region, their distribution, and the range of intra-specific variation and other characters.

Manila and the Singapore Gardens

By EDUARDO QUISUMBING

Director,
National Museum, Manila

THE NATIONAL MUSEUM of the Philippines, in Manila, greets the Singapore Botanic Gardens on the occasion of its centenary. We in the Philippines, who have immensely and continuously profited by its goodwill and co-operation, have every reason to feel proud of its achievement.

For the last 100 years, the Singapore Botanic Gardens and Herbarium have been known as institutions which are not only useful to Malaya but to all scientists the world over. While both have served as places of recreation and education for the people of Malaya, they have contributed their own share in the dissemination of plant knowledge and distribution of plant species to all parts of the world. The Herbarium itself is well known for its valuable collections and adequate library and serves as a seat for research and study of the flora of Malaya.

Many famous names have served as directors of the Gardens and many of its botanists have made invaluable contributions not only to the flora of Malaya, but also to that of Malaysia. Their works appear in the *Gardens' Bulletin*, which, likewise, has been considered as an invaluable scientific publication.

Our first scientific contact with the Singapore Botanic Gardens was established after the year 1910 by the late chief botanist (later director) Dr. Elmer D. Merrill, of our Bureau of Science. He had started the exchanges in botanical knowledge as well as in botanical specimens, which are equally valuable to both institutions. This co-operative work was continued by me after 1923 when Dr. Merrill left the Philippines and I became an official of the Philippines National Museum, which handles botany as well as all divisions of natural history. Besides our exchanges of specimens we also exchanged our publications—the *Gardens' Bulletin* for the *Philippine Journal of Science*, and *vice-versa*—and loaned Philippine and other Indo-Malayan mounted herbarium material to Malayan specialists for their study of Philippine representatives of various plant families or for their preparation of monographs on botanical groups.

It is a pleasure to recall at this time my personal visits to the Gardens—one in August 1928 and another in November 1938. From this latter visit I brought home with me some cuttings of the various varieties of bougainvilleas and a seedling of *Lagerstroemia floribunda*. The former now adorns the gardens of Malacañang, official home of the President of the Philippines, while the latter is a full-grown tree now serving as a graceful ornament in my private garden. The late Mr. Wester also brought many ornamentals from the Singapore Botanic Gardens.

The Singapore Botanic Gardens was and still is the centre of botanical work on the Malayan flora, just as Manila was and is for the Philippine flora. Despite the complete destruction of our herbarium during the war, the Philippines is at present in a position to begin—as it has already begun—to rebuild its collection and regain its place in its own field.

With such thoughts as the above on our past contacts and exchanges and close associations and co-operation in our particular branch of science, the centennial celebration of the Singapore Botanic Gardens has become truly significant to us. It is my hope that we can continue to carry on our present harmonious relationship for the mutual benefit and satisfaction that such relationship can bring us.

The Botanic Gardens and Conservation in Malaya

By H. M. BURKILL

*Director,
Botanic Gardens, Singapore*

RESOURCES are not only fodder for industry but include the matériel for man's existence and his mental and physical well-being. Conservancy is a rational policy to avoid wasteful destruction of resources, to ensure that what is renewable, such as plant and animal life, is not utilised (destroyed) beyond its capacity to maintain itself, and to put land to the best possible use for the country, thus avoiding conflicting demands on it.

The Botanic Gardens have been involved in various conservation projects which have contributed very significantly towards the development of modern Malaya*. The most important of these in the early days has without doubt been in the field of forestry, but there have been other matters the relevance of which to botany does not appear so obvious, as for example town water supplies and the resettlement of aborigines. But times and accents change and the present trend is towards nature conservation to protect the little of the natural landscape that is left to us.

Early writers on eighteenth and nineteenth century Malaya emphasised the extensiveness of the forests. In their extensiveness authority saw no need for protection. When the Botanic Gardens were first established in 1859, the Singapore forests had already been so destroyed that Government had on its hands no less than 45,000 acres of abandoned land. (I. H. Burkill, 1918.) That was over a quarter of the Colony. Such reckless destruction had spread to Malacca and Penang and into the Malay States.

Murton, Superintendent of the Botanic Gardens, 1875–80, pointed out in his first annual report (1876) that good timber trees had almost entirely disappeared from Singapore. Government became alarmed at the increasing damage done to the forest of the Straits Settlements and Cantley, who succeeded Murton, 1880–87, was commissioned in 1882 to report on the forests of the three colonies.

* Malaya is used here to mean both Singapore and the Federation of Malaya.

Cantley (1883) recommended the formation of forest reserves as much for the protection of the timber resources they contained as for improvement by re-forestation with valuable species. In addition he specified the need of proper control over water catchment areas supplying public water services, and for the drafting of reliable maps. It is significant that the world over forestry officers are styled 'conservators'.

In 1884 Government set up a Forest Department under the Botanic Gardens establishment. By 1895 when the Gardens relinquished control of the Forest Department, Cantley and Ridley, who followed him, had secured 88,336 acres of forest reserves in the Straits Settlements. There is no doubt that the official implementation of Cantley's recommendations marked the beginning of a constructive policy of land utilisation and conservation in Malaya.

One of the most besetting obstacles to forest regeneration in Singapore was the frequency of *lalang* fires over the areas adjacent to established reserves or in the pockets within the reserves. Cantley selected *Eugenia grandis* as a fire belt tree. Several of his avenues still exist.

During Cantley's time, the Gardens were concerned with the conservation of water resources. He became adviser to the Malacca and Penang Municipal Councils. Curiously the Gardens had nothing to do with Singapore's supply till very much later.

In the course of his duties with the water supply at Malacca, Cantley had to advise on a land settlement scheme for a part of an aboriginee tribe, the Jakun. This must rightly be considered a conservation of resources, not only because of the water scheme, but because people are a part of a country's resources and because conservation in a wider sense applies equally to a cultural heritage to which undoubtedly the aboriginee tribes of Malaya do contribute.

At a risk of altering the sequence of events, it is convenient here to mention the Gardens' contribution in the post war years to the land utilisation survey which culminated in the drawing up of the Master Plan for the development of Singapore Island. J. W. Ewart, Curator of the Gardens, was as well Agricultural Officer, Singapore, for the period 1948-54 during which time the survey was undertaken. Ewart working in conjunction with R. A. Wright, Singapore's Veterinary Officer, and the officers of the Land Office prepared plans for rural development and the demarcation of agricultural areas. With the creation of many new housing projects a large number of market gardeners were displaced and had to be resettled in the rural areas. These land utilisation plans brought up

many problems, not least of which was the loss of fertility of the upper slopes and tops of hills which had been bare of all but the most impoverished vegetation for decades.

In Singapore the water catchment area of the MacRitchie Reservoir had been extended by 1910 to the land surrounding the Peirce Reservoir. Much of it had previously been alienated for cultivation. The vegetation which returned was an *Adinandra* scrub which is typical of secondary growth on Singapore Island. In 1930 the Governor, Sir Cecil Clementi, saw in this land the makings of a public park. Therein lay a significant widening of the conceptions of conservation by the creation of a public recreational amenity. The Governor instructed that attempts be made to improve the forest and to create bridle paths and to beautify various vistas, which were afforded, with stately trees. The arboricultural work fell to the Botanic Gardens, but it was beset with obstacles and only a little success was achieved before the outbreak of the 1939–45 war stopped this work.

In the 1930's there was a growing public awareness that all was not well with the conservation measures for Malaya's wildlife. A commission of enquiry was established under the chairmanship of T. H. Hubback whose report (1930) advocated measures to protect game within delineated reserves. The Botanic Gardens took no part in this enquiry which confined itself exclusively to animals and Malaya's vegetation was mentioned only insofar as it provided a habitat for wild animals. Singapore itself got but passing reference—that the whole Island should be declared a refuge for most species of birds. The Botanic Gardens however saw the matter in a wider perspective and Holttum advocated to authority that since the F.M.S. enactments protected only animal life but not plant life, the principle that both should be considered together ought to be recognised. Holttum also advocated the reservation of areas containing uncommon plant communities before they were lost for all time under some other form of development. In particular he recommended the protection of Taman Sedia in the Cameron Highlands and Gunong Pantii in Johore. After the war Henderson advised in the setting up of Templer Park just north of Kuala Lumpur which has within its limits Bukit Batu Takun (1,387 ft.) a limestone outcrop with its peculiar flora.

In Singapore the Forest Reserves were deleted in 1935 and Holttum and Corner recommended Government to put those at Bukit Timah, Kranji and Pandan, under the Botanic Gardens. In 1939 these areas were reserved again under the Forest Reserves Ordinance and the Director of Gardens, after a lapse of 46 years,

became again the Conservator of Forests. But there was no intention this time of commercial exploitation: it was for absolute protection to provide areas for research, education, recreation and as samples of the country's biographic history and heritage.

These reserves survived the war thanks to the interest of the Japanese Director of Gardens, successively H. Tanakadate and K. Koriba. But in the years after the war the reservation of Bukit Timah came into conflict with granite quarrying interests. Government set up a commission and its reports (Harvey 1950, 1951) recommended the enactment of legislation to put the reserves on a modern footing under a Nature Reserves Ordinance. This recommendation was implemented in 1951. To the three reserves under the control of the Botanic Gardens were added Labrador Cliff, and the Municipal Water Catchment Area.

The intention of the new ordinance was: "*To provide for the dedication and administration of certain lands in the Colony of Singapore as Nature Reserves*". A Board of Trustees was created with the Director of Gardens *ex-officio* Chairman, and the Board was directed to undertake the propagation, protection and preservation of the indigenous fauna and flora of Singapore and to preserve objects and places of aesthetic, historical and scientific interest. The Board is empowered to provide facilities for study and research.

The reserves when they were created, and still are unique in Malaya. They put Malaya in fact in the forefront of the countries of South-east Asia from the point of providing field research facilities as well as providing educational and recreational amenities so close to the centre of population.

Nature conservation is in itself a development project just as are town planning or the building of aerodromes, roads or railways. But since its stock-in-trade is things which live, as a project it is not amenable to constant change and interference and so it must be considered as a long term one. Allowed to grow on its own it is a complementary anodyne for a modern society in this age of concrete.

This brings the matter up to the present time. The story has had an expanding theme from natural bounty to destruction, through exploitation for commercial benefit to cultural and educational ends. All these stages remain with us in varying degree, but it is to human advantage to eliminate for all time wastefulness. The part played by Botanic Gardens in this endeavour has been fundamental and of great significance in Malaya's development. These achievements have been and will continue to be of the greatest importance for the future.

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The Singapore Botanic Gardens and the Central Institute for Nature Research in Indonesia at Bogor Comments on Past and Present Co-operation and the Need to Continue it

By KUSNOTO SETYODIWIRYO

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THE WELFARE and progress of a country, especially of one with an economy and industry still in its infancy, depend a great deal on its natural resources and on the ability and good sense of its leaders to exploit and to make use of this wealth in such a way as to safeguard the well-being of its people from generation to generation.

The ability to make responsible use of the natural resources rests on a vast and profound knowledge of the soils, the waters, the flora and fauna of the country as well as of its wealth of minerals that are contained in the soils.

A wise and responsible management should be based upon a good understanding of the kind and the potency of the natural resources and of the best way of utilization for the prosperity of the country and the people now and in future.

In view of the welfare and development of a nation the leaders should attempt to know their colleagues in other countries and in the neighbouring states in particular, to create and maintain a mutual understanding, trust, respect and tolerance.

If this basic principle were followed in the field of research, it might become an endeavour to create an atmosphere of international co-operation and goodwill, a sincere spirit of "give and take" with respect to research projects, achievements, views and experiences, exchange of material, and reciprocated visits for research purposes, all for a mutual benefit and improvement. Only on this basis of goodwill and readiness to trust one another can the ideals of international co-operation be truly attained.

The prosperity and achievements of a neighbour state should be greeted with sympathy and rejoicings rather than with a complex of superiority or inferiority which will undoubtedly mar the friendly relations. On the other hand, the misfortunes that befall a neighbour state should be shared, looked into, and relieved as well as possible together as members of a family.

It is in this spirit of friendliness that I wish, on behalf of the Central Institute for Nature Research in Indonesia, to convey our sincere congratulations on the occasion of the centenary anniversary of the Singapore Botanic Gardens. The relations between the Central Institute for Nature Research in Indonesia and the Singapore Botanic Gardens, which has always been characterized by a mutual readiness to help one another, should, or rather needs be continued according to the good, extant tradition, and should even be expanded and intensified in the years to come.

Since the Central Institute for Nature Research in Indonesia, better known by the name of "Botanic Gardens of Indonesia" since its foundation in 1817, has a wider field of activities covering all that lives in nature, both on land and in the waters, this Institute would like to invite the Singapore Botanic Gardens to keep up a more extensive co-operation than the one dealing with the plant world only. I feel that the Singapore Botanic Gardens has a similar function in the State of Singapore as the Central Institute for Nature Research has in the Republic of Indonesia.

The integral task of the Central Institute for Nature Research in Indonesia can be outlined as follows:—

- (a) To conduct basic research and to give expert training in the field of natural sciences (Botany, Zoology, Ichthyology, Oceanography) under conditions prevailing in tropical areas, for the benefit of practical agriculture, horticulture, landscape architecture, forestry, conservation of nature and natural resources, veterinary science, fisheries and medicine.
- (b) To collect and to catalogue the plant and animal species occurring in Indonesia and the neighbouring areas, to select scientific names for them and to prepare monographs.
- (c) To exchange research material, scientific information and publications on the basis of international co-operation.
- (d) To provide Indonesian and foreign scientists with the accommodation and the facilities to perform research work in the various institutes.
- (e) To expedite the long-term project of the "Flora Malesiana" Foundation, i.e. to compile a standard work on the vegetation of the Republic of Indonesia and the neighbouring areas on the basis of international co-operation.

- (f) To protect and care for the natural resources of Indonesia as well as possible and to disseminate knowledge of nature conservation among the general public in accordance with the principles of the International Union for the Protection of Nature and Natural Resources, of which the Botanic Gardens of Indonesia are a member.
- (g) To maintain a Zoological Museum, a Marine Aquarium, a Freshwater Aquarium, and a Biological Station for Animals Protected by National Laws, for the benefit of popular education.
- (h) To render advice on the lay-out of parks and gardens, their upkeep and embellishment.
- (i) To build up a Central Library for the Natural Sciences and to supply books and periodicals needed by the different institutes of the Ministry of Agriculture.
- (j) To carry out orders from the various institutes for making scientific pictures, films and drawings, and to train candidates in scientific photography and drawing.

The above mentioned task is carried out concordantly by the following institutes of the Central Institute for Nature Research:—

1. Hortus Botanicus, founded on 18th May, 1817.
 2. Herbarium Bogoriense, founded in 1817.
 3. Flora Malesiana Foundation, founded on 21st October, 1950.
 4. Treub Laboratory, founded in 1884.
 5. Institute for Microbiology, founded in 1956.
 6. Museum Zoologicum Bogoriense, founded in 1894.
 7. Institute for the Conservation of Nature, founded in 1937.
 8. Biological Station for Animals Protected by National Laws, founded on 17th August, 1957.
 9. Institute and Aquarium for Marine Research, founded in 1904.
 10. Bibliotheca Bogoriensis, founded in 1842.
 11. Photographic and Drawing Studios, founded in 1878.
- All of which form one harmonious and inseparable unit.

The Importance of Tropical Taxonomy to Modern Botany

By E. J. H. CORNER

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EFFORTS TO LEARN about plants are called botany, when they are sufficiently rational. Efforts to grow plants and make new ones and to destroy the harmful and unwanted are parts of agriculture and silviculture, when they are sufficiently profitable. Our enjoyment of plants, wild or in the garden, has no name, but it is an aspect of civilisation as essential as art and literature; and horticulture is a sign of progress. Thus, in concourses of men, the academic, the applied, and the recreational sides of plant-lore have developed into the botany schools of universities, the plant-breeding stations of agriculture, the research institutes of forestry, the nature-reserves of wild-life services, the parks and botanical gardens of cities, and the flower-beds, window-boxes, vases, and books of the home. Wretchedly barren is that community unmindful. In this concrete age, which hardens our lives, we should reflect upon the appeal of kampong, sawa, pasir panjang, gunong hijau, sungei berassau, and kayu chondong. The beauty of Rio de Janeiro, so inspiring to the visitor, is the city in the bay of forested mountains. Seeing then that botany, if we use that word for all ways in which plants enter our lives, is a subject vital to learning, practice, and recreation, let us consider the harder word taxonomy.

Taxonomy. All sciences split up as particular methods are used in their study. Botany, too, is sundered into an increasing number of “-ologies”, many of which require not a knowledge of plants so much as of other natural sciences, and an electron-microscopist or radiographer may be a botanist. One of these divisions is now called taxonomy. It is the old core of professional botany, derived from the herbalists through the systematists who variously improved the classification of plants. It is regarded as old fashioned, being the parent, but rather is it the trunk to the branches, ever swelling as they multiply, gathering the information, and, I believe, still the core and heart of botany. Several “-ologies” and “ographies” are indeed, attributed to taxonomy, which means the method of orderly classification but we can understand better what it is from its outcome. Nowadays taxonomy is the classification of plants according to their evolution. The early botanists and zoologists

discovered that plants and animals were constructed in definite ways, from which an orderly classification could be thought out and named, so as to give a better and international understanding of biology. A good classification is needed in science to pigeon-hole the enormous and ever-increasing number of facts: that it is objective and satisfactory, international recognition proves. Until a hundred years ago, however, this classification was an enigma because there was no adequate explanation of the expanding, varying, and yet coherent, marvellous pattern of life which it revealed, or why it should have been satisfactory. Darwin's theory of evolution was not a flash in scholastic darkness, but the sun which rose on biology. The orderliness of classification was seen to express the evolution (and extinction) of plants and animals in the past. They were being classified on the peculiarities of their various lines of descent, or heritages; being founded on "raison d'être", this was the order so satisfactory. The sun, I think, was the spontaneous combustion of taxonomy, but that is another story. To appreciate the importance of taxonomy, as evolutionary classification, we must consider a method of scientific enquiry which it has introduced. This is the distinction between homology and analogy. The method is most useful in other branches of biology which have not been able, because of the baffling complexity of protoplasm, to advance as far as morphology, or the study of structure, on which taxonomy is based. I refer particularly to physiology, genetics, biochemistry, and other experimental subjects which are incapable of classifying living things, of correlating the facts of biology, and of organising biological thought.

Homology and Analogy. There are two ways of studying plants and animals, namely the particular and the comparative. In the particular we investigate one kind of plant or animal, or one part of it, intensively. Thus, we may study the respiration of a root or muscle, or the absorption of mineral salts by root hairs, or the inheritance of certain characters such as flowering-time, grain-size, or seed-production in a plant such as the rice-plant. As any of these subjects, or the means by which they are studied, can be developed into a particular branch of science, it can be seen how these branches multiply in modern research. Sooner or later comparison must be made with other plants or animals, but what ones? Obviously comparison of objects superficially similar, as fish and whales, or ferns and palms, may be exceedingly misleading, for their similarities are analogous, not fundamental; and, as we are dealing with the minute and intricate behaviour of this exceedingly complex, largely unknown, protoplasm of living things, we must avoid as

many unknown quantities as possible. The best comparison, therefore, will be between species which have been shown by modern taxonomy to be closely allied: their protoplasm will differ the least from each other and these slight differences may be exactly what the researcher needs. Basically, plants have a certain and not impossibly large number of properties, or things which they can do. Respiration, photosynthesis, cell-differentiation, and reproduction, for instance, are essentially the same in all green plants, but the species differ in the way in which these processes are variously amplified, side-tracked, baffled, distorted, suppressed, and so on. This baffling of living processes, as we may call it, occurs largely through the solid parts of the plants making up their visible structure, on which morphology, and so taxonomy, are built. Now any one living process consists of many steps. One species of plant may have steps A—D, another A—H: one may exaggerate B—D at the expense of A and E, or *vice-versa*: another may add N—Z, and another eliminate A—P: some steps may be passed over so rapidly as not to be detectable, and so on in endless variation. Thus, when we study one plant in particular, we cannot know how the process under investigation is baffled: probably we have only part of the picture, and we do not know which part. To understand more fully we must compare taxonomically related species (of the same general heritage) which will, through the very fact that they are not the same species (or genus) and have not precisely the same protoplasm, reveal other parts of the picture. This is homologous comparison as distinct from the artificial and analogous comparison which will introduce a multitude of unknown quantities; and homologous comparison depends on good taxonomy: it is, in fact, taxonomy. Obvious and simple as this important method of enquiry seems, it is far from being generally appreciated, and a great deal of botany is confused by analogous comparison. Nevertheless, it is being tacitly adopted because it works, and it is my purpose in this article to make sure that we understand why it works. Thus, comparative cytology, dealing with chromosome-numbers, structure, and behaviour, could never have been developed if there had not been the taxonomic work for it to follow: the tendency is to extol the new cytology and forget, if not to ridicule, the service of taxonomy. Laboratories have begun to look for new "guinea-pigs": hitherto they have adopted what was at hand, but they should be advised to enlarge their stock-in-trade taxonomically. Plant-breeding is scouring the world for wild species allied to crop-plants, whereby to breed new strains. Sylviculture is considering other timbers as world-demand exhausts supply. Horticulture is experimenting with the vigour and novelty of hybrids. In every case the

guide to requirements is in the pages of taxonomy, wherein the world's supply of species are catalogued for ready reference on the principle of hereditary construction. When we consider that this research demands taxonomic information from microscopic plants, as algae and yeasts, to timber-trees, orchids, and grasses, the importance of taxonomy can be understood. It has well been called the hand-maid of biology: in my experience, the higher the office, the greater the servant, and that applies both ways to taxonomy.

Tropical Taxonomy. I have assumed that our evolutionary classification is perfect. Of course it is not. Much is indisputably true, such as the recognition that aroids are not orchids, or casuarinas are not pines, but there are many plants, including casuarinas, the proper position of which in classification we do not know. In many groups, such as orchids, grasses, sedges, palms, and many trees, we do not know how to draw generic limits and, often, we have not the species properly arranged in the genus. We have no satisfactory classification of the orders of dicotyledons, and that of the larger fungi is extremely empirical. There are four great difficulties: firstly, the multitude of organisms is almost inconceivable: secondly, there have never been enough taxonomists to do the work thoroughly: thirdly, the material on which the taxonomist has to work is too often insufficient: and, fourthly, it is extremely difficult to distinguish analogy from homology, or, as we say, parallel from phyletic evolution. The result is that, when a new taxonomist has enough material to re-examine a deficient group, he almost invariably discovers that previous classification has mistaken analogy for consanguinity. One of the greatest revisions in this respect was the re-classification of the algae towards the end of last century: though scarcely mentioned in the history of botany, it has revolutionised the teaching. Now, nowhere are these defects so numerous as in the tropical countries. Fungi, ferns, and flowering plants have their headquarters in the tropics because here the broad-leafed trees have built up the richest biological environment of all—the tropical forest—wherein tens of thousands of flowering plants, ferns, and fungi dwell. You may think that north temperate students of fungi have a good knowledge of *Boletus*, but if we knew the boleti from Assam to New Guinea we would re-do the classification of *Boletus*! The “mushroom-soup” of Europe, which is a prized and limited commodity, is made from *Boletus edulis*, many allies of which grow in Malaya. If we understood the tropical polypores, which abound on wood from rubber-roots and tea-bushes to meranti and oil-palm, and in thousands in the forests, we would entirely revise the present artificial classification of these

fungi, with results of great significance for research: in fact, research on these fungi is baulked through lack of satisfactory classification. If we could revise the classification of the trees and lianes of the tropics from living plants and bring this improved knowledge into general botany, we could resolve many of the major problems of flowering plants. Living plants? So far, botany has had to deal mainly with dried specimens and pickled flowers of tropical plants; and more than half the plants of the world are known, accordingly, fragmentary and dead. There is the practical difficulty how to study these plants nearer to the places where they grow than the museums, herbaria, and botanic gardens of Europe and North America. The interest of most of these plants may be only academic, but we do not know which may not become a subject of intense laboratory or commercial interest. Thus *Rauwolfia* sprang to fame, and luckily it had been studied taxonomically. It has been said that, as timber supplies dwindle, bamboos of rapid growth will be required, and how many of us feel content with the meagre knowledge of bamboos? Indeed, with new methods of fibre-boards, silviculture may turn to entirely new practices with the small quick-growing trees of the tropics and the manager, or taxonomist, of these plants will be needed to advise. Most tropical fruits could be improved and diversified, but nearly all the general of tropical fruits need taxonomic revision for adequate research. The cultivated banana has demanded extensive botanical exploration in the last twenty years to collect as many wild species of its genus, *Musa*, as could be obtained. Solanaceous fruits, particularly of tropical America, may be called upon next, but we have no modern guide to the genus *Solanum*. In contrast, the durians have recently been monographed and here is the prospect for the improvement of this popular fruit.

Tropical Botanical Institutes. There is no fundamental difference between tropical and temperate botany, but the richness of the tropical flora means so much more to be discovered and the expansion of our thoughts. As rubber, coffee, cocoa, banana, and other tropical commodities in daily life, botany also should thrive on tropical ideas. Our textbooks, however, written from the north temperate angle, seem to me like the splendid treatises the Romans could have written about the world, ignorant of three-quarters of it; and it was the "barbarians" who took over! In tropical botany we are passing from the era of exploration, when we had to be content with the dead records of expeditions, to that of the scientific appreciation of the living plants now made possible by expanding civilisation. The former has still much to contribute, which tropical countries cannot by themselves achieve, as may be learnt from the

Flora Malesiana and similar works on Africa in process of publication. But, for the taxonomic progress with living plants and all the impetus to botany, theoretical and applied, which will follow, we must look to the botanical institutes in tropical countries. I am impressed by the growing number of young students in the tropics. The thirst for knowledge cannot be quenched. They will build, and civilisation will expect it. Western science has led the way to a better appreciation of nature, but the tropical countries must now help their eager students to extend this knowledge in their own rich heritage for the benefit of mankind. I have often thought that what has been started in botany in Europe and North America will eventually have its headquarters in the tropics where the plants themselves orientate thought. On the tropical students now falls the responsibility for writing their biological floras, as is the newest taxonomic development in Europe. Theirs will be the responsibility of preserving the native vegetation and the beauty of the country by wayside and in national park, and of collecting the living assemblage of economic, ornamental, and rare plants for research and recreation in botanic gardens. Theirs will be the opportunity to step up all botany by study of new sorts of protoplasm. It is a hopeful glimpse. At present they may lean on outside support, but I look to the time when students from outside will learn in the tropical institutes.

In conclusion, tropical countries have a duty to promote botany. They inherit a rich share of plant-evolution, which has yet to be incorporated into the wisdom, practice, and enjoyment of civilisation. Their students will expect intellectual progress. In practice, success will depend on taxonomic efficiency, which is the chief scientific work of botanic gardens; other subjects will be developed by universities, special institutes, and amateur societies. It is not a pole or bush to be grown, but a tree of knowledge, the trunk whereof is taxonomy.

The International Code of Nomenclature for Cultivated Plants with Special Reference to Tropical Botanic Gardens

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THE NAMES OF PLANTS are of three kinds, botanical or scientific names (e.g. *Mangifera indica*), common or vernacular names (e.g. Mango), and the names of the cultivated varieties or cultivars (e.g. the Mango 'Jaffna'). The use of botanical names is governed by *The International Code of Botanical Nomenclature*, under the control of successive International Botanical Congresses; common names are gloriously free from all control, except that of common usage; cultivar names of horticultural plants have for many years been, in theory, subject to an International Code, but, until recently, the Code was virtually unknown to most horticulturists, and it is only since 1953 that a widely circulated Code has been available to those concerned with cultivated plants. It is this Code that I want to discuss in this article, and especially its importance to the naming of plants cultivated in the tropics.

The *International Code of Nomenclature for Cultivated Plants*, published in 1953, was really a combined effort of the International Botanical Congress held at Stockholm in 1950 and the International Horticultural Congress held in London in 1952. Though entitled "for Cultivated Plants", it was drawn up primarily with *horticultural* plants in mind, and it soon became clear that several modifications would have to be made if it was to be equally serviceable to agriculturists and foresters. Accordingly, a special *International Commission for the Nomenclature of Cultivated Plants* was established under the International Union of Biological Sciences, and this Commission set to work to re-formulate the Code so that it would apply satisfactorily to *all* cultivated plants. The full history of the work of the Commission is set out in the Preface to the new (1958) edition of the Code that it produced, together with the names of the agriculturists, horticulturists, foresters and botanists responsible.

The Code is obtainable from the Royal Horticultural Society in London and, since its publication, is gradually becoming known

and accepted by those concerned with the cultivation of all types of plants throughout the world.

I would strongly recommend that all those interested should obtain a copy of the Code, but it may be helpful to summarize here some of its main provisions.

(1) The Code defines a cultivar or cultivated variety as "an assemblage of cultivated individuals which are distinguished by any characters (morphological, physiological, cytological, chemical, or others) significant for the purposes of agriculture, forestry, or horticulture, and which, when reproduced (sexually or asexually), retain their distinguishing features." It recommends the use of the international word "cultivar", but allows, of course, for the use of other terms normally employed as equivalents in various languages (e.g. Variety in English, Sorte in German, etc.).

(2) The various different *kinds* of cultivars are set out and defined (i.e. clones; lines; assemblages of individuals showing genetical differences but united by one or more characteristics differentiating it from other cultivars; and *fi* hybrids of the type now common in maize and other crops).

(3) The category *strain* is not adopted in the Code; any selection showing sufficient differences from a parent cultivar to render it worthy of a name is regarded as a distinct cultivar.

(4) It is recommended that, in future, all cultivar names should be "fancy names", that is, names markedly different from botanical names in Latin form, so as to distinguish them from the names of botanical varieties. However, existing cultivar names in Latin form are not to be altered.

(5) Various rules are set out governing the choice of new cultivar names. For example, they should preferably consist of only one or two words, and must not consist of more than three; words that are excessively long or difficult to pronounce in other languages should be avoided and there are many other similar common-sense provisions.

(6) Names may, of course, be in any language, and there are regulations for transliteration and translation into other alphabets and languages. Where a cultivar name, even though transliterated or translated, is "not commercially acceptable" in other countries, it may be changed and a "commercial synonym" substituted, provided the synonym is approved by the originator of the cultivar and by the official Registration Authority concerned (see below).

(7) For cases where two or more names have been given to a single cultivar, rules are laid down for choosing the correct name.

These are, broadly speaking, based on priority of publication, but exceptions are allowed for when strict application would lead to the changing of widely used names.

(8) Rules are provided for the description of cultivars and the publication of cultivar names. Any language may be employed for the description, but the use of English, French, German, Russian or Spanish is strongly recommended.

(9) The method of *writing* cultivar names is fully dealt with. All names should be written with capitals, unless the custom of the language concerned dictates otherwise. When printing a cultivar name "in full", it should follow the botanical (or common) name of the species or hybrid concerned and should be distinguished typographically from it, preferably by presenting the botanical name in italics and the cultivar name in roman type, and by enclosing the cultivar name in *single* quotation marks, e.g. *Mangifera indica* 'Jaffna'.

(10) Full regulations are included for the naming of hybrids produced in cultivation, and their cultivars.

(11) One of the most important sections of the Code deals with the establishment of official Registration Authorities for all the main groups of cultivated plants. The primary function of these authorities is to register the names of new cultivars in their groups, in much the same way as the names of race horses or pedigree dogs are registered, thus preventing duplication and ensuring that names are in accordance with the Code; but the authorities would also be responsible for publishing basic lists of all the cultivar names in their group (to be brought up to date from time to time), approving commercial synonyms and names retained against the rule of priority, and, in general, for acting as a central clearing house and "advisory bureau" for the cultivars with which they are concerned. The aim is to establish one International Registration Authority for each group, but either as a stage towards this, or, in the bigger groups, perhaps in addition to the International Authority, National Authorities may also be desirable. For horticultural plants, International Registration Authorities are appointed by an International Horticultural Congress and national authorities by agreement between those concerned.

A number of International Authorities has already been appointed by the Horticultural Congress held at The Hague in 1955 and at Nice in 1958. These are mostly for plants grown in temperate climates (e.g. The American Iris Society for the genus *Iris* and the Royal Horticultural Society for *Rhododendron*), and there will be a great need in the future for suitable bodies to undertake

the registration of names of cultivars of ornamental and useful genera grown in the tropics. This is where tropical botanic gardens might play a very useful role, especially in acting as registration authorities for ornamental genera. An increasing number of cultivars are being produced in these genera and it is important to begin registering their names, and printing basic lists, at as early a stage as possible, so as to prevent the development of overlapping and duplication. *Bougainvillea*, *Hibiscus*, *Nerium*, and *Zinnia* are genera that spring to mind, and there are, of course, many others, both ornamental and useful, that should be included in a comprehensive scheme. It should be emphasised that, although it is highly desirable to combine cultivar trials with registration, this is not essential, and the registration of names can be carried out independently of such trials. If any botanic garden or other suitable institution in the tropics feel that they are able and willing to act as a registration authority, they should communicate with the Secretary of the International Commission, Dr. H. R. Fletcher, The Royal Botanic Garden, Edinburgh.

I hope that this very brief account of the International Code and of the registration scheme that it embodies will be of interest to those concerned with the cultivars of tropical plants, and that they will promote international co-operation in this important field by following the provisions of the Code and by helping to set up registration authorities where they are needed.

The Importance of Biological Research in the Pacific Region

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AT FIRST GLANCE The Importance of Biological Research in the Pacific Region seems such an obvious topic that anything one might write about it would be a truism. The world, including the Pacific, is dependent for its food supply on the products of several branches of applied biology. Large parts of industry depend for raw materials on applied biology. We all depend for cures for our ills and injuries on applied biology.

Before going on it may be well to define our terms. Biology is the field of science that deals with living things. Its scope runs from minute bacteria and even viruses to flowering plants and from the simplest one-celled animals to dinosaurs, elephants and man himself. It deals not only with the kinds, nature and physiology of organisms, but with their relationships to each other and to their non-living environments. Research is the attempt to learn new facts and to determine their significance in relation to what is already known. It is biological research, of course, when the facts learned are about living things.

Hence, agriculture, husbandry, fisheries, forestry, and medicine are branches of applied biology, and are only some of the branches that affect our daily lives. And biological research is the search for new knowledge bearing on these vital activities. Who could question the importance of this? In view of the facts that we do not have enough food for all the people, that raw materials are often scarce, that we still fall ill and die before our normal life span is over, it would seem obvious that biological research would be regarded as perhaps the most important of all activities, that the demand for it would be unlimited and the amount of research would only be limited by the supply of competent and willing research workers.

Curiously enough, this is not generally the case. What we know about agriculture, forestry, fisheries and other applied fields in biology is taken for granted. The research worker is commonly regarded as a strange man, perhaps a little mad. That there should be a reason to pay him a salary, or that he should need funds for his work, are hard for the politician who controls the spending of

public money to understand and harder for him to accept. And when the budget must be reduced, the first and easiest item to cut out is research. This may seem incredible and incomprehensible but is a phenomenon observed repeatedly. It may be worthwhile to seek an explanation for it.

Clearly basic to the problem must be a lack of awareness that all is not going as well as it could. The politicians and the influential people that control them are not the hungry ones. Their economic situation is such that they can buy food when they need it regardless of its scarcity. If they are users of raw materials, scarcities only show up, during peace-time, at least, as increases in costs which are simply passed on to the consumer in the form of increased prices. Deficiencies in medical knowledge, indeed, do become evident to even the most comfortably situated and influential politician or magnate, at least when he gets old. And it is significant that medical research is by far the best supported of the research activities of biology.

Perhaps the best way to approach the subject of the importance of biological research is to examine the general system in which we live, to see just what troubles that result from an insufficiency of biological knowledge might be corrected by research. If attention can be directed to these and some indication given of how biological research is pertinent toward remedying them the general question may be clarified.

The fact that people are inadequately nourished was mentioned above. It has been said that this is due to inadequate distribution rather than under-production. However, if distribution of food were really equalized, probably the well-fed among us would gain a slight knowledge of the pangs of hunger and the presently hungry would only be a little less so. And with this somewhat more adequate nourishment more of the presently starving would survive, susceptibility to disease would be less, and population would increase to where the food supply would be on the whole more inadequate than now. Research in agriculture, and in the various basic aspects of biology that are applied by agriculture, can contribute greatly toward the alleviation of current food shortages, also of shortages of raw materials produced by agriculture. Few in Malaya will have to be told of the part played by botanical research in the present prosperity of the area. The entire rubber industry in Malaya stems from the experimental introduction of the *Hevea* rubber tree into the Singapore Botanic Gardens where it was nurtured by the botanist Ridley. Research has been the constant accompaniment of every step in the development of this industry from the stage of gathering gum from the wild trees in Amazonia to the

highly efficient plantation culture in modern Malaya. One hundred fifty years ago *Hevea* was only a botanical curiosity. Palm oil, cane sugar, quinine, and pineapples are only a few of the plantation crops that are produced in a very efficient and economical manner today because of large investments in biological research.

Although medical research has changed the lives of people in the tropics from continual struggles with a host of parasites no one would pretend that we have reached the point where long healthy lives are to be assumed as normal. Tropical medicine and public health are more than ordinarily dependent on basic biological research because they lack the long background of research possessed by temperate medicine. We do not even know the complete ecology and life history of some of our serious parasites and disease vectors.

A few years ago there was a fairly widespread idea that synthetic chemistry had pretty well taken over the drug field—that plant products were interesting only as examples of primitive medicine, not to be compared with sulphur and other synthetic miracle drugs. Then came penicillin, cortisone, and reserpine and a sudden intensive preoccupation arose with a large number of obscure plants, from microscopic bacteria and fungi to forest trees. These plants occur in all parts of the world, but the tropical Pacific has more than a small share of them, because of the enormous flora of this tropical region. Research on medicinal plants is slow tedious work, and much of it never pays off, but the occasional important discovery much more than justifies the entire outlay in work and money. This is, of course, much more apparent to the sick man than to the healthy one. Few people who have been cured of pneumonia by antibiotics would doubt the wisdom of money spent on pharmaceutical microbiology.

One of the serious difficulties in tropical countries is the degradation of the soils. Originally it is probable that most tropical soils were in a state of equilibrium with the biological communities that occupied them. When man came into the picture this equilibrium tended to become more and more disturbed. As man's ability to affect this environment increased, through his development of implements and technology, his numbers grew. More strain was put on his environment as more demands arose for its productions. One only needs to look at the waste places on Singapore Island to see in aggravated form the results of this pressure on the resources of the soil. Degraded vegetation and exposed subsoil, capable of producing almost nothing of value are almost the rule here as in many thickly populated tropical areas. Although great steps have been made in preventing and alleviating such conditions in the temperate zone little has been done in this direction in the tropics.

This is primarily a biological problem, one of managing vegetation and soil biota, of working out wiser methods of using the soil, and more importantly, of managing or slowing down the growth of human populations. Intensive research in the biological fields basic to all of these activities is urgently needed, especially as environmental failure is cumulative.

A specter haunting agriculture, forestry, and all activities depending on plants is plant disease. Crop losses and landscape degradation from plant disease reach enormous proportions. In temperate areas vast amounts of research in plant pathology are required just to keep pace with the increasing ravages of plant diseases. In the tropics there are, at present, more diseases and less research. And as agriculture and forestry become more intensive, disease problems increase, rather than decrease. Monocultures provide ideal conditions for the spread of diseases. New strains of disease organisms come into existence and become established. The same can be said of insect pests. At the present level of research in plant pathology and entomology we can not hope to hold our own, especially in the tropics.

So far the discussion has concerned only areas where serious difficulties are to be corrected or averted. Examples of these could be multiplied indefinitely, especially by going more into particular cases. Of importance, also, are areas where improvements in already tolerable existing conditions may be brought about by research. We have palatable fruits and other food crops in our gardens and fields. This does not say, however, that they are the best possible. Plant breeding has in the past made the difference between the inferior, often almost inedible wild products, and the fine domestic varieties that we have. This was accomplished without much knowledge of the principles underlying the evolution of new kinds of plants. Now the science of genetics is an advanced discipline and future possibilities in plant breeding dwarf completely past accomplishments. In the past necessity guided the groping plant breeder. Now, knowledge of the possibilities should provide the stimulus and imagination can furnish the direction. The same can be said of breeding of other classes of economic plants and animals.

The ways in which man's environment can be influenced to make it more agreeable for him to live in are countless, and many of them depend on biological research. Most of them, unfortunately, will take the form of counteracting detrimental changes brought about by man's own activities. Man was well adapted to his primitive habitat. As he has changed this environment it has in many respects become more unsuitable for his occupancy. This does not

seem to be necessary but it has happened and is continuing in accelerated fashion. The advice of ecologists is vital to retarding or reversing this trend. This advice must be based on extensive research, most of which has not yet been done. If man is not to foul his nest so completely that it will eventually be uninhabitable he must understand his own relation to his environment. This will come about by properly oriented ecological research.

So far this discussion has been devoted strictly to matters that affect man's material needs, comfort, and well-being. These are important, but there is all too great a tendency to consider them to the exclusion of everything else. Traditionally, the peoples of tropical Asia have been able to strike a better balance between the material and the higher aspects of life than most others. With the impact of Western culture there is a tendency for the material side to receive more emphasis. This is not necessarily good. It entails a loss in some of the virtues inherent in some Asiatic cultures. Though science is generally thought of as strictly a materially oriented activity it is fortunately not completely so, either in its motivations or in the benefits it yields. One or two of the other facets may be examined to give us a truer picture of the place and importance of biological research in the present phase of the cultural history of the tropical Pacific region.

The greater part of the people of this part of the world belong to newly independent nations, after varying periods of colonialism. During the colonial period the cultural patterns changed, here as indeed in western Europe, from a mediaeval, essentially feudal state, more or less self-contained and in equilibrium with local environments, to modern membership in a highly integrated world community, completely dependent on the application of scientific knowledge and accomplishment for its normal functioning. A heroic, if somewhat frantic, effort is being made by these peoples to participate in the material and social benefits of modern scientific achievement and technology. This is regarded as an inherent right. Most of the science at present emanates from the western world, much of it from former (and present) colonial powers. The question has been asked if the newly independent peoples are really ready for full participation in the modern scientific world community, whether an essentially parasitic status, scientifically, is proper or justified. The question has even been asked whether the members of these non-western cultures are capable of scientific achievement equal to that of their western colleagues.

On the basis of actual quantity and quality of work done in these countries at the present time there is a certain amount of valid reason for these questions. Rather little work is done and much of

it does not measure up to the best produced elsewhere. However, those of us with experience in these countries and with personal acquaintance with indigenous scientists there mostly realize that present inferiority in output results from the cultural situation rather than from any inherent lack of ability among the scientists. In cultures where in the past there have been few opportunities for scientific work among the local people, poor educational facilities for them, and no scientific tradition, there is not likely to be immediate superior scientific accomplishment. If the intellectual climate is not right for it, and if no prestige is attached to it, science will not flourish. At the present time in southern Asian countries there are few scientists and these are smothered by administrative duties. This is especially true of biologists. It is obviously of the utmost importance to correct this situation, and clearly the way to do it is to emphasize, in every way possible, officially and privately, the importance of biological research. It is clearly essential to show the world that countries newly emerged from a dependent status are capable, both of attracting first-class foreign scientists and of eventually training local scientists who are the equals of those in other countries. This is to be done, obviously, not by creating scientists by official decree, but by placing such emphasis on research that young people with high intelligence and with scientific inclinations will be attracted into scientific careers and will realize the necessity of achieving training and standards equivalent to those prevalent abroad. This is a long-term project and crash programmes are not the answer. Rather, steady emphasis on research and well-directed support for it will bring about sound progress.

Finally, it must be pointed out that, important as are the practical, economic, and political benefits of biological and other scientific research, the fundamental importance of this, as well as other intellectual activities, lies in the development of the human mind and in the satisfaction of man's curiosity and his desire to understand his universe and his place in it. This is the motivation for all research beyond the solution of obvious immediate practical problems. The place of pure research as an intellectual activity and the strength of the urge toward understanding in a culture is perhaps the best measure of its degree of advancement in the scale of civilization.

Role of Botanical Gardens in the Humid Tropics and UNESCO's Programme related to them

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LUXURIANT VEGETATION is a prominent feature of the humid tropical regions and yet very little of it is known. The nature of the plants making up this vegetation, methods of propagation, growth requirements, potential use for the benefit of man—timber, products, barks—have not been studied systematically so far. This handicaps planning and development of agriculture and forestry, important contributors to the economy of a tropical country.

The little information available at present has chiefly come from botanic gardens maintained by departments of agriculture or scientific societies. There are at present only a small number of botanical gardens in the tropical regions. Some of them are:

- Botanic Gardens, Peradeniya, Ceylon
- Central National Botanic Garden, Calcutta
- National Botanic Gardens, Lucknow
- Botanic Gardens, Singapore
- Jardim botanico do Rio de Janeiro
- Botanic Gardens, George Town, British Guiana
- Royal Botanic Gardens, Hope, Kingston, Jamaica
- Botanic Gardens, Bogor, Indonesia.

The gardens are of different size and their activities include maintenance of a representative collection of the vegetation of a region, demonstration of principles of conservation of vegetation, maintenance of nurseries of plants, collection, preservation and exchange of dried plant specimens for purposes of identification. It is commonly acknowledged that much of the natural vegetation of the humid tropical regions is cut down or burnt unmethodically resulting in erosion of the soil and this results in subsequent damage by floods. The botanic gardens—the large ones with extensive enclosures—have a definite role here to play in demonstrating to the general public the useful role of vegetation in binding soil, thus preventing erosion and making them useful for agriculture. It may be added here that in the desert tropical regions,

where the advance of sand dunes threatens valuable agricultural land, demonstration of fixing the sand dunes by appropriate vegetation is a definite function of a botanical garden located in a desert tropical region.

Secondly the gardens can play a valuable role in breeding plants resistant to various types of plant diseases in nurseries and trial plots and then distributing such varieties to agriculturists. It can and does help in introducing plants which thrive in similar environments in another region to its nursery for the first time and breeding one or more generations of them, thus making them adapted to their new surroundings. Further some plants are in danger of complete extinction from the surface of the earth owing to their inability to adapt to possible changes in the environments in which they grow. It would be valuable to protect them and to increase their numbers if possible, and the botanical gardens can play a vital role in this matter. Several botanic gardens undertake such projects and examples that come to the mind are the Medicinal Garden in Ganewatte in Ceylon, the Botanic Gardens of Hakgala and Gampaha, the Botanic Gardens in George Town, British Guiana, the Royal Botanic Gardens, Hope, Kingston, Jamaica.

Most of the botanic gardens maintain a herbarium wherein type specimens of plants are preserved for taxonomic studies. This material is annotated by competent botanists describing their chief characteristics, places from where they have been collected and their scientific names. In order to do this regular expeditions are undertaken to different areas to collect the plants. Several sets per species are collected and the specimens are suitably mounted on sheets of paper to preserve them. Identified duplicates of the specimens are exchanged with herbaria in other parts of the world. Preparation of floras of the region are undertaken utilizing the material preserved in such herbaria. The preparation of the flora of the Malaysian region is currently in progress and a large number of herbaria and taxonomists all over the world are co-operating in the project.

The humid tropics programme of UNESCO intends supporting the collection, identification, preservation and exchange of material in herbaria. Until now, material collected had to be sent abroad for identification purposes. This has naturally retarded the regular publication of the floras of tropical regions, important in knowing the features of the vegetation in the regions.

The first step is the organization of regular expeditions for collection purposes from a large number of selected institutions located in the humid tropical regions. In order to do so, a number of specialists have to be trained to undertake regular expeditions.

Relatively well-established institutions in the tropics would serve as key centres for organizing training programmes. UNESCO assistance would be utilized to finance this training programme, by provision of foreign specialists, equipment, etc. It would also bear the costs of publication of results.

UNESCO's Advisory Committee for Humid Tropics Research at its first session in Manaus (Brasil) in July 1957, recommended that the Secretariat study the practicability of establishing such key herbaria. Information from a large number of herbaria in the humid tropical regions was collected regarding the nature and total number of specimens, annual additions, sources of specimens, identifications carried out and exchange of specimens effected during the last three years. More than 100 institutions furnished this information, and it is hoped that a short list of suitable institutions for development as key herbaria will be established by the Advisory Committee.

Depending on the finances available, it is hoped to conclude agreements with these institutions to make arrangements for organizing training programmes.

Another form of UNESCO's activities in the field of Humid Tropics research in which we collaborate closely with the botanic gardens, is the convening of scientific symposia under the auspices of this UNESCO Office, e.g. the Symposium on the Study of Tropical Vegetation in Kandy, Ceylon, in March 1956, which was organized jointly by this UNESCO Office and its sister office in New Delhi; the Symposium on the Phytochemistry of Tropical Plants in Kuala Lumpur, Malaya, in December 1957, and the Symposium on the Vegetation of the Humid Tropics, held in Bogor, Indonesia, in December 1958.

It may also be mentioned that this UNESCO Office has on several occasions awarded grants to facilitate the exchange of research workers between botanical gardens and herbaria in the tropical regions.

It will be evident from the foregoing that UNESCO is deeply concerned with the development of botanic gardens. Their collaboration is indispensable for the implementation of the UNESCO programme in Humid Tropics research. The UNESCO Science Co-operation Office for South-east Asia is happy to express its appreciation of the scientific work done by the Singapore Botanic Gardens. We congratulate the Gardens on the Centenary and express our hope for fruitful collaboration in the future.

Regenerating High Forest on Singapore Island

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Introduction

NOTES ON SECONDARY or subseral vegetation on Singapore Island were given in a previous paper (Gilliland, 1958). Most of the island is covered with such vegetation today and the causes of this are made patent from the history of gambier, pepper and coffee cultivation and timber and fire-wood exploitation as recorded by Burkill (1935, p. 2201). The principal surviving relic of primary high forest has long been preserved first as a forest reserve by the Forest Department of the Straits Settlements, and later as a nature reserve by the Nature Reserves Board, Singapore. This relic of some 152 acres covers the upper slopes of the island's highest hill, Bukit Timah, and is the type-locality for a remarkably large number of species. The possibility of the existence elsewhere on the island of small relics of primary high forest was made manifest from a study of aerial photographs. A large area jointly maintained as a Nature Reserve by the City Council and the Nature Reserves Board comprises the catchment area of the three principal reservoirs of the City's water supply. The southernmost of these is the MacRitchie Reservoir and the photographs suggested that the vegetation along its southern shore would warrant study. Such study reveals the presence of a forest of Dipterocarp dominated type which has not been so exploited as to alter radically its character. This paper discusses the results of the application of a line transect sampling technique to this forest.

History

Enquiry from the City Water Engineer reveals that this Reservoir first came under the control of the City Council Water Department in 1857.

The Office of the Commissioner of Lands, Singapore, records that in the same year the piece of land on which this forest now stands was granted to Mr. Sim Wye Tye (Indenture No. 19) and Mr. Tan Ah Pok (Indenture No. 84).

Further sales of this land, of the first portion in 1876 and of the second portion in 1858, to further owners are recorded but in 1890 the Municipal Commissioners acquired all the land in this area. The acquired land was surrendered to Government and on

2nd June, 1906 was re-issued with new title to the Municipal Commissioners.

In 1910 the bridle path, which currently traverses the forest from west to east, was cut and in 1933 the road "Lornie Road" which, today, forms the southern boundary of "MacRitchie Reservoir Jungle" was constructed.

It is reasonable to conclude, especially in light of the more recent building of the paths and roads, that such occupation of the land as did occur was not wholly destructive of the then-existing vegetation. However, the existence of an old road crossing the reservoir from north to south, recently revealed during a drought period, indicates that communications, even if of different pattern from the present, did exist previously.

Principal Trees

There are many large trees in the area and specimens of the following with a diameter at breast height, or above buttress, of 2 feet or more (76 in. girth) were noted.

- | | |
|-------------------------------------|--|
| 1. <i>Adina rubescens</i> | 20. <i>Ficus consociata</i> v. <i>murtonii</i> |
| 2. <i>Alstonia angustifolia</i> | 21. <i>Gordonia singaporeana</i> |
| 3. <i>Anisoptera megistocarpa</i> | 22. <i>Heritiera simplicifolia</i> |
| 4. <i>Aquilaria malaccensis</i> | 23. <i>Irvingia malayana</i> |
| 5. <i>Artocarpus scortechinii</i> | 24. <i>Koompassia malaccensis</i> |
| 6. <i>Artocarpus lanceifolius</i> | 25. <i>Melanorrhoea woodsiana</i> |
| 7. <i>Artocarpus anisophylla</i> | 26. <i>Nephelium lappaceum</i> |
| 8. <i>Artocarpus rigidus</i> | 27. <i>Palaquium rostratum</i> |
| 9. <i>Calophyllum floribunda</i> | 28. <i>Palaquium obovatum</i> |
| 10. <i>Camposperma auriculata</i> | 29. <i>Pygeum polystachyum</i> |
| 11. <i>Castanopsis hullettii</i> | 30. <i>Quercus brevistyla</i> |
| 12. <i>Cinnamomum iners</i> | 31. <i>Santiria laevigata</i> |
| 13. <i>Cryptocarya griffithiana</i> | 32. <i>Santiria tomentosa</i> |
| 14. <i>Dipterocarpus hasseltii</i> | 33. <i>Santiria griffithii</i> |
| 15. <i>Dipterocarpus apterus</i> | 34. <i>Shorea ovalis</i> |
| 16. <i>Dipterocarpus kunstleri</i> | 35. <i>Shorea glauca</i> |
| 17. <i>Dyera costulata</i> | 36. <i>Shorea paucifolia</i> |
| 18. <i>Dysoxylum mollissimum</i> | 37. <i>Vitex pubescens</i> |
| 19. <i>Fagraea fragrans</i> | |

It seems reasonable to conclude on the basis of such mean annual increment data as are available (Edwards, 1930) that none of these trees is likely to be older than 100 years. This finding agrees with the supposition that following the original alienation of the land little more than the extraction of standing timber was done—the present trees would then represent the successful subsequent growth of existing regeneration (Richards, 1952).

Sampling Method

To contrast this with the secondary forest already examined (Gilliland, 1958) it was decided to make a similar line transect

sample. The sample consists of a belt or transect 1,000 feet long and 6 feet wide and is obtained as follows:—

- (a) It is divided into 10 sub-samples each 100 feet long, each sub-sample taken at random.
- (b) Each sub-sample is obtained by laying down a surveyor's 100 foot chain. Thereupon the No. 1 of the pair of observers prepares four 3 feet wands which are spaced and respaced along the chain to demarcate convenient portions 6 feet wide. No. 2 of the pair of observers acts as amanuensis recording data, and the team works its way along the chain.
- (c) All woody stems are measured with a diameter tape so that they may be recorded in the size categories 0-1; 1-3; 3-5; 5-7; and > 7 inches.
- (d) A specimen of any seedling, sapling, or tree which cannot immediately be identified is numbered and collected for identification.

It is wise to make two practice 100 foot samples before commencing on the serious record in order to become familiar with the principal plants present in all their stages.

A sub-sample takes between 1 and 2 hours to record in the field. As soon as the data for a particular sub-sample have been obtained work on the "unknowns" begins. This may occupy a further week. Not till this is complete does work on the second sub-sample begin. Identification was greatly assisted by the knowledge and help of 'Che Ahmad bin Hassan and Tuan Haji Mohammed Nor bin Mohd. Ghous both of whom had served on the Botanic Gardens staff for over 40 years. Much time and patience is clearly required to complete a sample.

As noted above 10 sub-samples were used for the collection of the data. The question then arose as to whether or not one can generalise from the 10 sub-samples and draw conclusions about the total area from which the sub-samples were taken.

The first step was to determine whether or not these 10 sub-samples could be treated as a random group of samples from the general area. The intention was to test this by the *analysis of variance* technique. One of the requirements of the analysis of variance technique is that the variability should be similar from one sub-sample to the next. Putting it another way the 10 sub-samples should be homogenous with respect to the variability of the frequencies. This test for homogeneity was carried out by means of Bartlett's test and the samples proved *not* to be homogeneous by this test. The results are presented in table I.

TABLE I

MEANS AND VARIANCES OF THE FREQUENCIES OF THE 205 SPECIES IN THE 10 SUB-SAMPLES.

<i>Sub-sample No.</i>	<i>Mean Frequency</i>	<i>Variance of Frequencies</i>
	1.33	21.90
	1.53	19.45
3	2.43	52.98
4	2.42	41.70
5	2.63	79.87
6	2.74	49.16
7	2.80	67.40
8	2.05	30.81
9	1.82	17.86
10	2.43	44.10

Bartlett's Test: $X^2 = 236.64$

P < .001

The result of Bartlett's test therefore made the application of the analysis of variance "F—test" questionable. The decision was made then to test all the possible differences between the means of the sub-samples by the "t"—test of significance. Forty-five t-tests then had to be carried out. With the 0.05 level of significance as the critical value, if the hypothesis of random sampling is tenable, there should be no more than 3 differences large enough to be judged significant at the 0.05 level and beyond. When the 45 tests of significance were carried out 3 differences barely reached the .05 level of significance. These differences were between sub-sample 1 and sub-sample 6, sub-sample 1 and sub-sample 7, and between sub-sample 2 and sub-sample 6. No difference reached the 0.01 level. Thus with respect to the means of the 10 sub-samples one can retain the hypothesis that they are random samples from the same population.

It is interesting to note that in spite of the violation of the homogeneity of variance test and in spite of the distributions being non-normal the overall F-test shown in table II clearly supports the conclusion above that the means can be assumed to be drawn from the same population.

TABLE II

ANALYSIS OF VARIANCE TEST OF RANDOM SAMPLING.

	<i>Sums of Squares</i>	<i>d.f</i>	<i>Variance Estimate</i>
Between sub-samples	.. 485.95	9	53.99
Within sub-samples	.. 86,742.58	2,040	42.52

F = 1.27

P > .05

The data were then rearranged from the index cards and each of the 205 species was classified according to its "B" (belongingness) value where the value of "B" is the number of sub-samples in which that species occurred; thus "B" = 7 means the species has been recorded in 7 out of 10 sub-samples and "B" = 2 means the species has been found in 2 sub-samples only. A "B" value was determined for each species.

It is clear from the above definition of "B" that one would expect a positive correlation between the frequency of a plant and its "B" value, but there is no reason to expect this relationship either to be linear or perfect. Table III shows the scatter diagram of the two-way plot of "B" values and frequencies. The positive relationship and its non-linearity can readily be seen from the table.

TABLE III
SCATTER DIAGRAM OF "B" VALUES AND FREQUENCIES.
"B" VALUES

"frequencies"	1	2	3	4	5	6	7	8	9	10	
200-299	2	
180-199	2	..	
160-179	2	..	..	1	
140-159	2	..	1	..	
120-139	1	..	1	
100-119	3	
90-99	1	
80-89	2	
70-79	1	..	..	..
60-69	1	..	..	..
50-59	1	..	1	..	1	1	
40-49	2	2	1	..	..
35-39	1	1	1	1	..	
30-34	
25-29	..	1	..	..	..	2	1	3	1	..
20-24	4	3	2	..	..	..
15-19	..	1	2	1	2	1	3	2	..	..
10-14	3	1	4	4	2	1	..	..
9	..	1	2	3	..	..	..	..	..	..
8	2	1	1	1	1	..	..	..
7	3	..	..	..	..	..
6	2	1	1	..	..	..	..	..
5	..	3	3	..	..	..	..	..	..	..
4	..	1	2	4	..	..	..	..	..	..
3	..	2	2	7	..	..	..	..	..	..
2	..	14	13	..	..	..	..	..	..	..
1	..	58	..	..	..	..	..	..	..	..
Tota's	..	75	23	25	7	16	14	19	9	6	11

(Note:—The grouping interval of the frequency variable has not been kept constant in order to show the non-linearity more clearly).

A priori considerations had led to the tentative conclusion that plants having a "B" value of 7 and higher were more likely to "belong" to that particular area than those with "B" values of 6 and lower. This hypothesis suggested dichotomizing the "B" variable and summarizing the relationship between *frequencies* and B values by means of a statistic such as the biserial product moment r . The formula for r is as follows:—

$$r = \sqrt{\frac{p}{q}} \left(\frac{M_H - M_T}{\sigma_T} \right)$$

where p = proportion of plants in the group with the higher B values

$$q = 1 - p$$

M_H = Mean frequency of the higher group

M_T = Mean frequency of the total sample of plants

σ_T = Standard deviation of the frequencies of the total sample.

An alternative formula for the biserial product moment correlation coefficient may be written as follows:—

$$r = \left(\frac{M_H - M_L}{\sigma_T} \right) \sqrt{pq}$$

where the symbols are defined as they were for the formula above and M_L equals the mean frequency of the group with the lower B-values. From the alternative formula it can be seen that the magnitude of the r is a function of the difference between the mean frequencies of the higher and lower groups. The use of the biserial product moment r has the advantage over the simple difference in that it takes into account the variability in the total group and the proportions in the two groups thus making possible comparisons from one investigation to another.

Even though the original hypothesis had suggested dichotomizing at $B=7$ and higher to obtain the higher group, it was decided to investigate the correlation at other possible points of dichotomy. The results are presented in table IV.

TABLE IV.

BISERIAL PRODUCT MOMENT CORRELATION AT DIFFERENT POINTS OF DICHOTOMY.

Pt. of dichotomy	p .	$M_H - M_T$	r
B=10 .. ..	.0537	110.66	.60
B= 9 and 10.. ..	.0829	100.47	.68
B= 8 and higher .. ..	.1268	71.20	.61
B= 7 and higher .. ..	.2195	56.71	.68
B= 6 and higher .. ..	.2878	43.24	.62
B= 5 and higher .. ..	.3659	32.59	.56
B= 4 and higher .. ..	.4000	28.77	.53

(Note:—Computations based on ungrouped data of table III).

The highest correlation viz. .68 is obtained with the dichotomies at B=9 and B=7. It should be obvious that the B=7 is a more desirable point of dichotomy.

The biserial product moment r as a summary statistic of the relationship between *frequency* and B value was examined for data from two earlier investigations in order to check whether or not the dichotomy at B=7 and higher would have been best for those data. In one of the earlier investigations (Gard. Bull. XVII 1958) the r 's for dichotomies at B=8, B=7, B=6, and B=5 were .49, .46, .45 and .39 respectively and in the second earlier investigation, the r 's for dichotomies at B=8, B=7, B=6 and B=5 were .61, .56, .49 and .41 respectively. (Sarawak cf. Trans. Bot. Soc. Edn. 1959). These results would lead one to retain the B=7 dichotomy since they do not conflict with the present study and since the B=7 dichotomy was chosen on the basis of other considerations prior to the statistical analysis.

Having established the dichotomy at B=7 the 205 species can now be separated into two groups:—

Group I those species with B=7 and higher.

Group II „ „ „ B=6 and lower.

This dichotomy resulted in 45 species being classified in group I and 160 in group II. The species in group I clearly represent the important plants of the present community; the group II species are those occurring less regularly and in smaller frequencies.

The 45 species in group I were further classified into A. Trees, B. Shrubs, C. Lianes, and D. Herbs.

The 160 species in group II were classified into Group G—22 species and Group H— 138 species. This further classification is presented below.

The main defect in the description of the community is the absence of quantitative data on epiphytes.

Since the data for the 10 sub-samples were combined for each of the six groups A, B, C, D, G and H, the question arises as to whether or not each sub-sample can be considered with respect to the group under discussion as random sub-samples from the total sample.

The results are summarised in Table V.

Results

TABLE V.

		No. of specs.	No. of plts.	% of total plts.
"B" = 7 or more	Group A. Trees ..	16	1,459	32.0
	" B. Woody Plants ..	17	1,096	24.1
	" C. Lianes ..	11	987	21.7
	" D. Herbs ..	1	8	0.1
				} 77.9
"B" = 6 or less	Group G. ..	22	273	6.0
	" H. ..	138	723	15.9
				} 21.9
		205	4,546	99.8

Bartlett's test for homogeneity of variance again showed a lack of homogeneity in the five groups tested (the D group had to be omitted because of only one species in it). Thus the application of the F-test for an overall test of differences was again questionable. The forty-five mean differences were therefore tested for significance in each of the five groups. A summary of results is given in table VI. With the chance expectancy of no more than 3 "significant" differences among 45 at the .05 level and beyond, the results showed no differences at the .05 level or beyond for the A, B and C groups. For the G and H groups there were 4 and 6 differences respectively which were beyond the .05 level although none of them reached the .01-level. When the A, B, C and D Groups are combined, only 2 differences reach the .05 level; the combination of G and H groups yields 4 differences at the .05 level and 2 beyond the .01 level.

These results suggest that the species in the A, B, C and D groups differ from those in the G and H groups in this forest area. Thus, all of the statistical analyses confirm the conclusion that the species in the A, B, C and D groups "belong" to this forest area while those in the G and H groups do not.

TABLE VI.

Means and Variances of the frequencies of the 10 sub-samples for each of the GROUPS.

Sub-sample No.	GROUP													
	A		B		C		A+B+C+D		G		H		G+H	
	M	V	M	V	M	V	M	V	M	V	M	V	M	V
1	4.81	100.30	4.24	78.57	6.27	82.62	4.89	82.37	.45	.93	.30	.67	.325	.70
2	5.38	71.72	5.35	82.99	4.18	49.96	4.98	66.61	.45	1.21	.57	2.36	.556	2.20
3	11.88	236.25	5.29	62.22	11.09	289.69	8.93	180.25	.73	2.02	.58	2.89	.600	2.76
4	11.00	184.66	7.18	114.78	6.73	113.42	8.29	135.44	1.59	3.87	.64	3.37	.769	3.52
5	11.44	203.33	4.82	25.65	17.82	789.36	10.27	286.20	.82	5.01	.43	1.71	.488	2.15
6	11.31	206.10	6.53	91.01	7.82	98.96	8.42	131.61	1.00	13.14	1.16	15.30	1.14	14.92
7	8.50	104.00	14.88	460.74	6.64	39.05	10.27	226.93	2.55	16.55	.41	.84	.700	3.46
8	6.94	61.93	6.18	38.40	11.45	237.47	7.62	94.69	1.59	8.63	.31	.86	.488	2.08
9	7.44	53.73	3.76	15.94	7.91	98.69	6.02	50.70	1.77	9.99	.46	1.10	.638	2.48
10	12.50	199.07	6.24	56.32	9.82	177.76	9.20	138.12	1.45	4.93	.38	1.13	.531	1.76

Bartlett's Test... 19.2*

No. of species 16

67.6**

17

38.3**

11

37.2**

45

76.2**

22

706*

138

507**

160

No. of Differences between Means at .05 level and beyond .. 0

* .01 < P < .05 ** P < .01

4*

6*

4*

2*

4*+2**

Group A, comprising those species whose mature individuals reach to canopy height, is listed in Table VII. Clearly dominance in this group could refer to the *Shorea spp.* but when Table XIII with a total of 513 Dipterocarps is taken into account the "family dominance" of the Dipterocarpaceae seems clear. It should be noted however that members of the Guttiferae (which includes *Garcinia* and *Calophyllum*) total 682 plants. Most of these (677) however fall into the first size class, the seedlings with a stem diameter less than one inch, and furthermore trees of these genera rarely reach to the height of the canopy.

TABLE VII.
GROUP A.—TREES

Species	DIAMETER CLASSES					Total	"B" Value
	0-1	1-3	3-5	5-7	Over 7		
<i>Shorea macroptera</i> ..	178	..	..	..	3	181	9
<i>Shorea parvifolia</i> ..	172	..	..	..	1	173	7
<i>Shorea parviflora</i> ..	83	..	..	..	..	83	10
<i>Girroniera nervosa</i> ..	26	2	..	..	1	29	8
<i>Pygeum polystachyum</i>	124	3	..	1	..	128	10
<i>Onchosperma horridum</i>	99	4	2	6	..	111	10
<i>Garcinia griffithii</i> ..	132	3	2	..	..	137	8
<i>Santiria tomentosa</i> ..	34	2	4	..	..	40	7
<i>Dacryodes laxa</i> ..	24	1	1	..	..	26	8
<i>Quercus sp.</i>	22	2	1	..	..	25	8
<i>Lindera lucida</i> ..	14	..	1	..	..	15	8
<i>Dialium sp.</i>	177	1	..	..	..	178	7
<i>Coelodepas wallichianum</i>	158	3	..	..	..	161	10
<i>Melanorrhoea woodsiana</i>	106	4	..	..	..	110	10
<i>Gomphandra affinis</i> ..	47	1	..	..	..	48	7
<i>Elaterospermum tapos</i>	14	..	..	..	..	14	7
	1,420	26	11	7	5	1,459	..

Group B, Table VIII lists the shrubs and small trees which do not reach to canopy height or potential trees which have not yet exceeded sapling size. The shrubs characteristic of this community are clearly *Agrostistachys sessilifolia* and *Aprosa benthamiana* (both Euphorbiaceae).

TABLE VIII.

GROUP B.—SMALL TREES AND SHRUBS

Species	DIAMETER CLASSES					Total	"B" Value
	0-1	1-3	3-5	5-7	Over 7		
<i>Agrostistachys sessilifolia</i>	234	4	..	..	..	238	10
<i>Aprosa benthamiana</i>	45	9	..	..	..	54	10
<i>Cryptocarya griffithiana</i>	16	2	..	..	..	18	7
<i>Calophyllum pulcherrimum</i>	182	..	..	..	..	182	9
<i>Calophyllum inophylloide</i> var. <i>singaporensis</i>	149	..	..	..	..	149	9
<i>Calophyllum ferrugineum</i>	95	..	..	..	..	95	10
<i>Xanthophyllum discolor</i>	77	..	..	..	..	77	7
<i>Garcinia parvifolia</i> ..	52	..	..	..	..	52	9
<i>Garcinia eugenifolia</i> ..	35	..	..	..	..	35	8
<i>Scorodocarpus borneensis</i>	45	..	..	..	..	45	8
<i>Anisophyllea disticha</i>	36	..	..	..	..	36	9
<i>Clerodendron disparifolium</i>	27	..	..	..	..	27	7
<i>Myristica crassa</i> ..	24	..	..	..	..	24	7
<i>Acronychia porteri</i> ..	20	..	..	..	..	20	7
<i>Eugenia longiflora</i> ..	19	..	..	..	..	19	8
<i>Eugenia</i> sp.	12	..	..	..	..	12	8
<i>Aquilaria malaccensis</i>	13	..	..	..	..	13	7
	1,081	15	..	..	..	1,096	

Group C, Table IX gives the lianes present and the prominence of the family Connaraceae is noteworthy and is indicated by * in the table.

TABLE IX.
GROUP C.—LIANES AND CLIMBERS

Species	DIAMETER CLASSES					Total	"B" Value
	0-1	1-3	3-5	5-7	Over 7		
<i>Willughbeia coriacea</i> ..	285	..	..	..	..	285	10
<i>Rourea</i> sp.* ..	150	..	..	..	..	150	7
<i>Rourea fulgens</i> * ..	85	..	..	..	..	85	10
<i>Agelaia</i> sp.* ..	147	..	..	..	..	147	7
<i>Psychotria ovata</i> ..	109	..	..	..	..	109	10
<i>Connarus</i> sp.* ..	64	1	..	..	..	65	7
<i>Fibraurea chloroleuca</i>	51	..	..	..	..	51	7
<i>Piper caninum</i> ..	35	..	..	..	..	35	7
<i>Tetracera indica</i> ..	26	..	..	..	..	26	9
<i>Ventilago</i> sp. ..	19	..	..	..	..	19	7
<i>Vitis macrostachya</i> ..	15	..	..	..	..	15	7
	986	1	..	..	..	987	

Group D, Table X the true herbaceous plants—i.e. those which are not seedlings or saplings of trees, shrubs or lianes, are represented here solely by the fern *Tectaria singaporeana*.

TABLE X.
GROUP D.—HERBS.

Species	Total	"B" Value
<i>Tectaria singaporeana</i> ..	8	7

Group G, is listed in Table XI. This group is distinguished from the remainder of those with "B" = 6 or less by the fact that some of them have a stem diameter greater than 1" at breast height. At least the first 8 are large enough to be reproducing themselves and the comparative paucity of their seedlings is noteworthy.

TABLE XI.

GROUP G.

Species	DIAMETER CLASSES					Total	B
	0-1	1-3	3-5	5-7	Over 7		
<i>Anisoptera megistocarpa</i>	8	..	..	1	1	10	5
<i>Dialium maingayi</i> ..	2	..	..	..	1	3	1
<i>Dipterocarpus verrucosus</i>	1	..	..	..	1	2	1
<i>Dipterocarpus hasseltii</i>	..	..	..	..	1	1	1
<i>Litsea grandis</i> ..	12	3	1	..	..	16	5
<i>Macaranga lowii</i> ..	8	..	1	..	..	9	3
<i>Timonius wallichianus</i>	4	..	1	..	..	5	3
<i>Diospyros lancifolia</i> ..	2	..	1	..	..	3	3
<i>Eugenia</i> sp. 4. ..	41	2	..	..	..	43	6
<i>Litsea</i> sp.	40	1	..	..	..	41	6
<i>Polyalthia angustissima</i>	24	3	..	..	..	27	6
<i>Aglaia glabriflora</i> ..	23	1	..	..	..	24	5
<i>Horsfieldia subglobosa</i>	16	1	..	..	..	17	3
<i>Zygia jiringa</i> ..	13	1	..	..	..	14	6
<i>Ochanostachys amantacea</i>	11	1	..	..	..	12	5
<i>Eugenia polyantha</i> ..	12	3	..	..	..	15	5
<i>Hopea megarawan</i> ..	8	1	..	..	..	9	4
<i>Elaeocarpus</i> sp. ..	7	1	..	..	..	8	6
<i>Baccaurea parviflora</i> ..	1	3	..	..	..	4	3
<i>Galearia</i> sp. ..	3	1	..	..	..	4	2
<i>Knema hookeriana</i> ..	1	2	..	..	..	3	3
<i>Salacia flavescens</i> ..	2	1	..	..	..	3	3
	239	25	4	1	4	273	

In contrast Group H, Table XII, with a total of 138 species represents plants which are seedlings or saplings of larger plants or rarely, and these are marked with an asterisk, Herbs of the forest floor.

TABLE XII.
GROUP H.

Species	Total	B	Species	Total	B
Actinodaphne pruinosa ..	5	3	Elaeocarpus ferrugineus	1	1
Adinandra dumosa ..	20	5	Elaeocarpus mastersii ..	2	1
Aeschynanthus sp. ..	2	1	Elaeocarpus petiolatus ..	1	1
Aglaia trichostemon ..	1	1	Elaeocarpus stipularis ..	1	1
Aglaia sp. ..	1	1	Elaeocarpus sp. ..	1	1
Aglaonema schottianum			Ellipanthus tomentosus ..	2	1
var. angustifolium* ..	13	3	Eugenia garcinifolia ..	15	2
Alsodeia floribunda ..	1	1	Eugenia grandis ..	1	1
Antidesma alatum ..	7	5	Erycibe maingayi ..	24	6
Aporosa sp. ..	1	1	Ficus callicarpa ..	3	3
Apostasia nuda* ..	3	2	Ficus sp. ..	2	1
Aquilaria hirta ..	1	1	Fissistigma latifolium		
Ardisia teijsmanniana ..	1	1	var. ovoideum ..	9	4
Ardisia spp. ..	21	5	Fissistigma fulgens ..	9	3
Artabotrys costatus ..	1	1	Fordia filipes ..	10	6
Artabotrys susveloens ..	6	3	Galearia phlebocarpa ..	1	1
Arthrophyllum diversi-			Garcinia gaudichaudii ..	2	1
folium ..	1	1	Garcinia mangostana ..	1	1
Artocarpus anisophyllum	4	2	Garcinia sp. ..	1	1
Artocarpus dadah ..	1	1	Glycosmis chlorosperma	38	6
Artocarpus integer ..	4	3	Gnetum macrocarpum ..	2	2
Artocarpus lancifolius ..	11	3	Goniothalamus macro-		
Artocarpus scortechinii	6	7	phyllum ..	1	1
Athyrium cordifolium ..	2	2	Goniothalamus malaya-		
Blumeodendron tokbrai	1	1	nus ..	1	1
Byttneria maingayi ..	2	2	Guioa pubescens ..	1	1
Caladium denudatum ..	2	2	Gymnacantha bancana	1	1
Calamus ornatus var.			Gynotroches axillaris ..	2	2
horridus ..	16	3	Helicia excelsa ..	1	1
Calamus javensis ..	21	6	Homalomena rubra* ..	2	2
Calophyllum sp. ..	29	2	Hoya ridleyi ..	1	1
Canthium horridum ..	5	2	Ilex cymosa ..	1	1
Centotheca latifolia* ..	1	1	Ipomoea maxima ..	1	1
Centrosema sp. ..	1	1	Ixonanthes icosandra ..	8	3
Champereia manillana ..	3	3	Ixora congesta ..	8	5
Chasalia chartacca ..	13	4	Ixora sp. ..	5	3
Chisocheton sp. ..	1	1	Knema communis ..	1	1
Cnestis palala ..	1	1	Knema malayana ..	8	4
Cordyline sp. ..	2	1	Korthalsia sp. ..	2	1
Cratoxylon formosum ..	2	1	Labisia pothoina* ..	16	4
Croton laevifolium ..	1	1	Lasianthus densifolius ..	4	3
Curculigo latifolia* ..	1	1	Lasianthus sp. I ..	12	5
Cyathocalyx ridleyi ..	1	1	Lasianthus sp. II ..	1	1
Cyathostemma viridi-			Lasianthus sp. III ..	1	1
florum ..	5	2	Licuala sp. ..	6	5
Daemonerops sp. ..	21	6	Lindera sp. ..	1	1
Desmos dasymaschalus ..	1	1	Luvunga sarmentosa ..	11	5
Desmos dumosus ..	3	3	Macaranga javanica ..	1	1
Dioscorea pyrifolia ..	2	2	Mangifera sp. ..	2	1
Dipterocarpus sublamel-			Nephelium lappaceum	1	1
latus ..	1	1	Oxymitra calycina ..	9	2
Dracaena granulata ..	1	1	Palaquium obovatum ..	10	3
Dracaena umbratica ..	12	6	Pandanus ornatus ..	2	2
	261			261	

GROUP H—continued

Species	Total	B	Species	Total	B
	511			588	
<i>Parkia speciosa</i> ..	3	3	<i>Sandoricum koetjape</i> ..	4	3
<i>Phaeanthus ophthalmicus</i>	1	1	<i>Scleropyrum ridleyi</i> ..	1	1
<i>Philodendron</i> sp. ..	2	1	<i>Shorea</i> sp. No. 4 ..	52	5
<i>Phymatodes scolopendrium</i> *	2	2	<i>Sloetia elongata</i> ..	2	1
<i>Abarema elliptica</i> ..	7	5	<i>Smilax calophylla</i> ..	3	2
<i>Plectocomia griffithii</i> ..	4	1	<i>Strombosia rotundifolia</i>	5	2
<i>Polyalthia cauliflora</i> ..	8	3	<i>Strychnos ovalifolia</i> ..	15	6
<i>Psychotria helforiana</i> ..	1	1	<i>Strychnos</i> sp. ..	3	1
<i>Psychotria maingayi</i> ..	1	1	<i>Tabernaemontana malaccensis</i> ..	26	6
<i>Psychotria</i> sp. ..	1	1	<i>Urophyllum glabrum</i> ..	6	5
<i>Pternandra</i> sp. ..	1	1	<i>Urophyllum griffithianum</i> ..	1	1
<i>Ptychoraphis singaporeana</i> ..	1	1	<i>Vatica wallichii</i> ..	1	1
<i>Quercus</i> sp. ..	1	1	<i>Vitex pubescens</i> ..	1	1
<i>Randia arisophylla</i> ..	9	4	<i>Vitis gracilis</i> ..	2	2
<i>Randia incurva</i> ..	1	1	<i>Wikstroemia ridleyi</i> ..	1	1
<i>Randia longiflora</i> ..	10	5	<i>Xanthophyllum</i> sp. ..	1	1
<i>Randia macrophylla</i> ..	20	5	<i>Xylopia ferruginea</i> ..	1	1
<i>Raphidiophora</i> sp.* ..	2	2	<i>Zizyphus horsfieldii</i> ..	7	5
<i>Rhodamnia trinervia</i> ..	2	2	Unknowns ..	2	1
	588			722	

TABLE XIII.

DIPTEROCARPACEAE.

DIAMETER CLASSES

Species	0-1	1-3	3-5	5-7	Over 7	Total	B
<i>Shorea macroptera</i> ..	178	..	..	..	3	181	9
<i>Shorea parvifolia</i> ..	172	..	..	..	1	173	7
<i>Shorea parviflora</i> ..	83	..	..	..	..	83	10
<i>Shorea</i> sp. No. 4 ..	52	..	..	..	..	52	5
<i>Anisoptera megistocarpa</i> ..	8	..	..	1	1	10	5
<i>Hopea mengarawan</i>	8	1	..	..	..	9	4
<i>Dipterocarpus verrucosus</i> ..	1	..	..	..	1	2	1
<i>Dipterocarpus hasseltii</i> ..	..	..	..	..	1	1	1
<i>Dipterocarpus sublamellatus</i> ..	1	..	..	..	..	1	1
Total ..	504	1	0	1	7	513	..

Table XIII summarises all the data of the family Dipterocarpaceae, totalling 513 records. This total, 513, represents 12 per cent of the total of plants recorded from the transect.

In conclusion the naming of the community gives little difficulty in terms of previous proposals (Gilliland, H. B., 1958). This is a *Shorea/Agrostistachys* community.

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The pH of Rain Water from the Botanic Gardens

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THE HYDROGEN ion concentration of rain water is always very small, typical samples containing from 10^{-5} to 10^{-8} moles of hydrogen ion per litre. Because the values are so small, it is convenient to represent the data in terms of pH, *viz.* the negative of the logarithm of the hydrogen ion concentration. On this scale, we would say that typical samples of rain water range from pH 5 to pH 8. If the pH is 7, we say that the rain water is neutral, if it is less than 7 it is acid and if it is greater than 7 it is alkaline.

Chemically pure water has a pH of 7 but rain water in the course of its condensation in clouds and passage through the atmosphere, can dissolve gases such as carbon dioxide, oxides of nitrogen and ammonia, which contribute to the pH, and also dust particles normally present in the atmosphere or discharged into the atmosphere during building operations, etc. The pH is also affected by any trace of alkali dissolved from glass containers.

The pH of the rain water falling in the Botanic Gardens has been examined over a three year period, March 1956 to February 1959 and, during the last ten months measurements have also been made on rain water samples collected at the University of Malaya. pH measurements were made in the usual way with a glass electrode standardised by a phosphate buffer. These pH values are not equilibrium properties for they change with time as dissolved gases escape and a further supply of gas is absorbed from the atmosphere; nevertheless, if the collection of samples and the method of measurement are uniform, the results should have some significance.

The results are too numerous to tabulate in detail but a summary is given in Tables I and II. Some features that stand out are as follows:—

- (1) There is a very wide variation in pH even in a period of one month. The average spread in a month was 1.45 pH units but in February 1957 the pH varied from 5.03 to 7.81, a difference of 2.78 pH units whilst in July 1958 it varied only from 6.71 to 7.32, a difference of

only 0.61 pH units, in the Botanic Gardens although values between 4.85 and 6.52 were observed with the University samples. The highest value recorded was 8.16 (19 November, 1957) and the lowest was 4.58 (14 November, 1958), the latter being at the University site.

- (2) There is an astonishing difference between the pH values found for samples taken in the Botanic Gardens and those from the University site only seven chains away. In all months from May 1958 to February 1959, the pH was between 0.44 and 1.38 pH units lower at the University site, the average value in the Botanic Gardens being 6.80 compared with 5.86 in the University. Whilst the total rainfall was about the same at the two sites—89.61" in the Botanic Gardens and 87.48" at the University, there is considerable difference in the distribution from month to month. Thus in June, 1958, 11.89" were recorded at the University against 11.90" at the Gardens but in November 1958, 18.75" fell at the University site compared with 21.65" at the Gardens.

An examination of the records of thunderstorms made at Singapore airport (some distance from the Botanic Gardens) shows that on the 139 days of thunderstorm on which samples were obtained from the Gardens, the average pH was 6.56 compared with 6.65 for the total of 548 samples. Some diminution in pH such as this would be expected as the result of the formation of oxides of nitrogen during thunderstorms.

On the days when no thunderstorms were recorded, there is some indication that a rainfall of less than 0.2" gives rainwater of average pH about 6.85: there seems to be no appreciable variation if the rainfall is between 0.2" and 2.25", the pH being about 6.43 but on the six occasions only on which a higher rainfall occurred, the average pH fell to 5.86, approaching the value, 5.68, expected for water saturated with carbon dioxide in equilibrium with atmospheric carbon dioxide. It would be interesting to confirm this with more samples.

- (3) The month of January 1957 gave inexplicably low pH values, averaging 5.92, at the Botanic Gardens.

- (4) Twenty-two times during the period May 1958 to January 1959, we were able to obtain not only composite samples from the Botanic Gardens but also the final sample left in the Recording Rain Gauge. The results are given in Table III. The first ten results tabulated refer to days in which more than one inch of rain fell in the Botanic Gardens and thunderstorms were noted at the same time at Singapore Airport. The rest of the results refer to days on which more than an inch of rain fell but no thunderstorms were noted. With the reservation that only a small number of results are available, some conclusions are suggested.

On days without thunderstorms, the average pH, 6.44, of the composite samples was almost that of the final sample, 6.43. We have noted in section (3) that over the entire period of the tests rainfalls between 0.2" and 2.25" tend to give a pH about 6.43. We might have expected a lower pH for the final samples from the rain gauge, in view of the statement in section (3) that rainfalls greater than 2.25" tend to a low pH of 5.86 but it will be noted from Table III that the value of 6.43 for the final samples from the rain gauge is based on twelve samples and in only one instance did the total rainfall exceed 2". The findings in this section and in section (3) are, therefore, not contradictory. The average pH of the composite samples on days of thunderstorms was 6.31: over this period the average of all samples was 6.80. This would suggest a considerable diminution of pH as a result of thunderstorms, greater than the difference noted in section (3). However, the average of 6.80 was deduced from all samples, even if the rainfall was only a few hundredths of an inch: we have already noted that such small rainfall has comparatively high pH, thus raising the average value. A fairer comparison would be between days with and days without thunderstorms, each with over an inch of rain; i.e. we compare an average of 6.31 in the first instance with 6.44 in the second. The influence of thunderstorms is now more consistent with that noted in section (3).

The average value of the final samples from the rain gauge on days with thunderstorms was 6.46, close to that on days without thunderstorms: this suggests that the first inch of rain succeeds in washing the atmosphere free of oxides of nitrogen.

Table I

pH OF RAIN WATER FROM THE BOTANIC GARDENS

		pH (average)	pH (minimum)	pH (maximum)	Number of days on which rain fell	Monthly rainfall (inches)
1956						
March	..	6.41	5.70	6.95	11	4.28
April	..	6.72	6.30	7.09	10	2.68
May	..	6.57	6.23	7.33	19	10.49
June	..	6.59	5.81	6.87	13	5.67
July	..	6.36	5.95	6.79	16	13.82
August	..	6.40	5.29	6.92	24	8.90
September	..	6.36	5.18	7.19	19	12.05
October	..	6.26	4.95	7.48	20	4.82
November	..	6.66	5.50	8.16	21	19.30
December	..	6.73	6.19	7.09	17	8.32
1957						
January	..	5.92	4.69	6.88	14	4.81
February	..	6.56	5.03	7.81	8	4.09
March	..	6.28	5.38	7.42	13	6.98
April	..	6.89	5.84	7.28	9	3.91
May	..	7.11	6.40	7.77	16	12.20
June	..	6.47	5.61	7.12	10	2.92
July	..	6.67	5.89	7.15	15	8.98
August	..	6.71	6.32	7.18	15	4.65
September	..	6.79	6.09	7.69	19	10.27
October	..	7.11	6.67	7.67	13	2.33
November	..	6.69	5.82	7.51	21	6.45
December	..	6.79	4.52	7.29	25	11.40
1958						
January	..	6.85	6.62	7.48	13	7.79
February	..	6.76	5.98	7.33	13	5.68
March	..	6.73	6.16	7.22	11	3.68
April	..	6.78	6.24	7.39	12	3.45
May	..	6.99	6.62	7.47	18	7.44
June	..	6.85	5.82	7.69	14	11.90
July	..	6.88	6.71	7.32	8	2.19
August	..	6.91	5.88	7.18	17	12.81
September	..	6.97	6.76	7.38	14	3.18
October	..	6.58	5.88	7.28	18	12.35
November	..	6.51	5.89	7.33	20	21.65
December	..	6.89	6.50	7.28	12	4.43
1959						
January	..	6.78	5.59	7.49	19	9.78
February	..	6.63	5.98	7.19	10	3.88

Table II

pH OF RAIN WATER FROM THE UNIVERSITY SITE

		<i>pH</i> (average)	<i>pH</i> (minimum)	<i>pH</i> (maximum)	Number of days on which rain fell	Monthly rainfall (inches)
1958						
May ..	..	6.56	5.14	7.29	19	5.54
June ..	..	5.89	4.95	7.12	15	11.89
July ..	..	5.76	4.85	6.52	7	3.19
August ..	..	5.53	4.85	6.16	15	13.85
September ..	..	6.04	5.44	6.69	9	3.00
October ..	..	5.65	5.04	6.37	15	11.58
November ..	..	5.48	4.58	5.83	16	18.75
December ..	..	6.00	5.52	6.33	8	4.70
1959						
January ..	..	5.92	5.56	6.39	11	10.38
February ..	..	5.77	4.59	6.72	9	4.60

Table III

DATA FROM RECORDING RAIN GAUGE IN BOTANIC GARDENS

<i>Date</i>	<i>Time of Thunderstorm</i>	<i>Time of Rainfall</i>	<i>Composite Inches</i>	<i>Sample pH</i>	<i>Final Inches</i>	<i>Sample pH</i>
25-5-58	.. 0830-0920	0810-1000	1.52	6.62	0.52	7.20
12-6-58	.. 0720-0755	0630-0730	1.10	5.82	0.10	6.19
29-8-58	.. 0615-0755	0505-1015	1.89	6.30	0.89	6.18
8-10-58	.. 0510-0630	0415-0900	1.13	6.74	0.13	6.82
22-10-58	.. 1040-1150	0930-1130	2.92	5.88	0.92	6.06
1-11-58	.. 0240-0350	0135-0735	1.82	6.16	0.82	6.10
1-11-58	.. 1755-2055	1830-2200	1.48	5.89	0.48	6.49
16-11-58	.. { 1530-1620 2305-2320 }	{ 1445-1630 2145-2400 }	1.37	6.02	0.37	6.33
24-11-58	.. 0130-0345	0100-0335	1.25	6.68	0.25	6.90
27-11-58	.. 1730-1820	1630-1800	1.31	7.03	0.31	6.28

<i>Date</i>	<i>Composite Inches</i>	<i>Sample pH</i>	<i>Final Inches</i>	<i>Sample pH</i>
6-5-58 ..	.. 1.82	6.93	0.82	6.83
22-6-58 ..	.. 1.95	6.50	0.95	7.10
29-6-58 ..	.. 1.97	6.70	0.97	6.39
17-8-58 ..	.. 1.90	5.88	0.90	6.04
18-8-58 ..	.. 1.08	6.18	0.08	5.76
1-10-58 ..	.. 1.68	6.89	0.68	6.51
14-11-58 ..	.. 1.81	6.18	0.81	6.42
15-11-58 ..	.. 1.24	6.10	0.24	5.81
17-11-58 ..	.. 3.61	6.08	0.61	5.90
18-12-58 ..	.. 1.32	6.27	0.32	6.34
6-1-59 ..	.. 1.99	6.84	0.99	7.00
12-1-59 ..	.. 1.20	6.72	0.20	7.07

In the latter part of the table, the rainfall refers to a 24 hour period commencing at 0800 on the day noted in the first column.

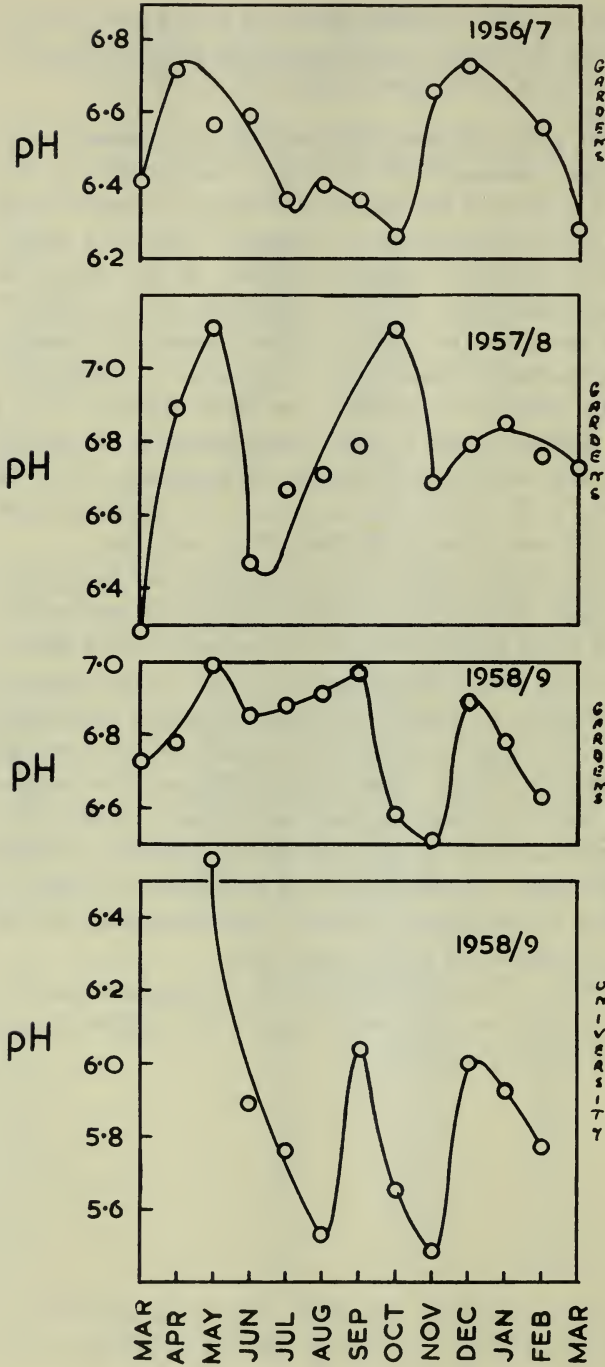
- (5) In spite of these variations from day to day and from site to site, the graph of average monthly pH plotted against time shows some remarkable features (Fig. I).

After the first year's measurements had been completed, it was thought that the variation with time was characterised by two maxima, one in April and the other in December. It could well be argued that the small maximum in August is due to a chance fluctuation. This maximum appears, however, in the graphs for each of the succeeding years. It is also remarkable that the data for the University site show the same variation although the monthly pH values are uniformly lower and the incidence of rainfall different. All four graphs show maxima one about April or May, a second about September and a third about December. It may be significant the first two maxima occur at the beginning and at the end respectively of the South-West monsoon: the third maximum occurs about half way through the North-East monsoon.

The measurements described in this paper were not designed as an elaborate study: at first, we were interested only in answering a question which arose from some work on the corrosion of metals: what is the average pH of Singapore rain water? In the course of this work a number of related problems suggested themselves, some of which have been described. The answers we have given are tentative because the original experiment was designed for one purpose only. If this work could be continued, several modifications could be suggested, such as the collection of separate samples during thunderstorms, the observation of thunderstorms from the site of sampling and not from a distant observation post, and the examination of samples for nitrite and nitrate.

I am grateful to Professor Gilliland, Mr. Purseglove and Mr. Burkill for the collection of samples and to Mr. Mather for the provision of meteorological data.

Figure I





Botrychium daucifolium Wall.
from Cameron Highlands

Malayan Fern Notes

By B. MOLESWORTH ALLEN

A preliminary note

BOTRYCHIUM DAUCIFOLIUM Wall. ex Rac., Flor. Btz., I. 4. (1898). The genus *Botrychium* has not previously been recorded for Malaya. Holttum however, when discussing the Ophioglossaceae in "Ferns of Malaya" (1954), page 38, notes: "*Botrychium* occurs in both Borneo and north of Malaya, so that it may occur in mountain forests in Northern Malaya." Thus it was not surprising when I found it in the Cameron Highlands area of Pahang in April 1958.

The plants agree with the description of *B. daucifolium* given by van Alderwerelt van Rosenburgh in "Malayan Ferns" (1908) page 778 (the *forma typica* of his supplement (1916), page 455). Most are a little smaller than his measurements, and the segments of the sterile frond are inclined to be coarsely toothed. I have not seen Wallich's description, so do not know whether the presence of copious pale hairs on very new growth and the almost glabrous state of the mature fern, is typical. This is not mentioned in any description I have seen, but Beddome's illustration in "Ferns of British India & Ceylon" (1892), page 470, shows a very hairy stipe and rachis of an adult plant. This is not described in the text. None of my mature or nearly mature specimens approaches this state.

The path to Gunong Perdah, for about one mile past the Gunong Jasah turnoff, follows a more or less flat contour, along the sloping sides of the hills, which are clad in tall rain forest. This is at about 5,000 feet in altitude. Here nine plants of *Botrychium* were found in a small area of about two square metres, where there was a slight opening in the tall dark forest. Apparently a tree had fallen sometime previously widening the opening already made by the path. In the immediate vicinity there were no plants growing between the tall saplings which were nearly two metres high, and the scattered plants on the forest floor. The tallest of the latter were about 45 cm., and were mostly a species of *Didymocarpus* and young *Cyathea* species.

The earth was rich in humus being black and sticky, and the situation was some distance above a stream. The *Botrychium* plants were a paler green than the surrounding vegetation and showed up

clearly. The largest plant measured was nearly 36 cm. tall and had the remains of a very old fertile spike which projected beyond the sterile portion of the lamina. The sterile leaves were also past maturity, but there was one very new and uncurled frond, most parts of which were covered with transparent spreading hairs. All the older fronds examined were almost, or quite, glabrous. Amongst the other plants there were only two fertile spikes, both being very new, but many of the other fronds still showed where a fertile spike had been. Two of these can be seen in the accompanying photograph.

Although the adjacent ground, both above and below the path was searched, no more plants were found here, but further on towards the Jasah turnoff, eleven more were found. They occurred sporadically on the pathside for about half a mile, in similar places to the first lot except that there was seldom as much light on the forest floor. Most of these had new fertile spikes which were often nearly mature.

Further field observations are necessary to determine whether *Botrychium* dies off in the same way as some of the other Ophioglossaceae in Malaya. The presence of bases of old fertile spikes rather suggests that they do not do so, yet a plant may produce more than one fertile spike in one season before a die-back. I had hoped to return in July, but new emergency regulations have closed this area, so no further notes have been made since the first collection.

Botrychium may not be uncommon in these forests where the floor is flat and where damp (not wet) conditions prevail. They appear to require a certain amount of light so perhaps the normal tall jungle provides only a temporary habitat after an opening has been made, and before other plants of more vigorous growth cover the ground. The path here no doubt, has provided this sort of habitat, for since the emergency it has remained practically undisturbed. Saplings on the path edges have become tall and so have kept that part of the floor fairly clear. The saplings are now however, at a height where the undergrowth can and probably will start covering the ground again. So possibly *Botrychium* may be on the decline here. It will be interesting to see the position in a year's time, and probably much will depend on whether the paths have been cleared. Perhaps the original habitat is in the light shade provided by the smaller trees in the *padang* areas of higher altitudes.

A living plant is at Kew and herbarium specimens No. 3930 were sent to the herbaria of Kew and the Singapore Botanic Gardens.

Malayan Fern Notes, II

By BETTY MOLESWORTH ALLEN

MALAYAN HILL STATIONS are always interesting botanically, especially so where the clearing of jungle is still taking place and therefore the plant formation is continually changing. In the past, however, cleared areas such as roadsides, lawns, golfcourse and garden edges and forest paths have been kept cut for so many years that small, light loving plants, both native and introduced have often become established. Now, because of the present emergency, some of these areas have remained almost undisturbed for nearly ten years, allowing a taller and different succession of plants to take over. Many paths through the jungle received little or no clearing, and in the Cameron Highlands district of Pahang, some of the gardens of remoter bungalows became neglected. In the lower part of the now deserted garden of one such place, Walkerburn Cottage, several interesting ferns have become established amongst short second-growth and lank grass. These include *Cyathea excavata*, *Cystopteris tenuisecta*, *Athyrium amplissium*, *Merinthosorus drynarioides*, *Thelypteris beddomei* and *T. brunnea*.

The fairly new car road to the summit of Batu Brinchang, a mountain of 6,666 feet in the Cameron Highlands area of Pahang, enables the botanist to spend more time and energy at its higher altitudes. Here on clearings caused through roadmaking, colonisers (seen in 1956) were small, some being rare plants which will no doubt disappear when larger plants become established. In fact this has already begun to happen and in two years there has been a marked change on some of the higher mist swept ridges over which the road runs. It is a pity that some systematic record could not have been kept of these early stages of plant succession, for in the past six years or so, roads have been built up to other summits and high ridges of Malayan mountains for V.H.F. wireless stations.

In 1956 on Kedah Peak in Kedah, I found that the then unfinished road up the last part of the very steep and narrow summit, had already influenced plant growth below. The road was draining water away from the flatter ground above the resthouse where previously large patches of *Sphagnum* were common in the wet ground. Most of these patches had disappeared together with the little local *Schizaea malaccana* Bak., which grew amongst the *Sphagnum*, and the ground was very dry and almost devoid of plant growth.

Again the emergency has contributed directly to a changed vegetation in places in the lowlands. Previously fertile ground such as riverine areas and terrain near the bases of limestone hills (especially in the Ipoh district of Perak) have for many years been under almost continual cultivation. During the emergency these areas were cleared of squatters and put under curfew. Thus neglected for nearly ten years, the rich soil together with the moist hot climate induced a quick succession of *belukar* (a local name for secondary scrub formation). In many places this resulted in a growth tall and thick enough for terrestrial ferns, which would not tolerate full sun, to appear. For instance, *Phymatodes longissima* (Bl.) J. Sm., apparently not a common fern in Malaya, is now abundant in *belukar* in these places around the Ipoh district. With better political conditions approaching however, curfews have been lifted in many of these places and people are going back on to the land. Since June 1958 many areas have been cleared again by cutting and burning, and already much is under vegetable cultivation. Thus possibly 1959 will see the end of this interesting decade of undisturbed *belukar* near the towns.

The order of the following annotated list and the nomenclature, follows those used by R. E. Holttum in his "Ferns of Malaya", 1954, and the page number of the species discussed, is given in brackets.

All collecting numbers quoted are of my personal series, the specimens being either in my private collection or in the herbarium of the Botanic Gardens, Singapore. Duplicates have been distributed to other herbaria including Kew and the British Museum (Natural History).

The list contains results of field observations, including some extensions of known distributions and notes on two species of ferns not previously recorded from Malaya.

***Trichomanes motleyi* v.d.Bosch, (Holttum p. 92).**

Growing on the vertical side of a large boulder in a stream bed in tall forest on the lower slopes of Penang Hill, at Batu Ferringhi. April 1956. Previously known from Singapore, Pahang and Selangor. Fertile fronds were common but the specimens I found in Kepong, Selangor which were in a similar habitat, had, in August, very few fertile fronds. I have since found it on a tree trunk about two feet from the ground, in a stream in tall forest at Ginting Simpah, Selangor. Penang specimen no. 2795.

Cyathea excavata Holttum, (Holttum p. 121).

So far this fern is known only from Cameron Highlands in Pahang. Holttum states (p. 122)* that only old sori have been seen. In August 1956 I found fertile fronds with immature and newly mature sori and the following description is taken from several large plants growing either in open or fairly open places in Cameron Highlands.

The largest middle pinnae measured were up to 63 cm. long (commonly 60) by 20 cm. wide, usually short stalked. It will be seen that these measurements are somewhat larger than those given by Holttum. Unless the frond is past maturity the lobes are much closer together than their own width when living and the edges are nearly always conspicuously toothed, sometimes lobed, being entire only towards the apex. Veins were forked up to four times, two to three being usual. The smooth stipes were almost black at the bases, but were green higher up. I found practically no scales on the stipe, even when young; they were present only on the very new and curled fronds. These scales were not thin, but fairly thick and large (often over 1.5 cm. long). Sori were 1 to 4 (commonly 1 to 2) at the bases of the pinnule lobes near the costae. Mature sori coalesced when dry, obscuring the lower part of the costules. Fronds frequently produce very few sori; a pinnule being fertile for only half its length, and the frond itself being sterile towards its apex. The very thin transparent indusium completely covers the young sporangium, but appears to break down at a very early stage of maturity. I have found that in pressed specimens, if the sporangia have burst during the process of drying, they seldom show any traces of indusia, yet if they have reached maturity normally before drying, some vestiges can be seen as described by Holttum. One and sometimes two, dark brown thin appendages similar to paraphyses were noticed attached to the base of a sorus, curving round it to about half its height. I saw these only on large fronds when the sori were immature. Paraphyses amongst the sporangia were not seen.

In the field this fern is most distinct from other species of *Cyathea*. The fronds when living are pale green, soft and inclined to hang laxly. A distinctive feature, not found to the same extent in any other Malayan *Cyathea*, is that the old dead fronds remain on the trunk, hanging down more or less concealing it, in much the same way as in some *Dicksonia* species. Another field character, but I am not sure how constant this is, is that all the plants seen had more than one trunk. Two was usual, but occasionally there

* From "Ferns of Malaya" unless otherwise stated.

were three, and on these trunks, at their bases, and up to about 60 cm., young adventitious plants were growing (I have seen the same in *C. recommutata* Copel. and in *C. polypoda* Bak.). One plant had become quite large and had fertile fronds.

Three mature plants of *C. excavata* were found fairly close together by a stream above Sultan Abu Bakar Road near Brinchang village in 1956, at about 5,000 feet altitude. In 1958 several more were found in this area and others at Taman Sedia, which is about 4,500 feet. Since then more plants have been seen in open or semi-open places, but only in the Cameron Highlands area. It appears to prefer streamsides, well above the normal water level, on forest edges. In Taman Sedia however, they were growing in open grassy places where there was only an occasional small tree and several tall specimens of *Cyathea contaminans* (Hk.) Copel. *C. excavata* appear to be on the increase where streamsides have been cleared or partially cleared, and some plants have grown a great deal since first seen here. Trunks 150 cm. high were not uncommon, and some were higher. The plants at Taman Sedia at least, are undoubtedly in an artificial habitat, for Holttum originally found *C. excavata* in shady forest by small streams, so it will be interesting to watch their development if they are left undisturbed.

Colysis acuminata (Baker) Holttum, (Holttum p. 162).

Sungei Buloh, Selangor; on the base of a large tree and on the ground beside a stream, well below the flood level; tall lowland forest; rare. March 1952, specimen no. 1875; June 1953, no. 2387.

Previous records are from Perak and Pahang. Holttum says that it occurs in the same situations as *C. macrophylla* (Bl.) Presl, which I did find near the Selangor specimens, but I have only found *C. acuminata* in association with streams and growing where it must frequently be inundated. In Perak it grows on rocks in the beds of small shallow streams. *C. macrophylla* on the other hand is more common in flat places in moist lowland forest, but not necessarily near streams.

Loxogramme scolopendrina (Bory) Presl, (Holttum p. 168).

Batu Caves, Selangor; January 1956; specimen no. 2686. Near the summit of this limestone hill, probably about 900 feet altitude. It was growing in a pocket of earth on steep ground and was rare.

Holttum lists this species from Pahang, Perak and Kedah.

Aglaomorpha heraclea (Kze.) Copeland, (Holttum p. 185).

Cameron Highlands, Pahang; altitude 5,000 feet. Although this fern record is only 500 feet higher than the highest altitude given

in "Ferns of Malaya", it has been included, as all the plants seen in the forest were small and infertile, indicating that they may be of recent origin. In June 1958 plants were seen on trees in tall forest on the slopes of Gunong Jasar and G. Purdah. They were not uncommon here. In the garden of Walkerburn Cottage at about the same altitude there is a large clump of *Aglaomorpha heraclea* perching on an *Erythrina* sp., and this was fertile in June.

Merinthosorus drynarioides (Hook.) Copeland, (Holttum p. 186).

The following are some field observations on this fern which has been recorded from several localities in Malaya.

In February 1948 I first saw a plant of *Merinthosorus* on a rock in a fairly open place near Robinson's Falls at Cameron Highlands, Pahang, at about 4,500 feet in altitude. It was small and not fertile, but the rhizome scales distinguished it from *Aglaomorpha heraclea* which it resembles in leaf character. When I visited this area again in 1956 the fern was no longer there, but I subsequently found another plant on a concrete wall, in almost full sun in the deserted garden of Walkerburn Cottage, near Brinchang village. Here the altitude is about 5,000 feet. The plant was young and infertile then, and so far (1959) has not produced sori although it has increased in size.

I have not seen *Merinthosorus* growing elsewhere at this altitude in the Cameron Highlands area, but it is common as an epiphyte on tall trees from Ringlet (circa 3,500 feet) downwards, until the jungle gives way to rubber estates, and they can be seen from the road. I have seen this fern in the following localities in Malaya:—

PERAK: Maxwell's Hill, on rocks in open places near the bungalows at 3,200 feet in altitude; on canopy trees in tall forest at 2,400 feet. On road to Cameron Highlands (but still in Perak), on a vertical rock bank beside road at c.3,000 feet (mostly young plants); high up on canopy trees in tall forest at c.1,700 to 3,500 feet. PAHANG: Cameron Highlands district on rock and wall in open places; Fraser's Hill, common on stone walls by bungalows*, about 4,000 feet altitude; on large boulders in a meadow at Jeriau Farm, 3,400 feet. SELANGOR: In tall forest common from about 1,500 to 3,000 feet, below and above the Semangkok Pass (The Gap); Ginting Simpah, on Rain Trees (*Enterolobium saman*) which have been planted on the roadside at the 17th milestone, at about 1,000 feet altitude; on tall forest trees in the forest near this altitude.

* In June 1958 most of the ferns from the stone walls had been removed.

I have not found *Merinthosorus* on Penang Hill (from where it was originally collected in Malaya) although I have searched for it during three months when I was living on the hill.

Merinthosorus in common with other acrostichoid ferns in Malaya, only periodically produce fertile fronds. In this genus however, it is almost certain that they are developed twice a year, (not just once a year, as for instance is the case with *Elaphoglossum* spp.) and possibly more frequently on rock walls. The latter may be induced by the frequent cutting back that they receive. The following, although not yet complete, show the months during which fertile fronds have been observed. *Fertile on rocks*:—Maxwell's Hill, February and November; Fraser's Hill, April, August and December. *Fertile on trees*:—Maxwell's Hill, November; road to Cameron Highlands, June and August; above and below the Semangkok Pass, June, December; Ginting Simpah, June. Only Fraser's Hill has been observed during December.

In 1957 I was able to watch the development of some *Merinthosorus* plants which were growing on the previously mentioned Rain Trees at Ginting Simpah. Although these plants must be fairly recently established, they were mature, and had the advantage of being easily and frequently seen. During February and March there was no noticeable growth, only sterile fronds being present, but during April new (sterile) fronds appeared. A few weeks later the bases of each of these new fronds became brown and dead-looking for less than one-quarter of their length, the rest remaining green. This gave a remarkable resemblance to the scale or nest-leaves of a *Drynaria*, and the plant from a distance would surely be taken for *D. sparsisora* (Desv.) Moore. It was the beginning of May when the bases turned brown, and a month later the fertile portion appeared on these new fronds. Since then I have observed similar growth on other *Merinthosorus* plants on trees by the Cameron Highlands road. Although this scarious condition of the frond has been noted previously, I am not aware that its development has been described. This, and the fact that it is epiphytic on uppermost branches and on crowns of very tall canopy trees in dense forest, is probably the reason that it has escaped notice in these places for so long. This habitat I believe is almost certainly the natural one in Malaya.

In the north of Malaya at least, *Merinthosorus* is probably quite common high up in the large trees of tall midmountain forest where the humidity is high. Even so, field glasses are often necessary to detect the fern. On rocks in open places and at hill stations I think it is most probably of recent origin, appearing after the

jungle was cleared and that it will increase in these areas, for it appears to adapt itself easily to the sides of large rocks and walls where there is good drainage.

Polypodium prainii (Bedd.) C. Chr., (Holttum p. 204).

Holttum describes this only as an epiphytic fern. It is still very common at Cameron Highlands in Pahang, but I have found, with only a few exceptions, that it is terrestrial there. It grows where there is abundant moss and liverwort both on rocks and wet rocky ground, above streams where there is often much undergrowth and little light. It may have become a terrestrial fern by adoption in areas where the tall trees have been removed, for branches are usually left in the forest, and it is in such places that it has been seen most commonly. It occurs quite frequently however, on the ground on the lower slopes of Brinchang and Jasar mountains where the tall forest appears to be little disturbed.

Polypodium prainii appears to have a seasonal die-back. In July only very old fronds were seen, and none were found in the same area in August, but when again visited in late September, new fronds were common. I have never seen it at Fraser's Hill.

Christiopteris tricuspis (Hook.) Christ. (Holttum p. 211).

Slopes of Gunong Terbakar in the Cameron Highlands district of Pahang, at 3,800 feet, August 1956.

Plants of this fern were growing out of the base of a large plant of *Aglaomorpha heraclea*, which was on a tall tree in a very exposed position. The *Christiopteris* had fertile fronds. It was not seen elsewhere here, but should be looked for wherever large clumps of *Aglaomorpha* grow, for it has only been found in association with this fern.

The accompanying photograph shows a small fourth lobe on a fertile frond of *Christiopteris* from Fraser's Hill. The frond was taken from a plant which is more or less established on the ground at the base of a fallen *Aglaomorpha* on the roadside near Pahang bungalow. This development has not been previously observed in Malaya, and all other fronds from this plant had the normal three lobes.

Since writing the above, more plants of *Christiopteris* have been found at Kuala Terla at Cameron Highlands, at 3,800 feet altitude. They were young and infertile, growing from an *Aglaomorpha* on a tree over the Terla River.

Grammitis crispatula Holtt., (Holttum p. 218).

Maxwell's Hill, Perak, February 1952. Herbarium specimen no. 1828. Although originally found in this locality, the fern does

not appear to have been seen in recent years. My field notes state that there were only a few plants and these were growing on a very large moss-covered rock in tall jungle, on a ridge just below 3,000 feet, but not anywhere near a stream. The fronds were dull and dark green with conspicuously crisped edges. My identification was kindly confirmed by Dr. E. B. Copeland to whom I sent a specimen with viable spores.

Ctenopteris celebica (Bl.) Copeland, (Holttum p. 233).

Robinson Falls, Cameron Highlands, Pahang, at about 4,500 feet. August 1956. This fern was not seen elsewhere and was found on a sloping mossy tree trunk in a very damp place overhanging the river. It was growing amongst *Hymenophyllum badium* Hk. & Grev. and *Grammitis hirtella* (Bl.) Tuyama. Fronds when living were pale yellowish and dull, with conspicuous red hairs on the stipes. Some of the fronds had new sori. The tree has since been destroyed by blasting operations for the new hydro-electric dam, but it surely must occur elsewhere here. Specimen no. 2895.

Thelypteris brunnea (Wall.) Ching, (Holttum p. 240).

This fern has obviously increased greatly in recent years for it is now very common at Cameron Highlands, growing in grassy places in full sun, by streamsides in shade, and on banks by roads. It sometimes becomes very large in the first mentioned habitat, largest fronds measured being nearly 200 cm. long including stipe, 160 cm. being about average.* The stipe is always shining and rather red. I have however, examined many plants from Camerons and from Fraser's Hill and have found in every case that the stock is either erect or suberect, but never long-creeping which is characteristic of this species. I have collected *Thelypteris brunnea* on Mt. Kinabalu in British North Borneo and although the fronds appear similar, the rhizome is entirely different, being creeping, with fronds widely spaced and not bunched as they are in Malayan specimens.

I have found what I consider to be normal *T. oppositipinna* (v.A.v.R.) Ching at both Cameron Highlands and Fraser's Hill, but never commonly. In the field it looks very different from *T. brunnea*, yet there is very little real difference, and I have found them growing together. The late Mr. Alston of the British Museum, to whom I sent specimens of *T. brunnea* said they appeared to be that species except for the rhizome, so presumed they belonged to *T. oppositipinna*. Holttum notes that the rhizomes of the Malayan specimens were missing.

* From the overgrown garden at Walkerburn Cottage.

I believe that the true species of *T. brunnea* as interpreted by Ching (Bull. Fan Mem. Inst. Bot. 6: 1936) has not yet been found in Malaya and perhaps this species should bear another name, if really different from *T. oppositipinna*.

***Thelypteris beddomei* (Bak.) Ching, (Holttum 240).**

Cameron Highlands, Pahang, August 1956, c.5,000 feet. no. 2876. Previously known only from Maxwell's Hill where I found it in 1949, and where it is still common. In the Camerons it is fairly widespread and abundant where it does occur. It was growing above streams in open places and in semi-shade on the edges of light forest. In some places it formed stands so thick that there was little other growth. Old rotting fronds formed a deep loose layer (sometimes to 45 cm.) beneath the living fronds so that the latter had greatly elongated stipes (to 60 cm. long). The longest lamina measured was 40 cm. The fern seemed well established in this area just below Walkerburn Cottage, but when I returned in June 1958, grass and the shrub *Melastoma muticum* Ridl. had become tall and this fern had decreased quite considerably. It had become abundant however, on the more recently neglected lawn near the house, but the fronds were short.

In July 1958 I found *T. beddomei* growing between the tea bushes at Sungei Palas Tea Estate at c.5,500 feet. Sometimes it was so abundant that it covered the ground to the exclusion of other plants. It was also common on and above the roadsides here, and wherever the ground was sloping. As at Maxwell's Hill, the ferns were in full sun and the fronds were quite short, agreeing with the measurements given by Holttum.

I examined many fronds and found that, as Dr. Holttum notes, indusia were always present, and were evident even when the specimens were dry.

***Ampelopteris prolifera* (Retz.) Copel., (Holttum, 299).**

Collected once in Malaya during last century by King's collector, on the Kinta River in Perak. In April 1956 I found one patch of this fern on the Kedah-Province Wellesley border where the old Bambong Lima bridge spans the Muda River. It was growing just below the road in alluvial soil, on flat ground which is frequently flooded by the river. It was scrambling over, and covering small bushes with quite a dense growth. Buds were produced five to six times along a lamina; these in turn became proliferous as they matured, so tracing the overall length was difficult. Stipes and

fronds were dark green when living. I found only two fronds bearing fertile pinnae and these were on tertiary fronds. *Athyrium esculentum* (Retz.) Copeland was very common nearby. In August 1958 I found *Ampelopteris* in Perak. It was alongside the Kinta River near Batu Gajah, possibly near the place of the original collection. For at least 150 yards along the river bank it was common to abundant, scrambling up small trees. Although the stipes and primary rachises were living, nearly all the pinnae, together with the secondary and tertiary fronds, were dead. No new nor fertile fronds were found. Here the river lies fifteen to twenty feet below the bank which is flat and composed of heavy soil, which was then very dry and hard. Apart from one small patch on the river bank, *Ampelopteris* was confined to a narrow band starting about ten feet from the bank edge and running parallel. This is where the trees occurred, and beyond was cropped grass which I believe is frequently burnt back, and no ferns were found there. Other ferns growing amongst the *Ampelopteris* were *Athyrium esculentum* and *Cyclosorus aridus* (Don) Ching, both of which it slightly resembles in the field. In the following December fertile plants were found here, with mature sori on secondary fronds and very new sori on tertiary fronds.

The rootstock of *Ampelopteris* is very surface-rooted, being easily pulled out; the fronds when dry could be easily burnt. So perhaps as river edges are so often cultivated, this fern may have been eradicated from many areas. Otherwise it is difficult to understand why it is not so common as is *Athyrium esculentum* in these places. It is apparently seasonal as it is in other countries, dying back (in Perak) during the dry months between June and August. I have seen this fern with mature sori in December on riverbanks in west Siam. I have grown some plants by the Pinji River in Ipoh to observe their development. Herbarium specimens: 2794, 4090.

Microlepia puberula v.A.v.R., (Holttum p. 312).

Kepong and Sungei Buloh, Selangor. Collections made between 1951 and 1955. Herbarium specimens: 1382, 1482, 2333, 2393, 2541; from Ginting Simpah, Selangor in 1957, no. 3473.

Lindsaya cultrata (Willd.) Sw., (Holttum 328).

Near the 14th milestone, Cameron Highlands Road, Perak, September 1958, 1,000 feet; no. 4017. Locally frequent on mossy rocks in bed of large stream in jungle. Probably from plants swept down river from the mountains.

Leucostegia pallida (Mett.) Copel., (Holttum 353).

Although this fern has been seen recently by Sinclair, its habitat is of interest because of its doubtful native state. On a path alongside the water pipeline at about 2,400 feet on Maxwell's Hill in Perak, it is locally abundant, growing on the tops of large boulders. Here the fronds grow to at least the maximum length as given by Holttum; new fronds, which were produced in quantity in November, were bright pink. This immediate area, although clothed in tall forest has been cleared of a great deal of undergrowth, so that the boulders are only lightly shaded. Well away from the path the fern becomes less common, not occurring on the many similar boulders in the untouched forest where the light is poor. It grows however, on mossy tree trunks on, or just above the streamsides, and is quite widespread on this side of the hill at about this altitude. The fronds, although there were mature and old ones, were very much smaller than those from the first mentioned habitat.

I have looked for it several times in 1956, in similar places on Mt. Matang in Sarawak, from where it was formerly collected, but without success.

Blechnum orientale L., (Holttum p. 446).

A bi-pinnate to tri-pinnatifid form of the above fern was first seen on the forest edge by Girdle Road at Fraser's Hill at about 4,200 feet. Another plant was seen later on the roadside to the farm, but was very much smaller. In December 1956 I found this form was not uncommon locally near Batu Lintang Road in Kuching, Sarawak at sea level.

Only the Girdle Road plant showed transition fronds. There were very old fronds which were quite normal, others had deeply lobed pinnae and the newest (pink) fronds were bi-pinnate becoming almost tri-pinnate at their bases. When this plant was revisited sometime later, all the fronds were like the last mentioned ones, some measuring 145 cm. long. Unfortunately this plant was destroyed during roadside clearing operations. All plants examined had fertile fronds. It would make an attractive fern in cultivation. Specimen no. 2202.

Blechnum fraseri (A. Cunn.) Luerssen var. **Philippinense** Christ, Bull. Herb. Boiss. 6.149; van Alderwerelt van Rosenburgh, Malayan Ferns, 382. 1908.

Gunong Batu Brinchang, Cameron Highlands district of Pahang; 6,500 feet altitude, August 1956. Specimen no. 2920; February 1959, no. 4145. A living plant was sent to Kew in 1956.

Not previously collected in Malaya, but this variety is known from the Philippine Is., Borneo, Sumatra and New Guinea. *Blechnum*

fraseri belongs to the sub-genus *Lomaria* to which, in Malaya, only the mountain *B. vestitum* (Bl.) Kuhn, belongs.

Apart from the adult plants being larger, the Malayan specimens agree quite well with the descriptions I have seen of the variety, and with plants I subsequently saw on Mt. Kinabalu in British North Borneo. The following description is taken from Malayan plants from a series collected from one area on Brinchang.

Mature plants frequently (?) stoloniferous. *Rootstock* elongated into an erect caudex, the tallest measured being 235 cm. high, with a diameter of 5 cm. at approximately half way up the caudex, but more commonly 200 cm. by 6 cm., plants becoming fertile when caudex reached a height of 30 cm. Base of caudex thickened by a mass of old roots to 16 cm. or more through. Caudex or trunk rough, dark brown almost black, the greater part being scaly and rough from the remains of old stipe bases, but from the base extending upwards to c.90 cm. covered with close thin adventitious roots. Through these protrude scale-covered adventitious buds, 2-3 cm. long, which, near the trunk base had elongated into prop-roots 10 cm. and more long by about 1 cm. thick. *Stolons* 1 to 2 (or more?) from a parent plant, horizontal for at least 20 cm. before becoming erect and forming another plant which later becomes independent. Some of the thin adventitious roots from the upper side of the stolons elongate and growing downwards, anchor the plant. Caudex of new stoloniferous plant densely clothed with scales. *Scales* on caudex, stipe bases, and buds more or less similar, dark brown, thick with narrow elongated non-clathrate cells; length of scale to about 15 mm. and 2 mm. wide at base with subulate apex; edges entire with pale thin margins which are deciduous. *Fronds* bipinnatifid, whorled near the apex of the caudex and rather tufted at the crown. Fronds from shaded plants with thin elongated stipes, and laminae large, lax and dark green above, thin in texture; fronds in semi-shade or open places, nearly erect, shorter, upper surface yellowish-green, firm in texture. In both forms, upperside, shiny and glabrous; undersurface, dull, pale, sometimes almost glaucous and glabrous, except for sparse pale thin scales on rachises, costae and costules. Fronds dry olive brown above and greenish below. *Stipe* bases thickly clothed with dark spreading scales. *Sterile* fronds varying greatly in size according to habitat, up to 100 cm. long including stipe, by 35 cm. wide in shade specimens, but more commonly 56 cm. by 19 cm. Fronds widest about the middle, tapered to the apex. Base narrowed. Rachis winged throughout connecting pinnae, wing with triangular lobes, contiguous. Middle pinnae on large fronds to 17 cm. long

by 2.5 cm. wide but more commonly 10 cm. by 1.5 cm., deeply lobed with a long tapered apex which is entire for a length of 1 cm. or more at its tip. Upper pinnae ascending, gradually reduced in size to a lobed acuminate apex. Lower pinnae reflexed and reduced in size to about 7 cm. long on large fronds to 4 cm. on small fronds. Rachis wing continuing down the stipe gradually disappearing, leaving the triangular lobes as small auricles, until ceasing near the stipe base. Pinnae lobes entire, or toothed in shaded fronds, falcate, blunt or occasionally with very short pointed apices; lobes 2–4 mm. wide, cut to a costule wing 1.5 mm. wide, each lobe being separated by a hyaline membrane. Lobes becoming less deeply cut and decreasing in size towards the apex. *Fertile fronds* similar in shape to the sterile, but usually smaller and slightly contracted, to 60 cm. long by 20 cm. wide, with entire lobes gradually reduced in size for threequarters the length of a pinna, then rather suddenly contracted forming a long thin entire apical lobe, which is about 25 mm. long by 3 mm. wide. Sporangia covers the lower surface of the lobes, indusia are thin and light brown, just visible at maturity. Spores, anisopolar, pale, slightly verrucose, perispore folded. *Veins* translucent in thin fronds, but mostly obscured in those of firm texture. This description is taken from the former:—Two veins at each side of a costule base, springing from the costa, sometimes forked, ending within the lobe margin with a small hydathode. Veins springing from costule, to about 7 pairs, forked up to four times, more commonly three times, never reaching the margin. Forks of the lowest pairs occasionally anastomosing. Young, non-stoloniferous plants have short erect stocks, simply pinnate fronds with the bases of the bluntly toothed pinnae decurrent on the rachis.

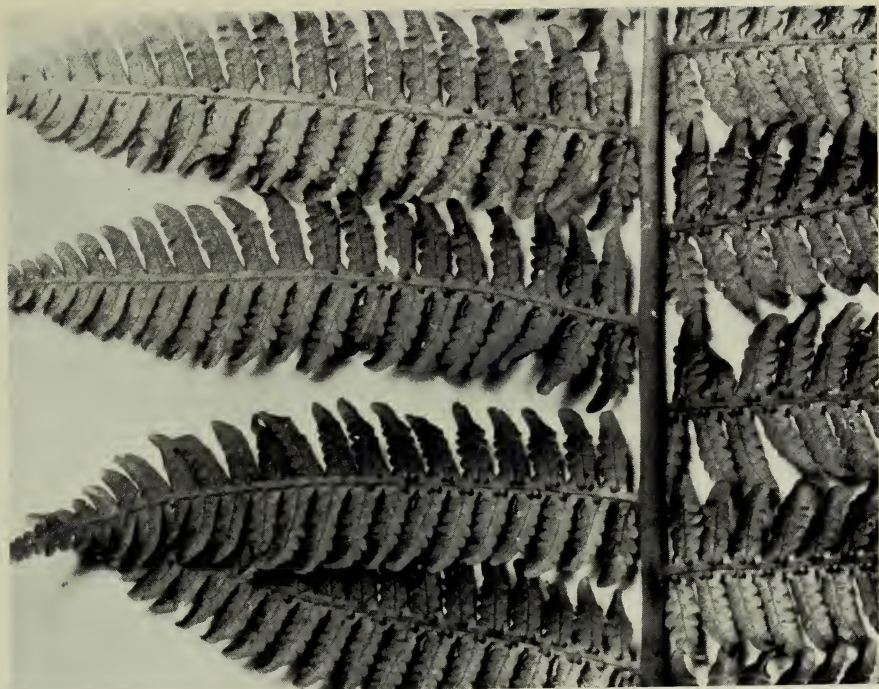
On the left hand side below the road to the wireless station on Batu Brinchang, there is an almost vertical rock face about 150 feet from the mountain's summit. Here a long time ago there has been a landslide exposing the rock, and the earth from this slip has formed a shelf some 50 feet below the road. It was here in 1956, amongst mixed second growth of about 3 metres high, that the mature plants of *Blechnum fraseri* were found. It was then impossible to move through this vegetation, so an accurate count of this fern was not made, but twenty plants were noted. The largest, with trunks up to 200 cm. high, were concealed by a Melastomaceous shrub, by plants of *Cyathea latebrosa* (Wall.) Copel. var. *indusiata* Holtt., and by *Polygonum chinense* Linn. A few small infertile plants were growing in peaty soil on the road edge, and were only about 15 cm. high. Nearby on the cliff edge, in loose soil, were some slightly larger but still infertile plants; these were trunkless.

The two latter places were newly established, having been made during the road construction. On the cliff edge there were few other plants apart from a sedge and a dwarf *Thelypteris viscosa* (J. Sm.) Ching. In April 1958 all except one of the very small roadside plants of *Blechnum fraseri* had disappeared; the others on the cliff edge had grown considerably, but had not yet formed a trunk, nor were they fertile. The latter were almost concealed by the sedge, which had grown enormously but not yet flowered. In another area, in an open place a quarter of a mile away, and about 50 feet from the summit, there is another plant of this fern. It was of medium size, with a small trunk but was not fertile. This year (1959) I again descended to the earth shelf and found that the cover plants had grown so much it was now possible to crawl under them. *Blechnum fraseri* had certainly increased a great deal and within an area of approximately 35 by 25 metres, I counted 137 plants of this fern. More than 30 had definite trunks, some of these being more than 150 cm. high. The tallest specimens were in amongst the vegetation on the shelf, and were nearly all bearing fertile fronds, whereas the smaller and more sturdy specimens, which were fertile only when a trunk was developed, grew where there was only other sparse growth. In small pockets of earth on the rock face and in other quite open places, very young plants were exceedingly common.

The stoloniferous habit was found only amongst those specimens growing in full shade, where none of the young normally produced sporophytic plants were seen. Unfortunately this place is being used as a repository for old tins and boxes discarded from the wireless station above, so examination for stolons was difficult, and it has not been ascertained how common the habit is, in this variety of *Blechnum fraseri*. A new plant arising from a stolon which was measured, had a trunk 17 cm. high with a diameter of 1.5 cm., but had not produced any fronds, but already adventitious roots were strengthening its base.

In New Zealand *Blechnum fraseri* is a common fern of the Kauri (*Agathis australis* A. Cunn.) and other dry forests in the north, forming colonies but the caudex seldom exceeds 75 cm. in height.

Apart from the dendroid habit which makes this fern look like a diminutive *Cyathea*, it is an interesting addition to the Malayan fern list. The fronds show an intermediate state between simple and double pinnation, and the production of stolons, although a common feature in the type in New Zealand, may not have been recorded previously for the variety. The occasional anastomosis of



Cyathea excavata Holtt.; part of a pinna



Cyathea excavata Holtt.; stipe base showing excavations



Christiopteris tricuspis (Hook.) Christ.



Blechnum orientale L. Bipinnate form; one frond



var. *philippinense* Christ.

Blechnum fraseri (A. Cunn.) Luers.
var. *philippinense* Christ.
Sterile and fertile fronds



the veins is interesting although this may be more accidental, than indicative of development towards those Blechnaceae with regular anastomosis, for it seems to appear only in the large shade fronds.

The area where this *Blechnum* was found is fairly newly established as the growth of this fern and the other vegetation suggests, so perhaps there is another older established habitat here. In Borneo it grows in fairly open but short mossy forest, a similar kind being found on some of our higher mountains. On Batu Brinchang, however, a search for a different habitat of this fern is now practically impossible around this altitude. Below the road, every accessible place is being used for depositing rubbish. It is a great pity that such an interesting area is being ruined, as well as being rendered unsightly.

Elaphoglossum melanostichum (Bl.) Moore, (Holttum p. 455).

Maxwell's Hill, Perak; 24.1.1956, at 3,200 feet, no. 2711 was sent to Kew where Dr. Holttum kindly checked the specimen.

Previously known from Penang Hill. This fern occurs locally on Maxwell's Hill between 3–3,200 feet, on trunks of tall trees, usually on the forest edges in semi-shade. There were several plants on a tree about 60 cm. from the ground and in November 1955, nearly all of these had new fertile fronds.

Elaphoglossum decurrens (Desv.) Moore, (Holttum p. 458).

Summit of Gunong Brinchang, Pahang; 31.7.1956, 6,666 feet, no. 2911 sent to the British Museum and determined by the late Mr. Alston.

In Malaya this has been collected twice previously in the lowlands, but has however, been collected on Mt. Kinabalu in Borneo at "5,000 feet and more" (see Holttum).

Dryopteris subarborea (Bak.) C.Chr., (Holttum p. 491).

At Cameron Highlands this fern is terrestrial (see Holttum 492), but at Fraser's Hill I have never found it so, but always as an epiphyte in tall primitive forest and usually hanging down from large clumps of *Asplenium nidus* Linn., apparently as Kunstler found it. At Maxwell's Hill it grows on mossy logs and sloping tree trunks in tall forest, but also on boulders on the exposed ridge near The Box, and here has small fronds.

Dryopteris sparsa (Don) O. Ktze., (Holttum p. 492).

Near Taman Sedia, Cameron Highlands, Pahang, at about 4,700 feet. In 1956 this fern was locally common on mossy rocks in the river and on moist earth banks in shady places. Plants were fertile.

Tectaria melanocaulon (Bl.) Copel. Ph. Journ. Sc. 2C, Bot., 6: 416. 1907; van Alderwerelt van Rosenburgh, Malayan Ferns 245. 1908 (Aspidium); Backer & Posthumus, Varenflora voor Java, 74.1939 (*Tectaria melanocaula* Copel.).

In tall forest near road to Cameron Highlands in Perak, at 26th milestone; 3,200 feet, June 1958, specimen no. 3985.

Not previously recorded for Malaya. Plants were found in one place but were very common here. They were on steeply sloping ground near a large rock face. Only one plant was fertile; it is hoped that later fuller field notes can be made.

The shining black stipes and rachises and very pale green fronds, distinguish this fern from any other Malayan *Tectaria*. Distribution: China, Malaysia.

Since writing the above, Dr. Holttum, who kindly compared my material at Kew, writes that the correct name should be ***Tectaria melanocaulis*** (Bl.) Copel.

Pleocnemia conjugata (Bl.) Presl. (Holttum, p. 534).

This fern has been collected twice in Malaya, near Malacca and at Baling in Kedah, the latter place suggesting that it may be a limestone fern. In April 1956 I went to Baling hoping to find it on the limestone hill of that name, but was unsuccessful. About four miles on the road to Kroh, however, I found it growing in a small quantity by the roadside, but not near any limestone. Twelve plants were seen which were nearly all young, but some had fronds to 170 cm. long, with stipes over 100 cm. long. There was only one plant with fertile fronds, and these showed the indusia clearly. Fronds were pale yellowish-green, but I have seen the same colour in fronds of *P. hemiteliiformis* (Racib.) Holtt. (normally much darker) when growing in sunny places at Fraser's Hill. In this area the *belukar* is frequently cut back for emergency reasons and possibly this has encouraged the growth of *P. conjugata* here. Apparently it requires only light shade, and was not being smothered by taller growth. Specimen no. 2793.

Cystopteris tenuisecta (Bl.) Mett., (Holttum p. 540).

This fern is worthy of note, for when it was first found in Malaya by Holttum in Cameron Highlands in 1936, it was apparently confined to a small area on a newly cut earth bank. When I saw it 11 years later, it was growing on the forest floor in the same area and was still rare, but the fronds were larger than those found by Holttum. In August 1956 I was unable to go back to the original place, but found that it was a common fern at about 5,000 feet

altitude. The favourite habitat seems to be on loose earth overhanging small streams in dark places, but here it was seldom fertile and the fronds were small. On a flat area just above normal water level above the stream, I found large plants which were fertile. The largest frond measured was 130 cm. long by 51 cm. wide, but were more common at about 80 by 30 cm. Fertile fronds were either very new or just mature, and no old fronds were seen. Since then I have found it at higher altitudes, up to 6,000 feet on Batu Brinchang. It appears now to be one of the common streamside ferns at 5-6,000 feet at Cameron Highlands.

Athyrium japonicum (Thbg.) Copeland, (Holttum p. 551).

Cameron Highlands, Pahang; July 1956; specimen no. 2904.

Previously collected from Maxwell's Hill in Perak and from Fraser's Hill in Pahang, so links the two localities. In 1956 there were several small plants of this fern at Robinson's Falls, growing in crevices on the large rocks in the river. Together with it were *Lindsaya cultrata* and *Dryopteris sparsa*, all of which must often be submerged. *Athyrium japonicum* had only one fertile frond. In 1958 I saw it in several places by and above streams in the vicinity of Kemunting and Sultan Abu Bakar roads, at about 5,000 feet in altitude. Large patches were on steep grassy banks just above the roadside near Sungei Palas Estate bungalow. Here it is well away from water, and is fairly exposed, and the fronds are uniformly small (about 18 cm. long).

Athyrium curtisii Holttum, (Holtt. p. 560).

Ampang, Selangor; June 1957; specimen no. 3436.

Athyrium velutinum (Holttum) Holttum, (Holtt. p. 567).

Cameron Highlands, Pahang, in the forest behind Walkerburn Cottage. Specimens no. 2936, 3937, 4022.

Only a few collections have been made of this fern. It appears to be not uncommon locally where the forest is dark, the ground sloping yet wet and rich in humus, but usually some distance above streams. I have found it at about the same elevations as are given by Holttum. In most plants that I have seen, the stock was not short, but usually quite stout and erect and sometimes was built up to 9 cm. in height, being supported by firm black roots. Living fronds are very dark green except when very young, then they are extremely pale. Fertile fronds always appear to be longer than the sterile and more deeply cut. They also have free pinnules for nearly half the length of each pinna. Pinnules are commonly 15 mm. long by 5 mm. wide (occasionally to 17 mm. long), but the sterile

fronds are about the same as given by Holttum. Indusia are a medium brown colour in living specimens.

Athyrium boryanum (Willd.) Tawaga, (Holtt. p. 567).*

Near streams by road to Cameron Highlands, Perak, at 22 $\frac{3}{4}$ milestone; 2,000 feet, August 1958; specimen no. 4006. A few plants with large rootstocks were found just above a stream on rocky ground at the forest edge. Although this fern has been collected in Perak previously, it has not been found in this State in recent years.

In February 1959 I came across a few plants of *Athyrium boryanum* near Trinkap, in the Cameron Highlands area, at c.4,000 feet altitude. The ferns were growing in the protection of a large rock in a fairly open place on the roadside. Fronds were large and fertile and all quite new.

This fern is certainly seasonal in its growth, fronds dying off at certain periods, so this may be the reason that in Malaya, it escaped the notice of collectors for about 50 years. In Perak there were no plants showing in June, and in August they were all new. At Fraser's Hill where I first saw *Athyrium boryanum* in 1952, my notes indicate that new fronds are produced earlier than in the Perak plants. During April, June and August I have recorded new fronds, but there were none at all in January when I searched for it in the same place.

A note should be made of the rootstock of *Athyrium boryanum*. Descriptions usually state that the rhizome is either erect or sub-erect, whereas in the Malayan form it is most certainly creeping, with fronds borne closely together. The growing point occurs at one end of the longitudinal rhizome, which is usual in truly creeping rootstocks. The rhizome is thick and fleshy, and one which I have recently brought from Fraser's Hill for cultivation, measures 15 cm. long by 7 to 8 cm. through, and this is by no means the largest. About 2 cm. of the old stipe bases remain attached in a horizontal manner on the rhizome, each facing the growing-point. They remain green and fleshy until they eventually fall off. The oldest ends of large rhizomes are usually pitted with hollows where the stipe bases have been.

Athyrium amplissimum (Baker) Holttum, (Holttum p. 569).

Cameron Highlands, Pahang, near Walkerburn Cottage; c.5,000 feet altitude. Specimen nos. 2935, 3936. On light forest edge in fairly open places and in light shade. Previously found in Cameron

* Since preparing these notes, this species has been referred to a new genus, *Parathyrium* Holttum, Kew Bulletin, 3, 1958. p. 448.

Highlands, but only fronds with old sori had been seen and the presence of an indusium had not been determined. In August 1956 I found several plants with fertile fronds. On these I found no indusia, nor evidence that there had been any, and one of the fronds had young sori which ought to have shown them, had they been present, unless they fall long before maturity. Immature sporangia were pale greenish in colour, but were dark and almost black when mature.

No note, so far as I am aware, has been made of the mucilage which completely covers new fronds at the top of the stout erect stock. The mucilage was copious, and was present on all the plants I saw; there were no scales visible and I seldom found any on the new growth. There were, in fact very few broad scales present, the stipes having none, but as Holttum points out, the scaliness varies a great deal.

Athyrium dilatatum (Bl.) Milde, (Holttum p. 574).

Fraser's Hill, Pahang, at c.4,000 feet; specimen nos. 3325, 3328, 4197. On two occasions, a few plants were found growing in shady places in wet rocky ground, by pathsides in tall forest. One was below Girdle Road near Peninjau, and the other was below Lady Maxwell Road, both being near streams. In the third locality plants of this fern were abundant in a narrow wet ravine, in tall forest near the golf course, and so it is possible it is not uncommon in similar places throughout this area. The plant sizes agree with Holttum's measurements, but the pinnules were cut half way to the costae or less, never more. The colour of the living frond is dark green.

Coniogramme fraxinea (Don) Diels, (Holttum p. 589).

Near the road to Cameron Highlands, Perak, between 2,000 and 3,000 feet. On sides of rocky streams in tall forest, it is not uncommon here. A persistently variegated form, which I have also seen on the Taiping Hill, occurs frequently in the former locality.

Vittaria angustissima Holttum, (Holttum p. 610).

Cameron Highlands, Pahang; April 1958. On tree trunks; slopes of Gunong Kemuning, c.5,000 feet, specimen no. 3941; slopes of G. Jasar, c.5,400 feet, specimen no. 3928.

Vittaria flexuosa Fee, (Holttum p. 611).

In Malaya, the usual habitat for this fern is on trees in forest where conditions are constantly humid (see Holttum). In the Ginting Simpah forest on the Selangor side, there are many small to very large granite outcrops. These usually contain plants quite

different from those in the forest surrounding these cliffs. Here, between 700 and 2,000 feet, *V. scolopendrina* is usually to be found with its rootstock wedged in small crevices in the vertical rock. Usually the fronds are of normal size, others being fertile when scarcely 20 cm. long. These outcrops are seldom near streams and although sheltered by the tall forest trees, frequently become very dry.

Vittaria flexuosa Fee, (Holttum p. 611).

Penang Hill, Penang, c.2,500 feet; May 1956, specimen no. 2822. This plant agrees with the description of this species in Holttum. It was growing out of an epiphytic spongy root mass which was dead, but similar to that of an *Asplenium nidus* L. The *Vittaria* was intermixed with *V. ensiformis* Sw., from which it was easily distinguished. The fronds of *V. flexuosa* were pendulous, the longest being 90 cm., but none was wider than 5 mm., often narrower. The stipe was slender, the underside black and shiny and the upper surface black at the very base. There were new fronds with immature sori. When dry the frond edges become strongly incurled.

The root mass was in the fork of a small tree in short, rather sparse secondary growth on Western Hill and was fully exposed. Only a small portion was collected and so it is hoped that the remainder will survive in this locality.

Salvinia cucullata Roxb. ex Bory, (Holttum p. 621).

Kota Bharu, Kelantan, May 1957, specimen no. 3399. Previously collected from Kedah. I found that this little fern was not uncommon on the edges of the rice fields near the airfield at Kota Bharu. They were in small patches, to about 13 cm. long and were often mixed with *Azolla pinnata* R.Br. At this time of the year nearly all the fields were dry, but in corners where moisture remained, *Salvinia* was seen. I did not find any fertile plants.

I am grateful to Dr. R. E. Holttum for his continued help in comparing and identifying my material at Kew, and to the Director of the Singapore Botanic Gardens for checking nomenclature.

An interesting new record from the Malayan beach: *Spilanthes urens* Jacq., its synonymy and distribution

By J. H. KERN & C. G. G. J. VAN STEENIS

Flora Malesiana Foundation, Leyden

IN 1934 Mr. Corner collected on Jason Bay, Johore, a remarkable creeping Composite which at the time defeated identification. It grows as most beach plants with a horizontal, more or less subterranean stem, at the nodes giving off downward roots for anchorage and upward simple (lateral) stems (10–40 cm. high), each with a few pairs of opposite narrow leaves and a terminal, rather long-peduncled (5–15 cm.) head. The leaves are strictly opposite, 3-plinerved, 3–9½ by 0.4–1½ cm. The head consists entirely of tubular, white flowers and measures c. 1 cm. diameter. The achene is rather peculiar, being flattened elliptic, with one, less frequently two, awns on top and 2(–3) yellowish, rounded ridges (obviously corky), distinctly set off against the rather dark colour of the fruit itself.

It has now appeared that it had been referred in *Spilanthes*, a well-known genus of mostly erect, annual weeds. Bentham (1866) had referred a North Bornean specimen collected by Barber to the North Australian *S. anactina* F.v.M.; Martelli (1883) identified a specimen collected by Beccari in Sarawak as belonging to the American *S. urens* Jacq., and finally A. H. Moore (1907) had described a North Bornean specimen as a new endemic species, *S. chamaecaula* A. H. Moore.

The remarkable thing about the latter species appeared its rarity, its exacting habitat, and the fact that it seems to lack immediate relationships with any other Malaysian species in the infrageneric system of the monographer A. H. Moore. He placed it with the S. American *S. urens* Jacq. and some other species.

This circumstantial evidence raised our suspicion as it does not fit with the generally wide distribution of plants restricted to the tropical beach.

This led us to a closer examination of the characters A. H. Moore used in his revision to discriminate it from its allied species.

It appeared that *S. chamaecaula* was keyed out against *S. urens* on the strength of two characters, viz. the uniaristate achene (in the other species there are 2 bristles) and the corky swollen ridges which were said to be absent in the other species.

The first character broke down at once in the Bornean material, as in one head both 1- and 2-aristate achenes were found to occur.

The second character appeared at first sight satisfactory in our scant material at Leyden. But in a bunch of S. American material of *S. urens*, which we borrowed through the kindness of Dr. Lanjouw and Dr. Jonker from the Utrecht Herbarium, we found pertinent proof that in *S. urens*, which both in habit and in habitat agrees so very well with *S. chamaeacaula*, in all heads containing mature achenes some of these are provided with the characteristic swollen corky ridges.

This induced us to re-examine a complete head of the scant Malaysian material and here we found to our satisfaction that besides the corky achenes there were in one single head also achenes without these ridges. Though it is possible that the ratio of achenes with and those without corky ridges differs slightly in Malaysian versus American material, it is useless for taxonomic distinction. It is rather astonishing that the presence of ridged achenes has hitherto been overlooked in *S. urens*, which is not a particularly rare plant in America. This demonstrated to us that for a good examination one must dissect an entire head; it is insufficient to pick just a few random achenes. In doing so we did not succeed in finding any regularity in the location of the corky achenes in the head.

We have come to the conclusion that Martelli, who referred the Bornean Beccari material to *S. urens*, was perfectly justified.

In the Old World a third species had been described from the islands in the Gulf of Carpentaria, viz. *S. anactina* F.v.M. Already Bentham, in the Flora Australiensis, had referred a Bornean collection of Barber (obviously in the Kew Herbarium) to it. F. von Mueller had described his species without having available ripe achenes. As the Queensland specimens agree perfectly in habit and habitat according to the description, we feel entirely at ease in reducing *S. anactina* also to the synonymy of *S. urens*. We feel the more confident as A. H. Moore merely distinguished *S. urens* from *S. anactina* by saying that it was found in the New World while *S. anactina* is from North Australia. There seems no doubt that this also represents the same species.

There is a fourth species which we feel should be critically re-examined, namely *S. pusilla* Hook. & Arn., from the New World. We have a strong suspicion that this is also conspecific with *S. urens*. The differences cited in Moore's key to exist between these two species appear very slight: the linear-spathulate leaves attributed to *S. pusilla* are quite common in *S. urens*.

It may seem remarkable that the localities in the Old World tropical beaches are so scattered and distant, but this is by no means uncommon in widely dispersed beach plants and is similarly encountered in mapping localities of *Scaevola plumieri*, *Ipomoea pes-caprae* ssp. *pes-caprae*, *Launaea sarmentosa*, *Suriana maritima*, *Digitaria longissima*, *Triumfetta procumbens*, etc.

The distribution of *S. urens* ranges from tropical and sub-tropical Central and South America to North Australia (Gulf of Carpentaria), and West Malaysia.

As far as we have ascertained within the scope of our examination the synonymy and the distribution in Malaysia run as follows:—

Spilanthes urens Jacquin, En. Syst. Pl. Carib. (1760) 28; Select. Stirp. Am. Hist. (1763) 214, t. 126, fig. 1; Martelli, Nuov. Giorn. Bot. Ital. 15 (1883) 296; Merrill, En. Born. (1921) 589.

?*Spilanthes pusilla* Hook. & Arn. in Journ. Bot., London 3 (1841) 317.

Spilanthes anactina F.v. Mueller, Fragm. Phyt. Austr. 5 (1865) 63; Bentham, Fl. Austr. 3 (1866) 541; Bailey, Queensl. Fl. 3 (1900) 863.

Spilanthes chamaeacaula A. H. Moore, Proc. Am. Ac. Arts & Sc. 42 (1907) 528; Koster & Philipson, Blumea 6 (1950) 353.

Borneo. North Borneo: Burbidge (Gray); Barber (K). Sarawak: pr. Sibiu, flowers white, leaves more or less fleshy, Beccari P.B. 1750 (Fi, L), June 1866.

Malay Peninsula, Johore: Sg. Tuenseh, Jason Bay, Corner S.F. 28459 (Sing, Bo, K, L, A), June 1934.

We hope that this little note will draw attention to this curious plant and stimulate collectors to find new localities.

A New Aroid from Sarawak

By C. X. FURTADO, *Singapore.*

AN ANOMALOUS AROID was noticed in the collections made three years ago in Sarawak by Mr. J. W. Purseglove, then the Director of the Botanic Gardens, Singapore. It belongs to the group of aroids which shed off the upper portion of the spathes before the fruits are formed on the enclosed spadices. Since the sheaths of the petioles of its leaves are broad and produce long, tongue-shaped free portions, the aroid could be a species of either *Piptospatha* or *Microcasia*. In their general appearance and the way they bend, the spathes resemble those of a *Piptospatha*, and the spadix is fertile up to the apex, a character mentioned for *Piptospatha* only and not for *Microscasia* which is described to have the spadix with a sterile apex or with an apex with sterile flowers. But in Purseglove's specimen the male flowers which occupy the upper two-thirds of the spadix have each two horns through the apical pores of which pollen is shed; and bicornulate stamens form a definitive character of a species of *Microcasia*. Hence the new species is assigned to this genus and named ***Microcasia purseglovei*** in honour of the collector.

Hitherto only two species of this genus were known, *M. elliptica* and *M. pygmaea*, both of which had helped to define the genus as having, among other things, a sterile apex to the spadix; but in view of the characters of the new species, the generic definition has to be altered to include also the species with fully fertile spadices.

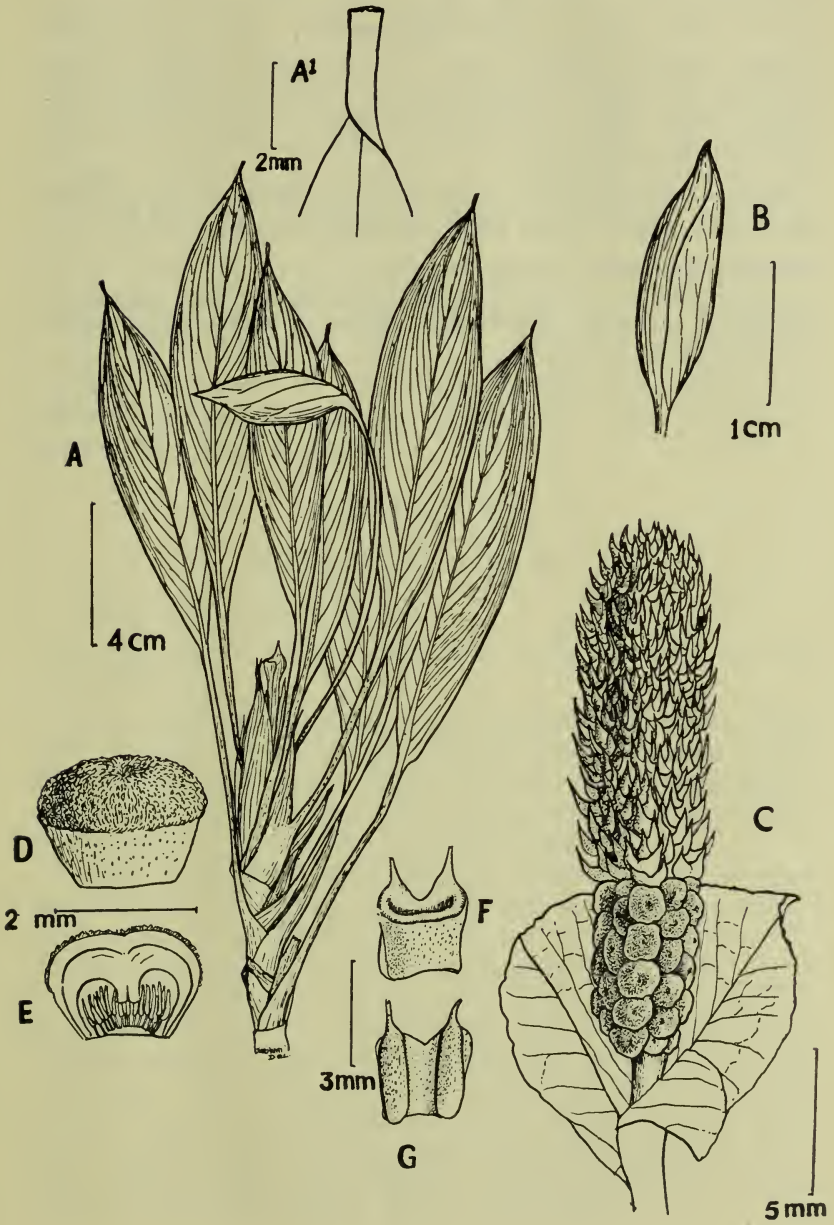
The two earlier described species were very tiny plants; but the new species is a very much larger plant in regard to the vegetative and reproductive parts.

***Microcasia purseglovei* Furtado spec. nov.**

A duabus speciebus usque adhuc cognitis haec species stirpibus omnino majoribus, spadicibus ad apicem usque fertilibus differt.

Caudiculus elongatus, repens, in parte erecta 25–30 cm. altus. *Folia:* petioli tenues, laminis paulo breviores vel eis aequantes, 6–8 cm. longi; vagina papyracea, superne in partem liguliformiter solutam 2.5–3 cm. longam producta; lamina supra saturate viridis,

subtus albo-squamosa, ambitu elliptica, utrinque paulatim curvato-attenuata, apice in pseudo-tubulum abrupte convoluta, margine angustissime revoluta, 8-15 cm. longa, 2.5-3.5 cm. lata, nervis



primariis paucis cum secundariis adscendentibus, dein margine sub-parallelis, utrinque vix prominentibus praedita. *Pedunculus* petiolos superans, 12–18 cm. longus, apice curvatus, spatham horizontalem modo Piptospathae spp. ferens. *Spatha* circa 5 cm. longa, leviter convoluta, cum tubo brevi viridescente persistente quam lamina caduca albescens circa triplo brevior. *Spadix* quam spatha brevior, breviter stipitatus, circa 2.5 cm. longus, omnino fertilis; pars feminea basalis, parte mascula duplo brevior. *Ovarium* 1 mm. altum, circa duplo diametens, stigmate depresso. *Stamina* bicornuta. *Bacca* ignota.

BORNEO: **Sarawak**, Tau, juxta flumen Mayeng dictum (Purse-glove 5344, Holotypus in SING, isoholotypi in K, L, SAR.).

Microcasia purseglovei Furtado (Holotypus)

A, Planta. A1, Folii apex. B, Spatha. C, Spadix cum parte spathae. D, Ovarium. E, Ovarium longitudinaliter sectum. F, Stamen antice visum. G, Stamen postice visum.

Some New or Noteworthy Species of Malaysia

By C. X. FURTADO

WHILE ARRANGING the material of the genus *Ardisia* in the Singapore Herbarium, some new species or new records were noticed, while others had to be excluded from the genus. The status of some of these will have to be settled by comparing the types; but the following notes are published here in order either to clarify some confusions that existed in the herbarium and also in the recently published literature on the subject, or to give a status to some of the names that have been adopted in the Singapore herbarium where the types and other specimens cited in this paper are preserved. As originally published by Mez, the sections mentioned here were subgenera, but they have been treated as Sections by Merrill and others, an arrangement that seems to be more in accord with the present concepts of nomenclature.

ARDISIA Swartz

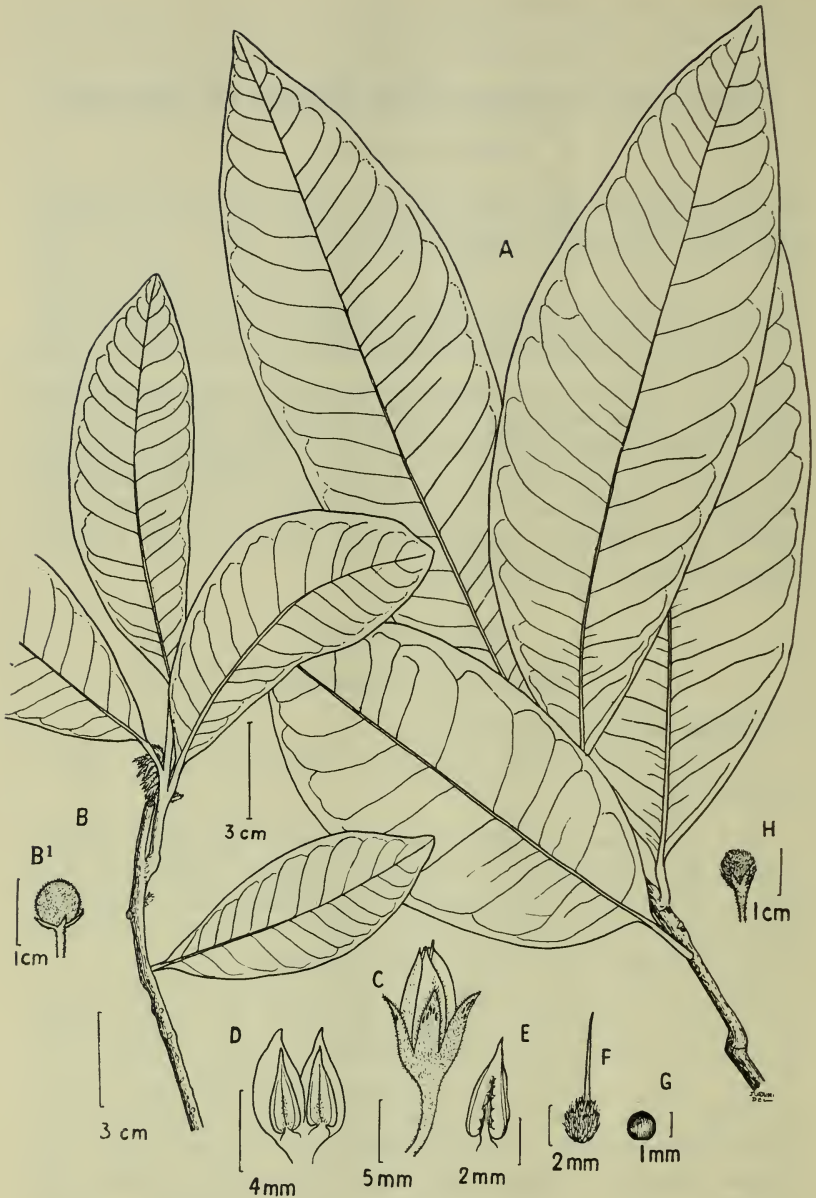
Section PIMELANDRA Mez.

1. *Ardisia ferox* Furtado sp. nov.

A. pachysandra (Wall.) Mez *sensu* Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

Ab A. fuliginosa, cui affinissima, innovationibus deciduo hirsutis; foliis utrinque glaberrimis, punctulis majoribus margines versus sitis, vix reticulatis; inflorescentiis valde abbreviatis, omnino hirsutis; sepalis liguliformibus, hirsutis, basin versus fere ¼-connatis; ovariis baccisque longe pilosis sat dissimillima.

Ramuli validiusculi, novelli dense ferrugineo pilosi, adulteriores mox glabrati. Folia petiolis hirsutis vel glabris, 10–12 mm. longis, in ramulos lineatim decurrentibus stipitata, coriacea, elliptica, 12–25 cm. longa, 4–8.5 cm. lata, utrinque glaberrima, nitida, nervis lateralibus utrinsecus 14–16 patentibus, prope margines arcuatim ascendentibus et inter se unitis praedita, apice obtusa, basin versus oblique angustata, immo paulo decurrentia. Inflorescentia valde abbreviata, flores hirsutos gerens. Sepala liguliformia, hirsuta, basi fere ¼-unita, haud imbricata. Petala sepalis longiora, extus hirsuta, ovata, acuta. Stamina ovato-acuta, petalis breviora. Ovarium valde hirsutum; ovula glabra, verticaliter corrugata. Bacca pisiformis, ferrugineo-pilosa, circa 5 mm. in diam.



Ardisia ferox Furtado (A-B1: Holotypus; C-H: Mat s.n.)

A, Ramulus cum foliis majoribus. B, Ramulus cum infructescentiis. B1, Fructus cum calyce. C, Flos ante anthesin. D, Petala duo postice visa. E, Stamen antice visum. F, Ovarium. G, Placenta. H, Fructus juvenilis.

MALAYA: Johore, Gunong Pulai (Nur & Kiah 7,778—Holotypus; Ridley 12,189; Mat s.n. in 1892): Omnia specimina in herbario Singaporensi conservata.

2. ***Ardisia fuliginosa*** Bl., Bijdr. (1826) 692; Mez in Engl.

Pflanzenr. IV 236 = Heft 9 (1902) 99.

A. tomentosa Presl., Rel. Haenk. II (1835) 66; Mez in Engl. Pflanzenr. IV, 236 = Heft 9 (1902) 100; Merrill, Enum. Philipp Pl. III (1923) 265. **syn. nov.**

A. disticha A. DC., Prodr. VIII (1844) 129.

SUMATRA: Atjeh (v. Steenis 6,186); Takigeum (W. & C. Bangham 726); loc. incert. (Forbes 2,142).

BORNEO: North Borneo, Marudu Kudat (Austin A 1,191); Tawao (Elmer 20,462). **Sarawak**, Rejang (Haviland 3,029).

JAVA: Besuki (Steenis 10,826).

PHILIPPINES: loc. incert. (Cuming 849, isoholotypus of *A. disticha*); Jamindan (Ramos & Edano 30,999); Mt. St. Isidoro (Fenix 30,008); Angat (Ramos & Edano 34,062), etc.

There is a good deal of variation in the tomentum of the leaves as well as in the branching of inflorescences.

3. ***Ardisia korthalsiana*** Scheff., Comm. Myrs. Arch. Ind. (1867) 57; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 99.

A. teysmanniana Scheff. *sensu* Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

MALAYA: Trengganu (Moysey & Kiah 33,384). **Pahang**, Gunong Tapis (Symington & Kiah 28,825); Sungei Tahan (Kiah s.n.); Sungei Teku (Kiah 31,709); Wray's Camp on Tahan (Ridley 16,241). **Malacca**, loc. incert (Alvins 1755, as *Kayu Segankan* & 582 as *Meddang Panjang*); Bukit Bruang (Derry 456, as *Tambang Sisir*); Lubok Kadondong (Ridley s.n. on 13-VI-1892); Bukit Besar on Mt. Ophir (Ridley in Dec. 1898); Selandor (Alvins 673 = 251, as *Pokok Lagan*). **Johore**, Gunong Belumut (Holtum 10,693 & 10,788).

SUMATRA: West Indragiri in Taluk region (Meijer 4,077 as *Balam Siram*).

ANAMBA ISLANDS: North Jemaja near Padang (Henderson 20,392).

There is a good deal of variation in the specimens. Some (e.g. Moysey & Kiah 33,384 & Kiah 31,709) are practically glabrous and shining in the lower surface with a few minute hairs on the

midrib and with minutely dense reticulations and black glands on the upper surface. The Johore specimens have glabrous and more coriaceous leaves, and though the leaves are similar, black glands are conspicuous on their upper surface in Holttum 10,788 but not in Holttum 10,693. Many other specimens have leaves which are more pilose beneath.

This is the first record in Malaya.

4. **Ardisia pachysandra** (Wall.) Mez in Engl. Pflanzenr IV 236 = Heft 9 (1902) 97 fig. 14 A-E, partim; King et Gamble, Mat. Fl. Mal. Pen. IV (1905) 331; Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

MALAYA: Kedah, Gunong Jerai=Kedah Peak (Ridley in VI—1893); Gunong Bintang (Haniff 21,118). **Perak**, Piah (Penak 39,221); Pulau Rumbia (Seimund on 28-III-1926); Tapah Ridley 14,062). **Penang**, Telok Bahang (Curtis = 1156, as *Limpanan*); Waterfall (Curtis 3,737; Nur 1,225); Government Hill (Curtis = 1156; Ridley = Curtis 1156); Penara Bukit (Curtis 1156); loc. incert. (Curtis ? 3181 & 3164). **Selangor**, Weld Hill (Rahman, Tree 334). **Johore**, Gunong Panti (Ridley in Dec. 1897); Sungei Kayu (Corner 29,197).

BANGKA: (Anta 212, & 685 & 966).

ANAMBA ISLANDS: near Terempak in Siantan (Henderson 20,186); Gunong Ranai in Bunguran (v. Steenis 1287); Padang Leting.

JAVA: **Tjibodas** (Yates 2,924); Gunong Gendero (Kanta 236); Besoeki (Buwalda 7,255 and 7,377).

This species is listed here to show the range of distribution. Usually non-Malayan specimens of this species are distributed unnamed or as *A. fuliginosa*.

There is a good deal of variation in this species, in regard to the size of peduncle and the sepals and in the distribution of tomentum and glands on the leaves; but the ovaries are glabrous. Some Javanese specimens can be mistaken for *A. fuliginosa* if ovaries are not examined.

Ridley 176 & 2,800^a which were cited here by Mez, have been transferred to *A. teysmanniana*.

5. **Ardisia teysmanniana** Scheff in Tijdschr. Nederl. XXXI (1870) 368; Mez in Engl. Pflanzenr IV 236 = Heft 9 (1902) 97; King et Gamble, Mat. Fl. Mal. Pen. IV (1905) 122; Ridl., Fl. Mal. Pen. II (1923) 241 p.p.

A. pachysandra Mez op. cit. p. 97 partim.

MALAYA: Perak? loc. incert (Ridley 462). Malacca, Sungei Udang (Derry 1,143 as *Medang Ketanak*). Johore, Sungei Sedili (Ngadiman 36,894). Singapore, Sembawang (Ridley 5,573); Chan Chu Kang (Ridley 6,788); Changi (Ridley 2,800; 5652 & 176; Goodenough 2,800); Bukit Timah (Ridley 2,800^a; Corner sn.; Chew 10).

Ridley 176 & 2800^a were cited by Mez under *A. pachysandra*.

Section AKOSMOS Mez

6. *Ardisia laevigata* Bl., Bijdr. (1826) 690.

MALAYA: Pahang, Cameron Highlands, 1500–1700 m. alt. (Henderson 18,022; Symington 21,016; Osman 20,810; Holtum 24,985).

JAVA: alt. 1500–2400 m.: Pasoeroea (N.-Ind. Flor. Serv. No. 7, 143); Tjibodas (Sapun 239; Burkill 8,265).

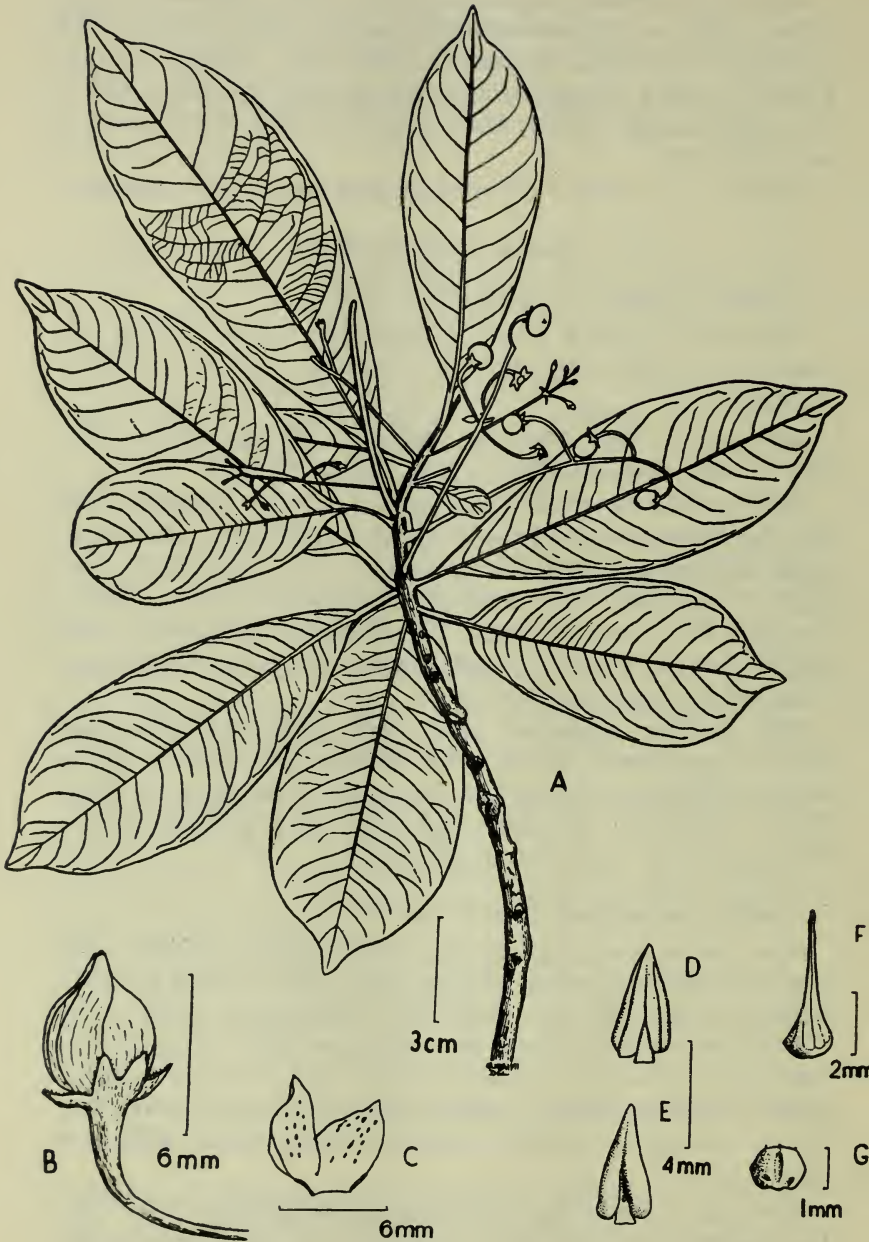
This is a first record for this species outside Java. Burkill notes that the flowers are downwardly directed and pinkish white, leaf-stalks crimson and berries round greenish, all found on the same plant at the same time. Henderson records as follows: "Small, straggling tree in swampy places. Ripe fruit red." Symington's notes suggest that the tree is 15 ft. tall and the fruit is green at first but turns red later and finally black.

The Malayan specimens show more coriaceous leaves and broader sepals which are somewhat ciliolate along margins. But no material differences are noticed to separate these from the Javan forms. Gland dots on sepals and petals may be found in the Malayan as well as the Javan specimens.

7. *Ardisia praetermissa* Furtado sp. nov.

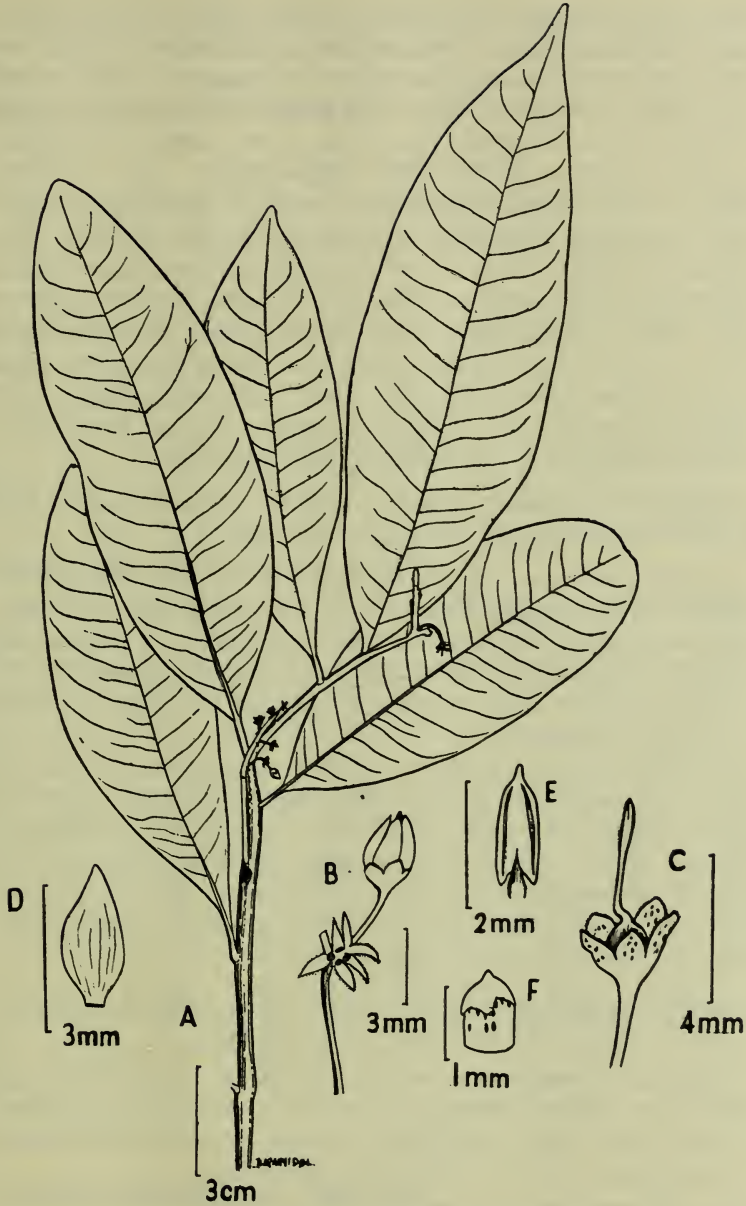
Inter species AKOSMOSIS insignis: innovationibus lepidotis; foliis coriaceis, ellipticis, primo utrinque serius subtus tantum lepidotis, margine integerrimis, laxe reticulatis; inflorescentiis quam petioli 1.5–2.5 cm. longi altioribus, in ramulos primarios apice floribus pedicellatis congestis et bracteolis ciliolatis fere linearibus praeditis divis; sepalis punctulatis ciliolatis quam petala valde brevioribus, basi $\frac{1}{2}$ – $\frac{1}{3}$ –unitis; staminibus petala brevioribus apice subito acuminatis.

Frutex circa bimetralis, in innovationibus lepidotos. *Folia* elliptica, coriacea, 12–18 cm. longa, 4–5.5 cm. lata, basin versus sensim vel rotundato attenuata, in petiolos 1–2.5 cm. longos, lepidotos, supra canaliculatos, margine scariosos paulo decurrentia, apice



Ardisia laevigata Bl. (Holtum 24,985)

A, Habitus. B, Floris alabastrum. C, Petala duo antice visa. D, Stamen postice visum. E, Ibid antice visum. F, Ovarium. G, Placenta.



Ardisia praetermissa Furtado (*Alvins* 342—*Holotypus*)

A, Habitus. B, Inflorescentiae ramulus cum bracteolis floreque. C, Flos petalis desumptis, ut stylus apice bifidus (?) appareat. D, Petalum. E, Stamen postice visum. F, Placenta nonnihil tabida.

obtusa vel acuminata, primo utrinque dein subtus tantum lepidota, supra veridescens et in costa mediana valde sulcata, patente nervosa, laxe reticulata, margine integerrima, punctulis multis minutis subtus fere inconspicuis supra saepe manifestis aucta. *Inflorescentia* axillaris, unica completa visa, circa 5 cm. longa, axi lepidota in 7–8 ramulos ad 12 mm. usque longos, apice umbellatim vel subumbellatim floriferentes, bracteolis persistentibus, circa 1–2 mm. longis, linearibus vel lineari-lanceolatis, margine valde ciliolatis praeditis divisa. *Flores* pedicellis 3–4 mm. longis deciduo lepidodulis suffulti, ante anthesin stylis exsertis aucti, in alabastro circa 5 mm. longi. *Sepala* extus minute lepidota, basi $\frac{1}{2}$ -unita, in lobis ovata vel ovato-oblonga, apice acuta, dorso sparse punctulata, margine albescentia ciliolataque, circa 2 mm. alta. *Petala* sepalis subtriplo longiora, apice acuta vel obtusa, fere ad basin libera. *Ovarium* glabrum; stylus tortuosus, apice bilobatus?

MALAYA: Malacca, Selendor (Alvins 679=342, nom. vern. *Pokoh Pelandok Payah*—Holotypus in SING.).

This specimen was collected by Alvins on Jan. 30, 1885, and was assigned in our herbarium first to *A. crassa* and then to *A. colorata*. According to Alvins, this plant is common in swamps and grows to a height of 6–7 ft. The label was originally numbered 679, and subsequently it was numbered 342, but the original number has not been cancelled.

The inflorescence is axillary bearing very short branches. In the axis of the only one complete inflorescence available, there are marks of fallen off branches and below its base a scar of the axillary leaf. Only 3 flowers were available, all badly preserved. The style of the one examined bore a mark at the apex as if it was bifid. The ovary and the placenta showed marks of disintegration. The petals seem to be free nearly to base.

8. *Ardisia singaporensis* Ridl. in Journ. Roy. Asiat. Soc. Str. Br. 79 (1918) 92 et Fl. Mal. Pen II (1923) 251.

MALAYA: Singapore, Pulau Ubin (Ridley 2,816, Isosyntype and s.n. in 1891; Goodenough on 3–III–1893); Changi Road (Goodenough 2,833, Isosyntype); Changi (Goodenough 2,814): All specimens cited are in Singapore herbarium.

The inflorescences are borne usually in the axils of the leaves near the apex, but sometimes also of the leaves much below the apex. The flowers are borne in umbels at the end of primary or secondary branches of the inflorescence axis, rarely at the end of the unbranched axis itself.

This species should be placed in Section AKOSMOS and is in no way related to *A. miqueliana*. Specimens of the species were distributed as *A. ferruginea* var. *glabrata* and some were named in Singapore herb. as *A. tuberculata*.

Section STYLARDISIA Mez

9. *Ardisia miqueliana* Scheff. in Tijdschr. Ned. Ind. XXXI (1870) 367 et in Flora LIII (1870) 253; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 115.

A. ferruginea Mez op. cit. (1902) 108; King et Gamble, Mat. Fl. Mal. Pen. IX (1905) 325; Ridl., Fl. Mal. Pen. II (1923) 250, non *A. ferruginea* H.B. & K. (1818)—**Syn. nov.**

A. rudis Sinclair in Gard. Bull. Sing. XV (1956) 24—**Syn. nov.**

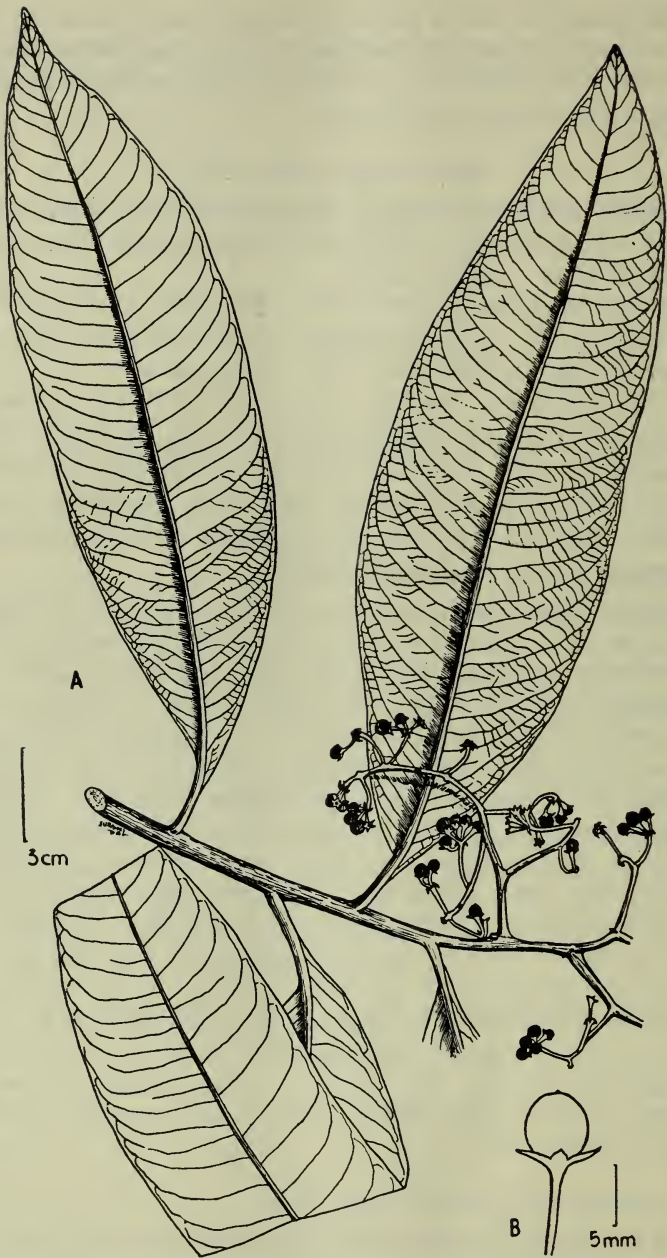
MALAYA: **Johore**, Kampong Simpai (Lake & Kelsall, 4032, Isoholotypus of *A. ferruginea* in Herb. Sing.); Kluang (Holtum 9,356); Bukit Lenggong (Holtum 24,927); Sungei Kayu (Corner, 32,236; Kiah 32,076); Gunong Belumut (Holtum 10,621). **Singapore**, Nee Soon (Sinclair 40,278).

Already King & Gamble had noted that the leaves were exactly like those of *A. miqueliana*. The specimens collected by Lake & Kelsall were apparently from a plant just beginning to flower and so the fact that the inflorescence was actually terminal became obscured due to the well developed lateral branches at the base of the terminal panicle. I do not know the reasons that led Ridley to transfer *A. ferruginea* Mez from Section AKOSMOS to Section CRISPARDISIA. But there is no doubt that the species should be placed in Section STYLARDISIA, the few well developed flowers showing their styles well above the petals of the unopened flowers.

The holotype of *A. miqueliana* was from Bangka. Corner notes that the plant is 20 ft. tall with monopodial side branches and with silvery grey pustular bark with small lenticels: Twigs, petioles and underside of leaves old hairy. Inflorescence hanging at the end of the side branches. Pedicels purplish upwards and at top. Bracts green. Sepals greenish white, but magenta at base. Petals white with a magenta spot at base. Filaments magenta; connective greenish, anther yellow.

10. *Ardisia nurii* Furtado **spec. nov.**

Ab A. crassa, cui valde affinis, foliis rigidioribus, nervis laterali-bus reticulationibusque subtus validioribus, inflorescentiis omnino minus tomentosus, floribus gracilioribus, sepalis fructibusque minoribus haec species facile distinguenda. Ab A. colorata var. colorata,



Ardisia nurii Furtado (Nur 10,511—Holotypus)
A, Ramulus fructiferus. B, Fructus.

quacum confusa, foliis coriaceis nitidisque, bracteolis flores axil-lantibus persistentibus, floribus majoribus robustioribusque sat distincta.

Arbusculus 3–4 metralis, ramulos robustos gerens. *Folia* oblongo-elliptica, apice acuminata, basi oblique acuta vel oblique decurrentia, vel rotundato-acuta, 18–25 cm. longa, 6–7 cm. lata, utrinque vel supra tantum nitida, subtus brunnescentia et lepidibus minutis deciduis praedita, glandulis haud visibilibus, nervis laterali-bus primariis pluribus subtus valde prominentibus supra immersis, in nervum intramarginalem interruptum conjunctis, nervis secundariis multo brevioribus, reticulationibus densis paulo prominulis percursa, petiolis 2–3 cm. longis stipitata. *Inflorescentia* apicalis, pyramidalis, in ramulos arcuatos bi- vel tri-pinnatim divisa, ferrugineo lepidota. *Bracteolae* minutae, linguiformes, ferrugineo-lepidotae, margine ciliatae, pedunculi apice fructiferi persistentes. *Bacca* subglobosa, circa 4 mm. longa, apice compressiuscula, nigra, laevis; pedicelli umbellati, dense lepidoti, 6–10 mm. longi; sepala ovato triangularia, extus dense lepidota, margine flavescentia ciliata, dorso atro-pustulosa, basi breviter tubulosa.

MALAYA: Pahang, Fraser's Hill, alt. 1300–1500 m. (Nur 10,551—Holotypus; Burkill & Holttum 8,514 and s.n. = 8,514; Henderson 11,232). Omnia specimina in Herb. SING. conservata.

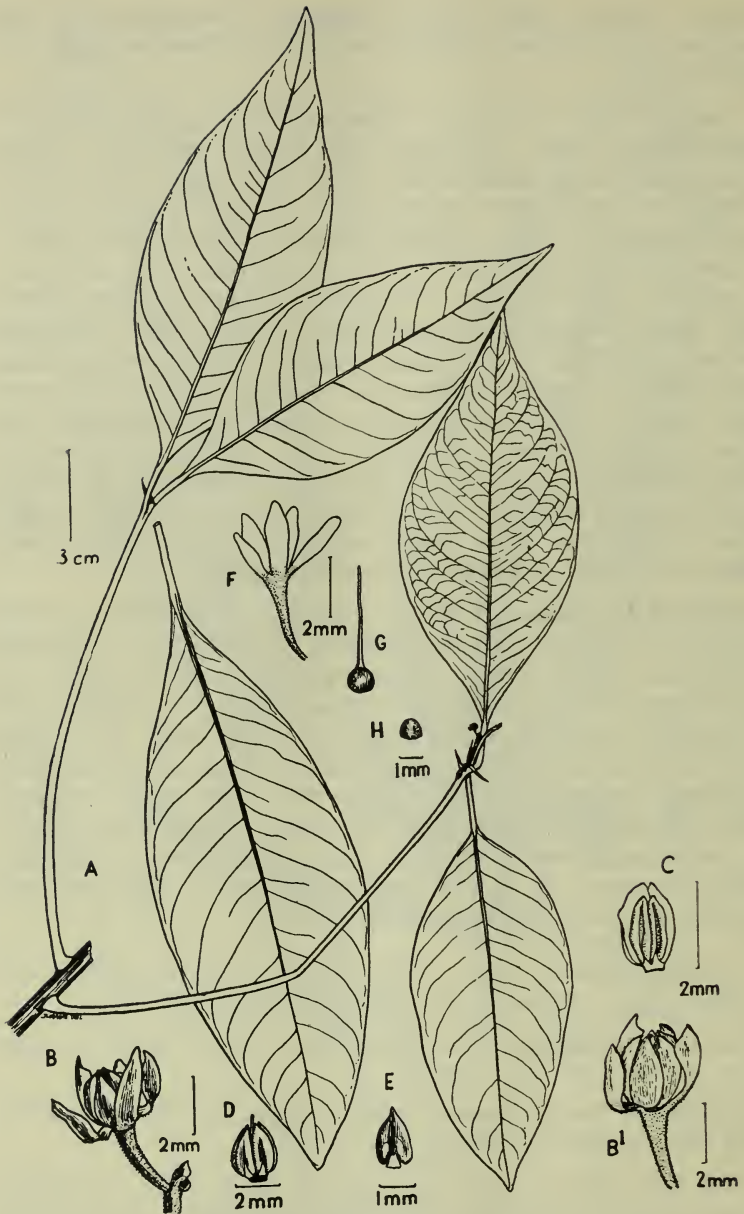
This appears to be localised to Fraser's Hill. The duplicates of the numbers were distributed to other herbaria under *A. colorata* from which this species is distinguished by its coriaceous and shining leaves, persistent bracteoles at the base of the fruits and larger and more robust fruiting calyces. The species appear more close to *A. crassa* which, however, bears much larger flowers and fruits, thicker tomentum on calyces, and less prominent veins and reticulations on the lower surface of the leaves.

11. *Ardisia sessilis* Scheff., Comm. Myrs. Arch. Ind. (1867) 69; Mez in Engl., Pflanzenr. IV. 236 = Heft 9 (1902) 115.

MALAYA: Singapore, Seletar (Ridley s.n. in 1894); Chan Chu Kang (Ridley 3,653 & 3,844).

BORNEO: North Borneo, Tawao (Elmer 21,404 & 21,424). East Borneo, Pelawan Besar (Act. 745).

This material has been named on the basis of the description given by Mez, and requires verification by comparing with the type. The Singapore specimens were quoted by Ridley under *A. crassa* in Fl. Mal. Pen. II (1923) 249, while Elmer's collections were referred doubtfully to *A. fortis* Mez by Merrill in Univ. Calif. Publ., Bot. XV (1929) 234.



Ardisia breviramea Merr. (Elmer 20,425—*Isotypus*)

A, Ramulus floriferus. B, Flos. B¹, Ibid sepalo desumpto ut petala fere libera apparent. C, Petala duo cum staminibus postice visa. D, Stamina calyce corollaque desumptis. E, Stamen postice visum. F, Calyx. G, Ovarium. H, Placenta.

The flowers are practically sessile and bear ovate, entire, acute sepals which are ciliate in the margins. The primary nerves tend to join and form an intramarginal nerve on the leaves.

Section ACRARDISIA Mez

12. *Ardisia breviramea* Merr. in Univ. Calif. Publ. Bot. XV (1929) 235.

NORTH BORNEO: Tawao (Elmer 20,425—Isoholotype in SING.).

Since the inflorescences are apical (a fact also noted by the author of the species) and since the styles do not protrude just before the flowers open, the species cannot be placed in the sections STYLARDISIA or AKOSMOS to which Merrill had referred doubtfully. He had not seen the flowering specimens. Since the Singapore specimen is the duplicate of the holotype and bears flowers, it has been illustrated here as a help in understanding this species which was described from a fruiting specimen only. As in *A. praetermissa*, the petals are free almost to the base.

13. *Ardisia goodenoughii* Furtado sp. nov.

Ab A. divergente, cui valde affinis, haec species foliis majoribus conspicue pustulatissimis, nervis lateralibus primariis pluribus, sepalis valde glandulosis differt. Ab A. polyacte, cui similis, petioli longioribus, foliorum glandulis pluribus conspicuioribus, floribus minoribus paucioribusque in axi distanter sitis, petalis haud acuminatissimis facile distinguitur.

Frutex circa 3 m. altus. *Folia* oblongo- vel lanceolato-elliptica, basi in petiolos 6–10 mm. longos corrugato-decurrentia, 12–20 cm. longa, 5–9 cm. lata, interdum ad 30 cm. usque longa et 11 cm. lata, omnino praecipue secus margines valde glandulosa, glandulis juvenilibus a tribus vetustioribus pustulosis, densissime reticulata. *Inflorescentia* apicalis, in ramos floribus pseudo-umbellatim praeditos divisa, foliis fere aequalis vel brevior. *Flores* pedicellis 10–15 mm. longis suffulti, deciduo-uberuli. *Sepala* ovata, apice rotundata, basi imbricata, margine minute ciliata, dorso valde pustulata. *Petala* extus parce pustulata, sepalis fere triplo longiora, ovata, apice acuta vel breviter acuminata. *Stamina* petalis breviora. *Stylus* ex alabastro ante anthesin haud exsertus.

MALAYA: Kemaman, Ulu Kajang (Corner 30, 432); Bukit Kajang (Corner s.n. on 30–X–1935); Ulu Bendong (Corner 30,046 & 30,099). **Selangor,** Bukit Tangkol in Ulu Langat (Mil-lard 1,380 as *Kayu Bilal*); Sungei Lalang in Kajang (Symington



Ardisia goodenoughii Furtado (A, Strugnell 12,716; B-H, holotypus)

A, Ramulus fructiferus. B, Ramulus floriferus. C, Flos. D, Corolla.
 E, Stamen postice visum. F, Stamen antice visum. G, Ovarium.
 H, Placenta.

22,681); Ampang (Strugnell 12,716); Kuala Lumpur (Good-enough 41, Comm. sub numero Ridleyano 10,481, holotypus in SING); Ginting Bidai (Ridley as *Mata Ayam*); Seminyih (Hume 8,371 & 8,401); Ginting Simpah (Hume 9,525). (Omnia specimina in Herb. Sing. conservata).

BORNEO: Sandakan (Cuadra A2,221 SING.).

The Kemaman and the Bornean specimens represent either material taken from young, vigorously growing shoots or a variety of the type form. The leaves are somewhat thinner in structure and the glands are largely not pustulose. In the Kemaman specimens the inflorescence is very much more slender in its axis, branches and pedicels, and the leaves are also much larger.

Section TINUS (Burm.) Mez

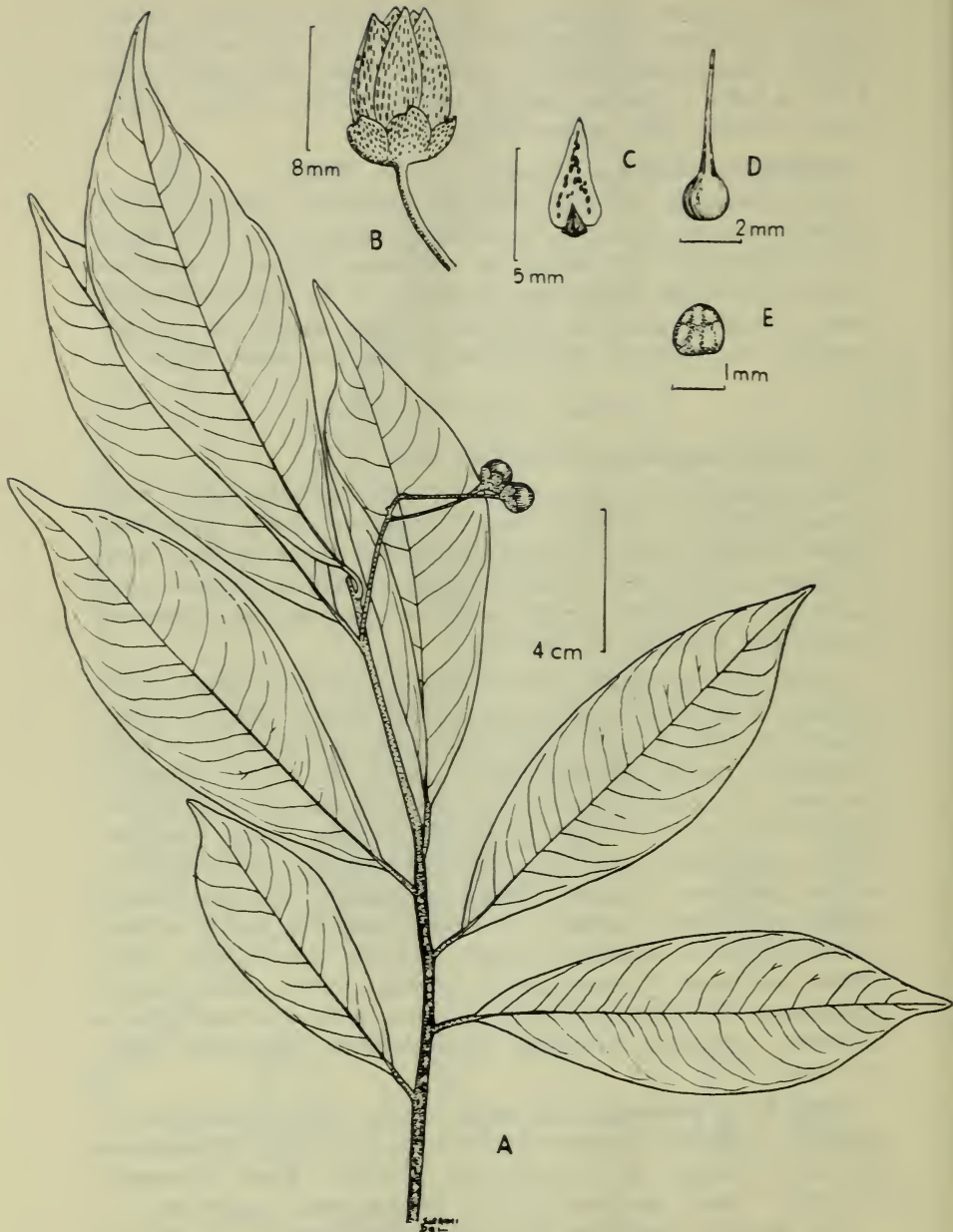
14. *Ardisia gambleana* Furtado sp. nov.

A. rhynchophyllae affinisima, sed petiolis longioribus, foliis obovato-ellipticis, utrinque dense reticulatis, nervis lateralibus prope marginem arcuatim porrectis paulatim evanescentibus, haud in lineam conspicuam intramarginalem conjunctis, inflorescentiis sueto tri- vel bifloris, sepalis ovato-rotundis margine plerumque emarginatis nudisque sat distincta.

Frutex circa trimetralis. *Folia* chartacea, obovato-elliptica, apice eleganter acuminata, basin versus cuneata, novella lepidibus minutissimis obscuris deciduis tecta, dein glabra, glandulis atris dense punctulosa, nervis primariis utrinsecus 7-10, prope marginem arcuatim porrectis praedita. *Inflorescentia* axillaris, tri- vel biflora, pedunculo 2-3 cm. longo, pedicellis fere aequilongo praedita, omnino glandulosa. *Sepala* basi breviter connata, valde imbricata, dense glandulosa, margine flavescencia nudaque, ovato-rotundata, emarginata. *Petala* sepalis fere triplo longiora, ovata, apicem versus sensim vel interdum abrupte attenuata, summo acuta, extus dense punctulata. *Stamina* petalis breviora, ovata, acuta, postice glandulosa. *Ovarium* globosum, glabrum, pauci-ovulatum. *Bacca* globosa, juventute flavescens glandulosaque, maturitate atra, corrugata.

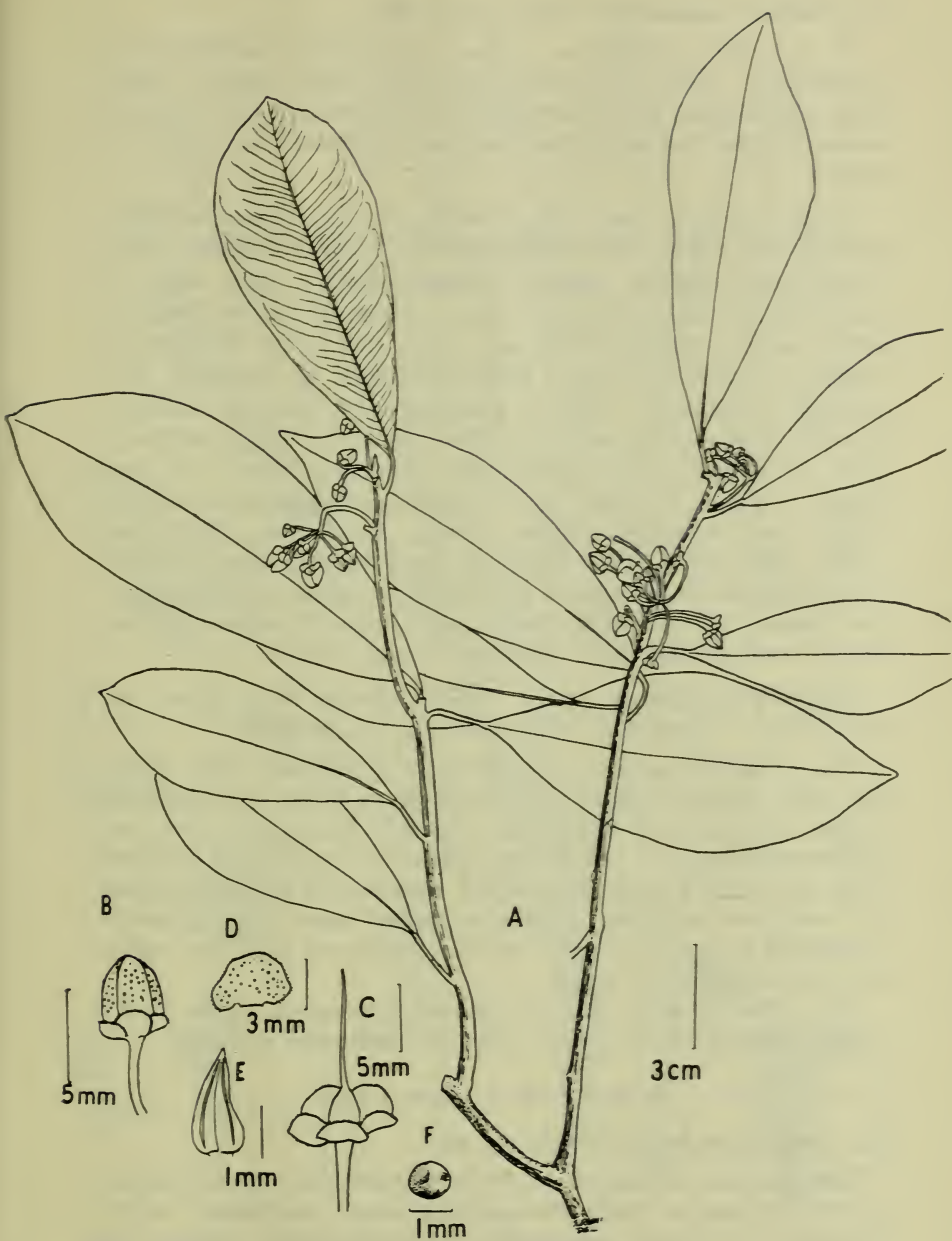
MALAYA: Pahang, Tahan River (Ridley 2,670—Holotypus in SING.): Jerantut (Holtum 24,746); Kota Glanggi (Henderson 22,438); Sungei Sat (Henderson 22,030); Raub (Strugnell 23,456). Omnia specimina in herb. Singaporense conservata.

The holotype specimen was referred doubtfully to *A. rhynchophylla* Clarke by King & Gamble in observation of *A. biflora* K. & G. in Materials IV (1905) 143, but it was not included as a Malayan species because of the imperfectness of the specimen.



Ardisia gambleana Furtado (A, Ridley 2,670; B-F, Holtum 24,746)

A, Ramulus fructiferus. B, Flos. C, Stamen antice visum. D, Ovarium.
E, Placenta.



Ardisia tiomanensis Furtado (Henderson 21,686—Holotypus)

A, Habitus. B, Floris alabastrum. C, Flos petalis desumptis. D, Sepalum. E, Stamen postice visum. F, Placenta.

15. *Ardisia tiomanensis* Furtado spec. nov.

A. monticolae affinissima, a qua foliis obovatis, inflorescentiis robustioribus, florum alabastris majoribus apice obtusis, sepalis semi-orbicularibus vel reniformibus valde imbricatis, extus deciduo violascenteque pubescentibus, margine ciliatissimis sat distinctissima.

Arbusculus circa 8 m. altus, saxatilis, cum innovationibus violaceo-pubescentibus. *Folia* petiolis lepidotis supra canaliculatis circa 2 cm. longis stipitata, coriacea, obovato-elliptica, apice acuta vel acuminata, basin versus sensim acuta, utrinque deciduo lepidota, nervis multis reticulationibusque densis supra fere inconspicuis subtus prominulis percursa, multi-punctulosa vel punctulis absconditis inconspicuis diffusa, bicoloria. *Inflorescentia* axillaris, omnino deciduo violaceo-tomentulosa, ad 2 cm. usque pedunculosa, 5–10 flores umbellatim gerens; alabastra circa 6–8 mm. longa, 5–6 mm. in diam., apice rotundata, pedicellis 8–12 mm. longis, violaceo-pubescentibus suffulta. *Sepala* fere reniformia, medio multo dilata, valde imbricata, basi breviter connata, extus violaceo-pubescentia, minute punctulosa, margine pallida optimeque ciliata. *Petala* deciduo ciliolata vel scariosa. *Ovarium* glabrum; stylus ante anthesin haud exsertus. *Bacca* ignota.

MALAYA: Pahang, Pulau Tioman, prope Ayer Surin, alt. 300–700 m. (Henderson 21,686—Holotypus in SING.).

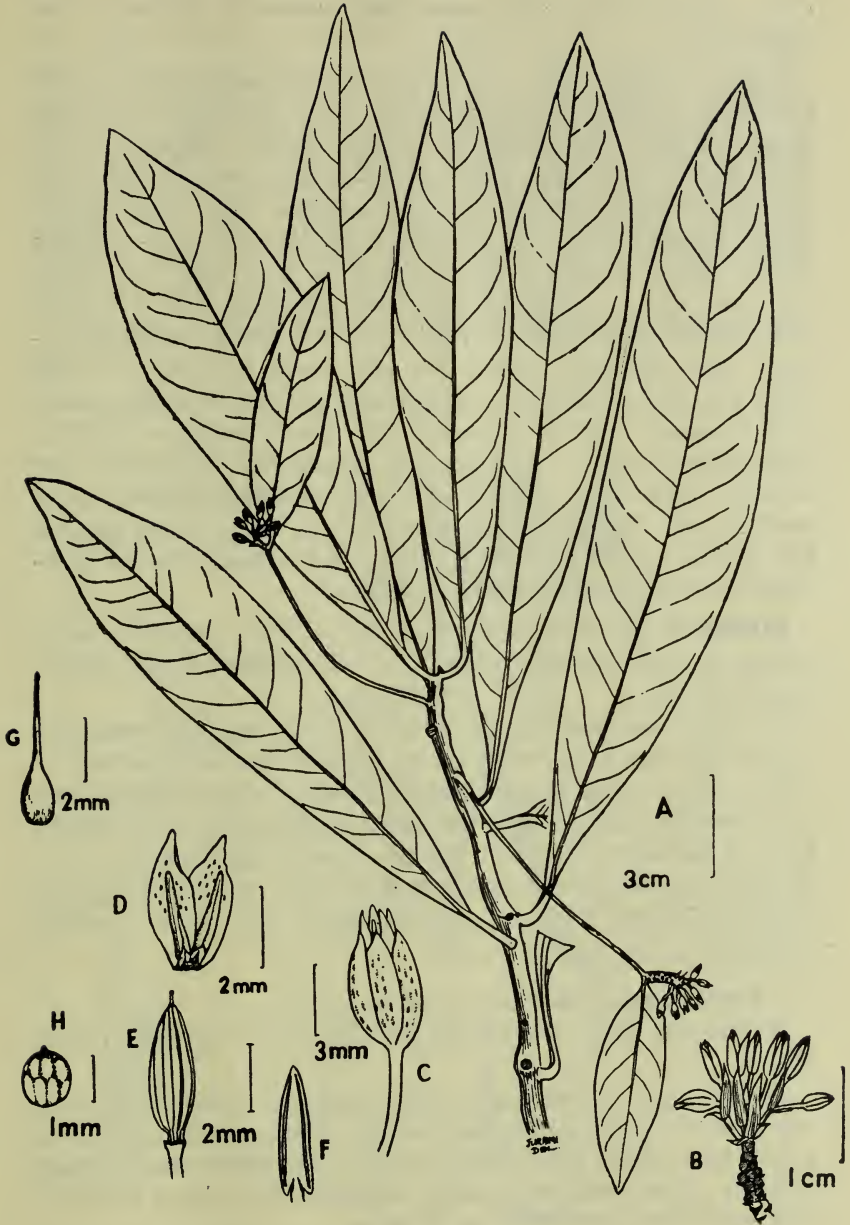
The collection has been distributed as *A. littoralis* Andr. which has very slender, acute flower buds, more united and glabrous sepals, narrower petals and septate anthers. Though the leaves are obovate-elliptic in *A. littoralis*, the violaceous pubescence is absent from the young growth. Similarly *A. tiomanensis* also differs from *A. monticola* which has elliptic-lanceolate leaves, no violaceous tomentum in any parts, very slender, acute flower buds, less imbricate sepals and acute petals.

The collector notes that this species is common in the rocky jungle, growing to 25 ft. or so tall and that flowers are pink.

Section PYRGUS (Lour.) Mez

16. *Ardisia calcicola* Furtado sp. nov.

Inter species ad Sectionem PYRGUM pertinentes peculiarissima facile distinguitur: foliis intergerrimis dense punctulatis, nervis lateralibus interrupte absconditis, haud reticulatis; floribus in pedunculo abbreviato, longe bracteolato, apice ramuli producto valde congestis; pedicellis conspicue punctulatis; sepalis pro rata longissimis, fere ad basin usque liberis, quam petala punctulata



Ardisia calcicola Furtado (Endert 5,134, holotypus)

A, Habitus. B, Inflorescentia. C, Flos. D, Petala duo cum staminis postice visa. E, Flos juvenilis sepalis desumptis ut stamina tubiformiter collata apparent. F, Stamen postice visum. G, Ovarium. H, Placenta.

circa $\frac{1}{2}$ -*brevioribus*, *ovato-lanceolatis*, *utrinque lepidotis*, *atro punctulatis*.

Suffrutex circa 50–75 cm. altus, flores in ramulorum apicibus lateralium racemoso-congestos gerens. *Folia* phyllotaxi in ramulis incerto excepto, subverticillatim collata, obovato elliptica, 30–35 cm. longa, 4–5 cm. lata, basin versus sensim attenuata, apice obtusa vel subacuta, eis ramuli 3–4-plo longiora, supra viridescencia, subtus brunnescentia, opaca, margine revoluta, utrinque pustulis minutis dense praedita, nervis primariis interrupte absconditis prope marginem arcuato ascendentibus utrinsecus circa 12, nervis secundariis fere parallelis inter primarios 1–2 fere inconspicuis percursa, haud reticulata. *Flores* 5–6 mm. longi; pedicelli 5–6 mm. longi, pustulati, bracteolis ovato-lanceolatis saepe acuminatis nonnihil breviores vel eis subaequilongi. *Sepala* utrinque lepidota, dextrorsum tegentia, atro-punctulata, petalis circa $\frac{1}{2}$ -breviora, fere ad basin usque libera, ovato- vel oblongo-elliptica, apicem versus sensim acuta. *Petala* sepalis paulo longiora, acuta, dorso punctulata. *Stamina* breviter stipitata, petalis vix breviora. *Ovarium* glabrum ovulis biserialiter dispositis praeditum.

BORNEO: in regione Centrali in provincia malaice Kutai dicitur, in saxis cretaceis, circa 30 m. alt. (Ender 5,134—Holotypus in SING.).

The collector notes that the shrub is 50–75 cm. tall, producing dark red flowers and growing on the edge of limestone rockface.

The calyx is rather long and deeply divided, but such long calyces are known to occur in the other sections of the genus. The flowers are in a bad state to admit a further scrutiny. No fruits are available. Because the flowers are borne at the apices of special branches and because the leaves are subverticillate, the species belongs obviously to the Section PYRGUS.

17. *Ardisia calophylla* Furtado sp. nov.

A. littoralis Andr. sensu Ridl., Fl. Mal. Pen. II (1923) 241 in obs.

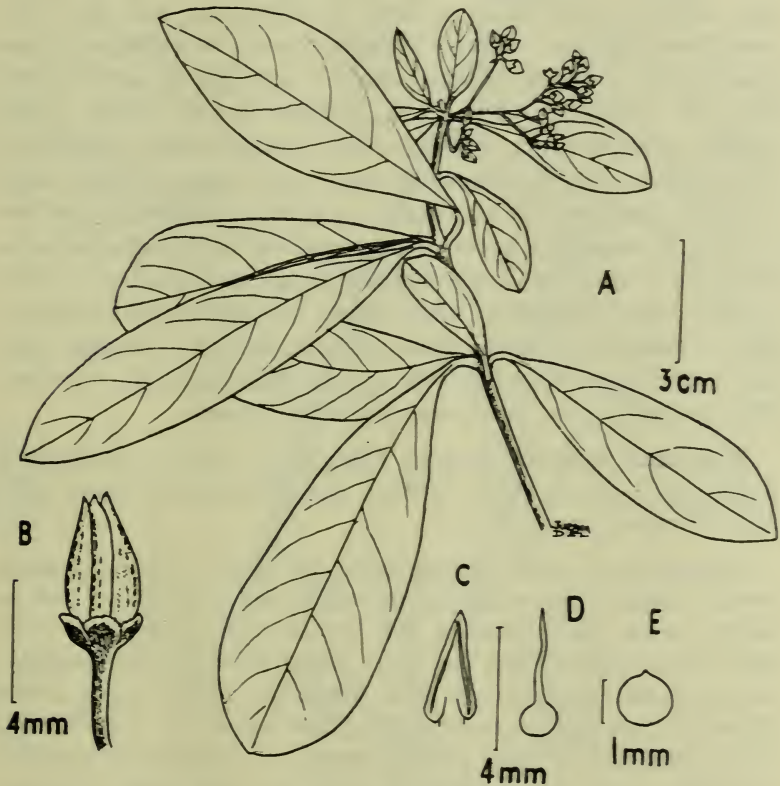
Ab A. kurzii, cui affinissima, foliis minoribus, coriaceis, obovatis cum nervis reticulationibusque obscuris; inflorescentiis paniculatis, quam folia paulo brevioribus; sepalis suborbicularibus margine ciliolatis, sicut petala punctulatis; antheris acutis dorso glandulas paucas distantes gerentibus sat distincta.

Ramuli glabri, in sicco sicut folia foenicolores. *Folia* glabra, punctis manifestis destituta, obovato-elliptica, apice arcuatim acuta vel breviter acuminata, 6–10 cm. longa, 3–4 cm. lata, basin versus

sensim cuneata, imo paulo decurrentia, petiolis supra sulcatis 5–10 mm. longis stipitata, nervis reticulationibusque fere obscuris praedita. *Inflorescentia* glabra, ramuli foliis subverticillatim praediti apice sita, paniculata, in ramulos floriferos valde divisa, ad 6 cm. usque longa. *Flores* ante anthesin conoidei; apice rotundati 3–4 mm. longi; pedicellis 3–5 mm. longis. *Sepala* basi 1/3 coalita, valde dextrorsum imbricata, fere orbicularia, glabra, dorso glandulosa, margine lutescentia, scarioso-ciliolata. *Petala* calyce subtripulo longiora, glandulosa. *Stamina* petalis paulo breviora, acuta, dorso pauciglandulosa. *Ovarium* ovoideum, glabrum.

MALAYA: Dindings, Bruas (Burn-Murdoch in 1909—Herb. SING.).

The collector notes that the flowers are white.



Ardisia calophylla Furtado (*Burn-Murdoch-Holotypus*)

A, Habitus. B, Flos per anthesin. C, Stamen postice visum. D, Ovarium.
E, Placenta.

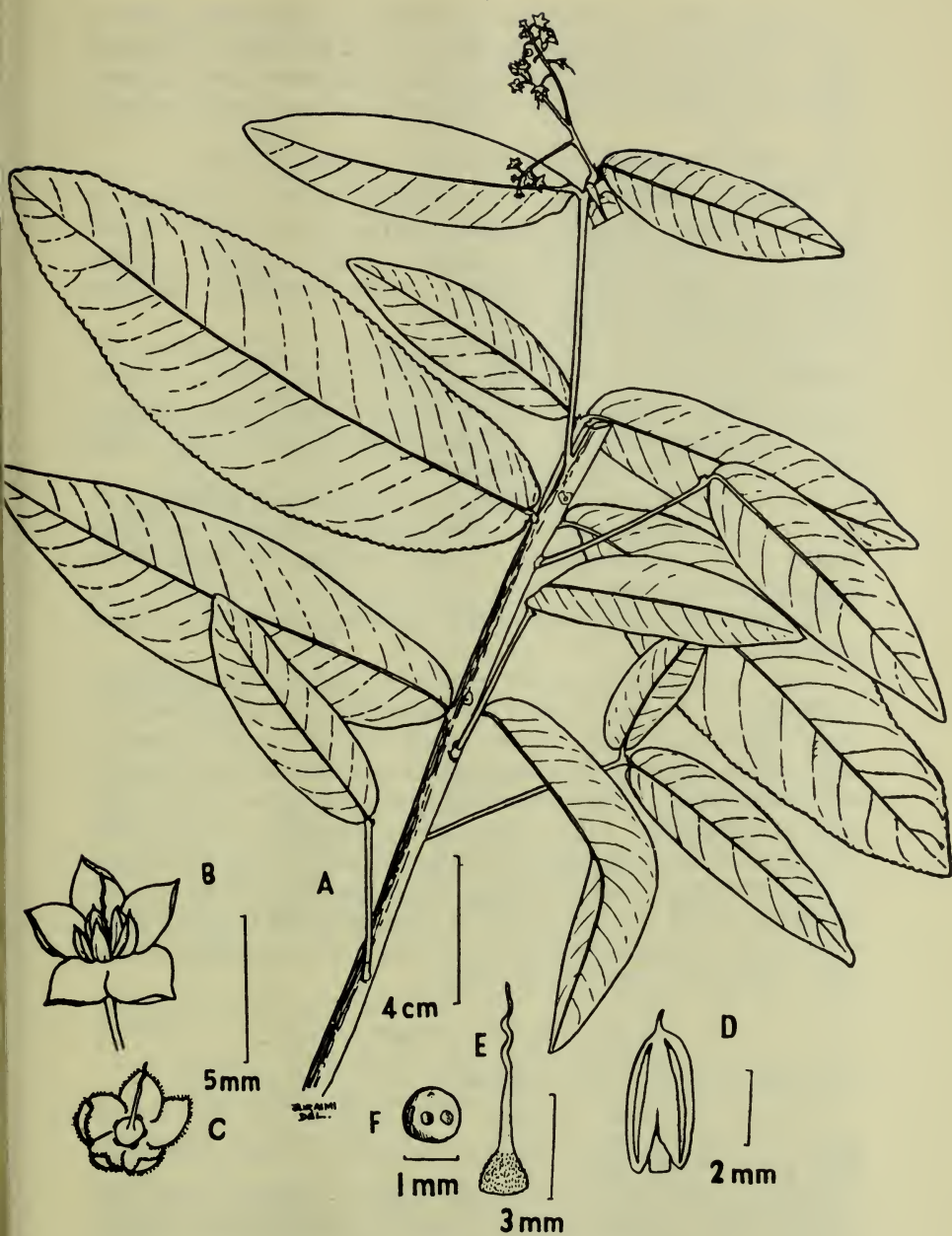
18. *Ardisia purseglovei* Furtado sp. nov.

A. candolleanae valde affinis, a qua foliis ovoideo oblongis basi pseudo-cordulatis, subsessilibus, glabris, margine obscure crenulatis, glandulas magnas mox deciduas unocuique sinu singulas gerentibus, subtus minutissime punctulatis, cum nervis lateralibus reticulationibusque obscuris; sepalis tetrameris vel pentameris, extus tomentosus, intus glabris, margine ciliatis, eglandulosis; ovarii tomentellis facile distinguitur.

Frutex circa 3 m. altus, cum ramulis spiculiferentibus 5–10 cm. longis. *Folia* coriacea vel chartacea, ovoideo oblonga, apicem versus arcuatim angustata, summo obtusa, basi rotundato truncata, imo ob rugas pseudo-cordulata, petiolis brevissimis ad 3 mm. usque longis stipitata, in ramulis spicas gerentibus subverticillata, margine obscure crenulata et revoluta, in unocuique sinu glandulas conspicuas deciduas singulas ferentia, nervis reticulationibusque obscurissimis praedita, subtus punctulis minutissimis dense aucta, 8–15 cm. longa, 2.5–4.5 cm. lata, utrinque glabra, novella subtus deciduo rubro-lepidota. *Inflorescentia* apicalis omnino tomentella, ex axi primario valde abbreviato, circa 2 cm. longo, in ramos circa 4, paulo ramulosos divisa. *Flores* in ramulis inflorescentiae primariis vel secundariis producti, tetrameri vel pentameri, pedicellis puberulis circa 5 mm. longis suffulti. *Sepala* coriacea, basi $\frac{1}{4}$ – $\frac{1}{3}$ -coalita, ovato triangularia apice obtusa vel subacuta, intus glabra, extus tomentosa, punctulis manifestioribus destituta, margine ciliolata. *Petala* calyce fere duplo longiora deciduo lepidotula, punctata. *Ovarium* pubescens, ovoideum, cum stylo tortuoso.

BORNEO: Sarawak, Gunong Pueh, alt. \pm 150 m. (Purseglove 4670—holotypus in Herb. SING.). Specimina isoholotypica in K. et L. distributa non vidi.

The species is readily recognised by the ovate oblong, subsessile, pseudocordulate leaves having practically no reticulations and its lateral nerves inconspicuous, the inflorescence being hairy (the hairs are capitate), and the ovary puberulous. The leaf-margins are somewhat crenulate, but as the margins are revolute, the crenulations are not easily seen especially if the leaves are mounted with their lower surface glued onto the sheet. *A. brachythyrsa* has also subsessile leaves, but in that the leaves are much more rigid and coriaceous, almost obovate, having their nerves and reticulations quite conspicuous on both surfaces. The sepals are smaller there and less tomentose and the ovary is quite glabrous.



Ardisia purseglovei Furtado (*Purseglove* 4,670—*Holotypus*)

A, Habitus. B, Flos post anthesin. C, Flos petalis desumptis. D, Stamen postice visum. E, Ovarium. F, Placenta.

As the leaves are crenulate and bear a conspicuous gland in each sinus, the species may be easily put in the Section CRISPARDISIA as defined by Mez, but the mode of flowering and subverticillate leaves have led me to place species in the Section PYRGUS.

19. *Ardisia vaughanii* Ridl., Fl. Mal. Pen. II (1923) 248.

MALAYA: Perlis, Telor Jambu (Ridley 14,932, distributed as *A. sanguinolenta* Wall.). **Kedah**, Gunong Baling (Kiah 35,383 & s.n. on 11-V-1938; Best 21,226; Nauen 38,022). **Perak**, Temengoh (Schebesta 2). **Pahang**, Kuala Tembeling (Holttum 20,552 & 24,723; Henderson 21,780).

The type was from Kelantan. Ridley placed this species in the Section TINOPSIS, but it should be placed in the Section PYRGUS (Lour.) Mez, the species being an ally of *A. kurzii* Clarke. Squires 848 from Anam, Indochina, distributed as *A. rigida* Kurz comes very close to the Malayan species.

According to the notes of the collectors, this is a shrub 6–8 ft. tall, bearing clusters of flowers having pale pink petals with dark centre, deep pink peduncles and pedicels, and red fruits which eventually turn black.

The following notes may be of use to supplement the original description:

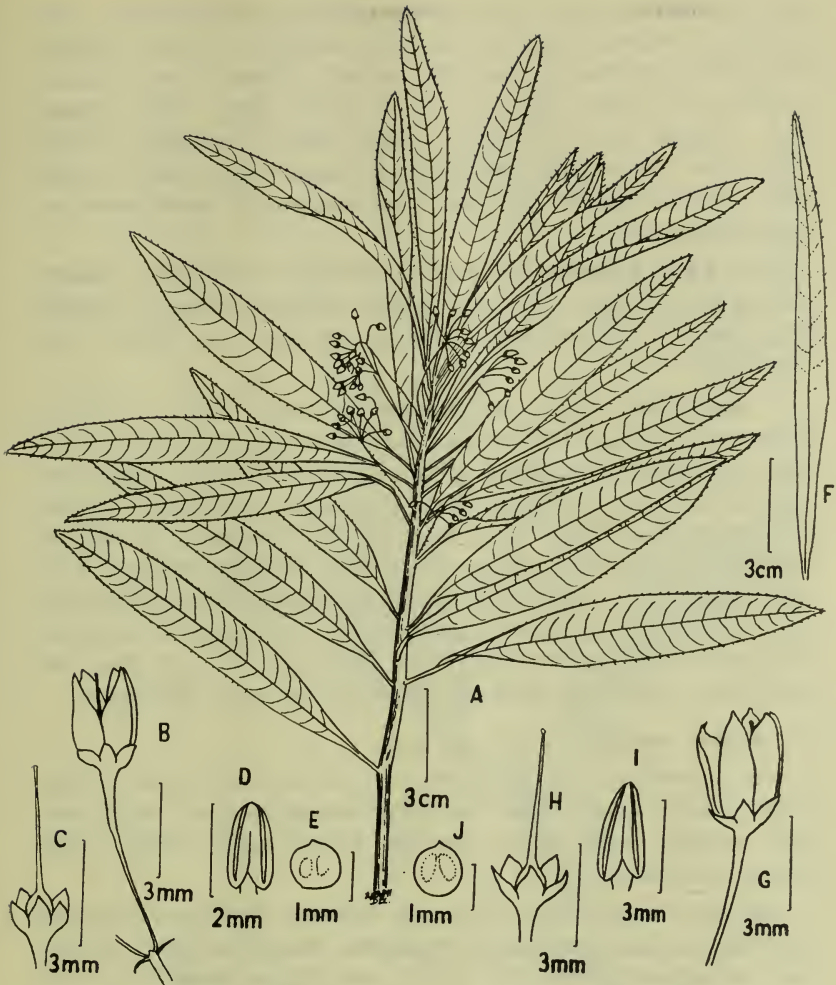
Leaves subverticillate on the main stem, with many small glands inconspicuous in some leaves, but generally quite conspicuous on both surfaces, glabrous. *Inflorescences* terminal usually borne on short lateral branches. *Peduncles* and pedicels deciduously puberulous and lepidote, somewhat ferruginous. *Sepals* ovate triangular with rounded apex, 1/3 united at base, imbricate in buds, glandular and minutely puberulous on the dorsum, ciliate in margins. *Petals* with many glands, gradually acute. *Stamens* nearly as long as the petals, acute or mucronulate at apex, provided on the dorsum with no or few glands which are not black. *Ovary* glabrous. *Fruit* black when dry, longitudinally ridged.

Section BLADHIA (Thunb.) Mez

20. *Ardisia foliosa* Furtado sp. nov.

A. linearifolia Ridl. in Journ. Roy. Asiatic. Soc. Str. Br. 61 (1912) 27 et Fl. Mal. Pen. II (1923) 255, non *A. linearifolia* Miq. (1860); **Syn. nov.**

Suffrutex parte erecta 20–40 cm. longus, in parte basali repens vel subterranea ramulos erectos gerens, cum innovationibus minute puberulis. *Folia* subverticillatim congesta, membranacea, costis medianis exceptis minute puberulis utrinque glabra, lineari lanceolata 10–12 cm. longa, 15–20 mm. lata, utrinque sensim acuta.



Ardisia foliosa Furtado (A-E, Holotypus; F-J, Merotypus *A. linearifolia* Ridl.)

A, Habitus. B, Flos post anthesin apice pedunculi situs. C & H, Flos petalis desumptis. D & I, Stamen postice visum. E & J, Placenta. F, Folium. G, Flos post anthesin.

apice plerumque mucronulata, margine valde denticulata et revoluta, supra brunnea, subtus pallidiora, nervis secundariis utrinsecus 16-20, reticulationibus remotis subtus prominulis supra obscuris praedita, glandulis novellis obscuris dein prominulis praecipue secus marginem et apice punctata, petiolis 10-15 mm. longis stipitata. *Inflorescentiae* axillares, simplices vel pauciramosae, axi

minute puberulae, cum pedunculis gracilibus bracteolatis, apice 3–8 flores congestis, infra apicem flores solitarios vel etiam ramulos florigerentes productis; pedicellis minute puberulis vel glabrescentibus 8–15 mm. longis. Flores 3–4 mm. longi, ante anthesin acuti. *Sepala* basi $1/3$ -unita, ovata, acuta, margine ciliolata, albescentia, dorso pauciglandulosa vel non. *Petala* ovato acuminata, interdum subito apiculata. *Stamina* petalis multo breviora. *Baccae* non visae.

MALAYA: Kelantan (Henderson 29,656—Holotypus). Johore, Sungei Kayu (Kiah 23,330). Perak, Gunong Bongsu (Haniff, Merotypus *A. linearifoliae*). Omnia specimina in Herb. Sing. conservata.

A. linearifolia Ridl. is an impriorable name since it is a later homonym. This and the fact that the species was based on a fragmentary material cultivated in the Botanic Gardens, Singapore, have induced me to establish a new species based on better material the duplicates of which have been widely distributed. In accordance with the definition given previously (Furtado in Gard. Bull. Straits Settl. IX, 1937 p. 289) I have employed the term merotype to designate the specimen taken from the type plant on which *A. linearifolia* Ridl. was based. In the plate figs. F–J are from the fragmentary merotype material preserved in herb. Singapore.

21. *Ardisia tumida* Furtado sp. nov.

Ab A. metallica, cui affinissima ut videtur, caule haud pubescenti, ramulis novellis deciduo ferrugineo-furfuraceis, foliis margine eserratis undulatisque, petiolis subtus valde tumidis haec species sat distincta.

Suffrutex circa 60–100 cm. longus, lignosus, in vivo cortice valde succosus, in sicco irregulariter angulatus, ramulis novellis axi deciduo ferrugineo-furfuraceis, 15–30 cm. longis praeditus. *Folia* saepe subverticillatim collata, petiolis 1–2 cm. longis, supra paulo alatis, sulcatis, subtus valde tumidis stipitata, obovato-elliptica margine undulata, membranacea, pellucida, utrinque glabra, basin versus paullatim angustata, imo sub-acuta, apice eleganter acuminata, 15–20 cm. longa, 4.5–7 cm. lata, nervis primariis utrinsecus 14–20 praedita, prominulo reticulata, glandulis minutis pluribus omnino dispersa. *Inflorescentia* stricte axillaris parva cum pedunculo 5–10 cm. longo, simplici vel bifurcato, 3–5 fructiferenti, pedicellis fructiferis gracilibus, circa 10 mm. longis. *Bacca* globosa, 6–7 mm. in diam., purpureo-glandulosa; sepalis $1/3$ -coalitis, carnis, glabris, obscure glandulosis vel non.



Ardisia tumida Furtado (Corner 30,290, holotypus)

A, Fragmentum caulis cum fructu. B, Fragmentum caulis ut petiolus
subtus tumidus appareat.

MALAYA: Kemaman in locis juxta flumina paludosis: Ulu Bendong (Corner 30,290—Holotypus in SING.): Sungei Nipah (Corner s.n. in Nov. 1935—SING.); Ulu Kajang (Corner s.n. in Nov. 1935—SING.).

The species is readily distinguished by its peculiar, water-holding cortex on the underside of the petioles, being very pronounced in older leaves. Similar cortex is found all over the stem, a reason why it dries to produce irregular ridges. Young twigs are covered with fugaceous, rusty-furfur. Leaf margins are undulate, but not serrate.

The collector notes that the plant is 3 ft. tall with pale red berries. No flowering specimen has been available.

HYMENANDRA A.D.C.

Hymenandra iteophylla (Ridl.) Furtado **comb. nov.**

Ardisia iteophylla Ridl. in Journ. Bot. LXII (1924) 298 et Fl. Malay Pen. V Suppl. (1924) 318: **basinymus**.

That the stamens are connate into a tube was noticed by Ridley himself; they have also a small free tip. In *Ardisia* the stamens are free.

This is a first record of the occurrence of the genus not only in Malaya, but also outside Assam.

TETRARDISIA Mez

Tetrardisia corneri Furtado **sp. nov.**

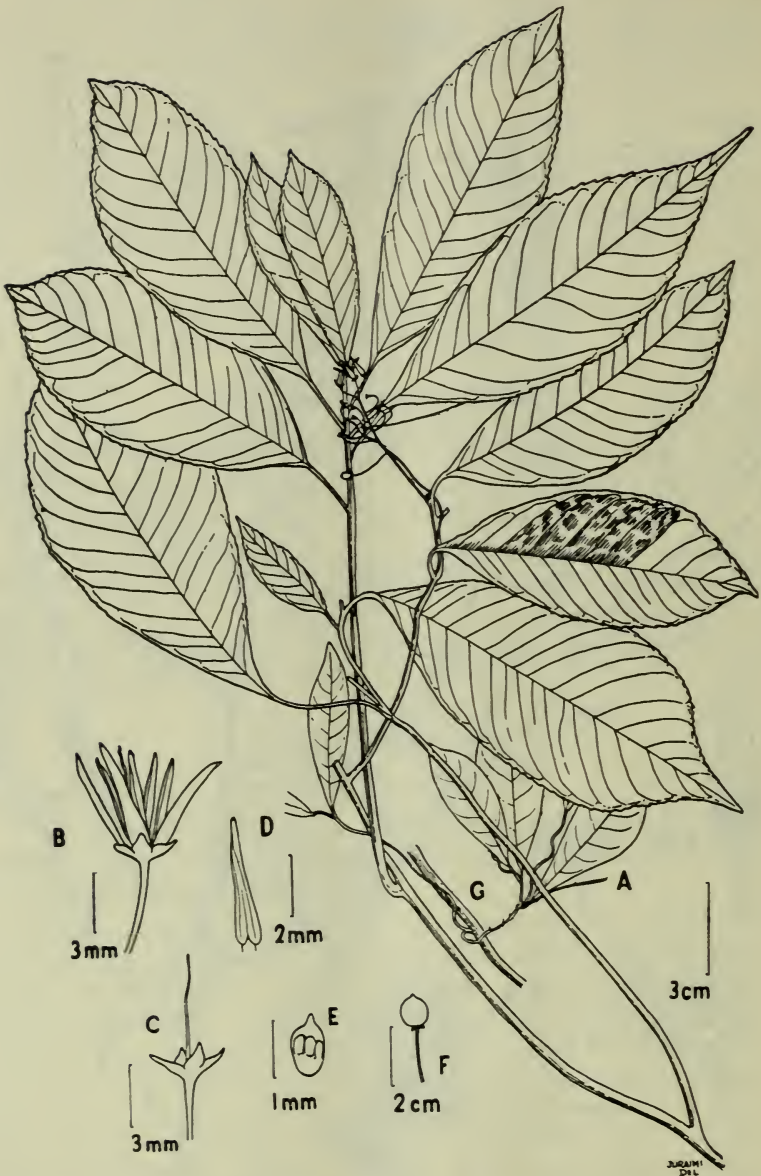
A T. denticulata (Bl.) Mez, *cui affinisima, sed foliis majoribus, obovatis vel oblongis, inter venae nonnihil bullatis, inflorescentiis longioribus facile distinguitur.*

Suffrutex circa 60 cm. altus, lignosus. *Folia* obovato-elliptica vel oblonga, basin versus sensim attenuata vel subito angustata, imo acuta, apice acuminata, margine crenata, reticulationibus densis utrinque prominulis praedita, nervis primariis utrinsecus 12–20 percursa, inter nervos bullata, 15–20 cm. longa, 4.5–8 cm. lata, punctulis pluribus, atrescentibus praedita. *Inflorescentiae* terminales vel axillares, 5–6 cm. longae, pedunculis gracilibus, apice flores distantes gerentibus, vel etiam in 1–2 ramulos circa 1–2 cm. longos florigerentos divisae; pedicellis 8–10 mm. longis, minute puberulis. *Flores* tetrameri, ante anthesin acuti, 6–8 mm. longi. *Sepala* imbricata, basi 1/3-unita, ovata apice rotundato-acuta, dorso minute glandulosa, in fructu reflexa. *Petala* calyce fere quadruplo longiora, apicem versus sensim acuta. *Anthera* petalis vix breviora, apicem versus sensim attenuata, dorso atropunctata,



Hymenandra iteophylla (Ridl.) Furtado (*Holttum 10,973, Isotypus*)

A, Habitus. B, Inflorescentia. C, Floris alabastrum. D, Calyx. E, Flos ut tubus staminem appareat. F, Ovarium.



Tetrardisia corneri Furtado (A-F, Corner, Holotypus; G, Corner, Paratypus)

- A. Habitus. B, Flos per anthesin. C, Flos petalis desumptis. D, Stamen postice visum. E, Placenta paulo tabida. F, Fructus cum pedicello. G, Inflorescentia in ramulum transformata (ex specimine paratypico mawaiensi).

longitudinaliter introrsum et per foramina apicalia dehiscentia. *Ovarium* ante anthesin unicum visum, imperfectum; stylus filiformis, paulo tortuosus, stigmatē punctiformi praeditus. *Bacca* globosa, circa 6 mm. in diam., novella glandulis pluribus conspicisque, in maturitate fere inconspicuis et sulcis verticalibus praedita.

MALAYA: **Johore** in locis paludosis: Sungei Berassau prope viam Mawai—Jemaluang (Corner sn.—Holotypus); Mawai (Corner sn.); Gunong Panti ad basin (Ridley—Dec. 8, 1892)—Omnia specimina in Herb. Sing. conservata.

The growth of inflorescence is somewhat similar to that in *T. tetrasepala* and the anthers appear to dehisce through both the apical pores and the longitudinal slits. Only one unopened flower was available (besides one opened one) and this had decayed somewhat. What looks like ovules in the ovary were really cavities.

One specimen (Mawai) had some inflorescences transformed into small plants, though its apical inflorescence bore fruits.

Probably Alvins 2336 from Malacca is this species, but the label does not belong here, for according to Alvins' notes the plant is a tree about 30 ft. tall with very hard, dark red wood. The leaves are longer, lanceolate elliptic or ovate elliptic, gradually narrowed to produce an acuminate apex and sub-rotund base. The specimen has scars of fallen peduncles.

Ridley's specimen from a herb grown in the Botanic Gardens, Singapore, in 1892 and figured in colours by Alwis in a plate preserved in the Singapore herbarium should also be assigned here, though being from a very young plant the leaves are smaller with shorter petioles. The drawing shows different shades of pink or mauve in the pedicels, calyx and corolla. Ridley suspected the plant to have come from Pahang.

Tetrardisia porosa (Clarke) Furtado **comb. nov.**

Ardisia porosa Clarke in Hook. f., Fl. Brit. Ind. III (1882) 522; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 118; King & Gamble, Mat. Fl. Malay. Pen. IV (1905) 132; Ridl., Fl. Mal. Pen. II (1923) 248 fig. 97. **Basinymus.**

MALAYA: **Perak**, Taiping Hills (Henderson 10,454 & 10,438; Ridley 14,262); Gunong Hijau (Ridley in February 1891); Batu Togo (Wray 2,160); Larut (Scortechini 116^a); Ayer Larut (Wray 39); Tupai (Wray 2,835). **Malacca**, Panchor (Goodenough) 1528). **Negri Sembilan** (Ridley in December 1890).

It is possible that the pollen shedding through apical pores of the anthers is also a characteristic of the genus *Tetrardisia*.

Tetrardisia tetrasepala (King et Gamble) Furtado **comb. nov.**

Ardisia tetrasepala K. & G. Mat. Fl. Malay. Pen. IV (1905) 352; Ridl. Fl. Mal. Pen. II (1923) 244—**basinymus**.

Ad descriptionem originalem adde:

Flores circa 10 mm. longi, ante anthesim valde acuti, tetrameri, 8–20 subumbellati, acropetales, in ramulo axillari vel apicali in singulos annos pedunculiformiter 3–20 mm. aucto siti; pedicelli graciles, 8–15 mm. longi. *Sepala* dextrorsum imbricata, ovata, apice rotundata, margine albescente nuda vel ciliolata, dorso minute punctulata, in fructu reflexa. *Petala* calyce fere triplo longiora, lanceolata, apice sensim acuta, punctulis parvis multis prope marginem picta. *Anthera* breviter stipitata, petalis vix breviora, apice sensim acutissima, dorso bene punctulata, introrsum longitudinaliter et per foramina apicalia dehiscentia. *Ovarium* glabrum vel minuti puberulum, cum ovulis paucis uniseriatim dispositis, stylo gracillimo, nonnihil spirali, petalis subaequante; stigmatate punctiformi.

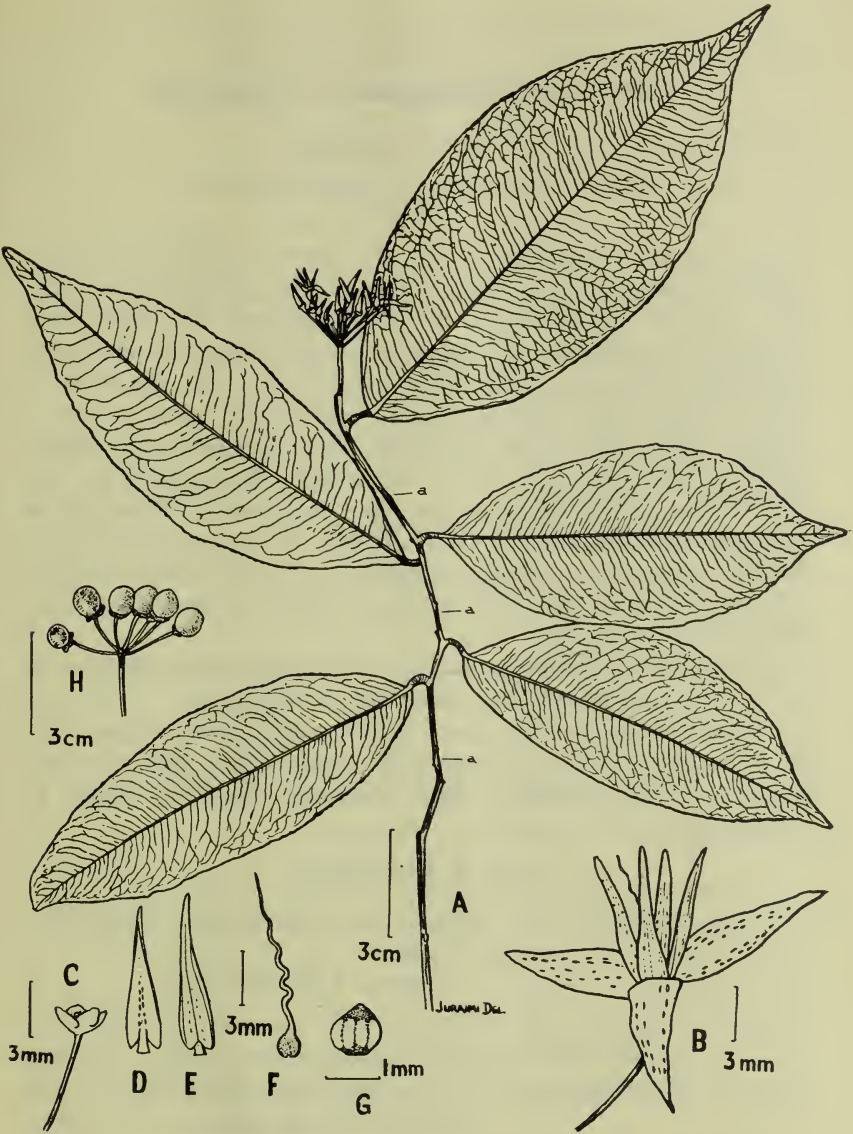
MALAYA: **Johore**, Gunong Pulai (Nur & Kiah 7,805—Apotypus; Ridley sn. & 12,193; Omnia specimina in Herb. SING.).

The inflorescence may be termed sometimes axillary and sometimes terminal. But what appears to be peduncles are really the current year growth of the axillary or terminal buds or twigs. When flowers and fruits are shed, the “peduncles” will grow again to produce flowers in the next season without producing any leaves. Later the same will produce one or more leaves before flowering again.

The tissues connected with the leaves produce a ridge on the stem from node to node and as the petiole of the terminal leaf grows much thicker than the main axis, the terminal inflorescence appears nearly axillary. This mode of growth also tends to make the stem zig-zag. Vestiges of fallen flowers may be seen on stem.

The anthers shed pollen both through apical pores and through longitudinal slits. The leaf margins are undulate and sometimes slightly crenate, and the petiole is often transversely wrinkled, the wrinkles acquiring dark brown colour.

Tetrardisia was not recorded to occur outside Java. King & Gamble had noted the tetramerous calyx, but they had no flowers to define the species generically. In the Singapore herbarium, of the three collections from the type locality in Johore (Gunong Pulai) only Nur and Kiah 7,805 have flowers which have served to place the species definitely into this genus. Hence it may be called the apotype. (cf. Furtado in Gard. Bull. Straits Settl. IX (1937) 288).



Tetrardisia tetrasepala (K. & G.) Furtado (A-G, Nur & Kiah 7,805, Apotypos; H, Ridley 12,193)

A, Habitus. A-a, Vestigia florum prioribus annis delapsorum. B, Flors per anthesin. C, Calyx cum pedicello. D, Stamen postice visum. F, Ovarium. G, Placenta. H, Umbella fructifera.

The Genus *Sphagnum* in Malaysia

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IN THE LARGE GENUS, *Sphagnum*, the degree of affinity and variability of the species occurring in South-East Asia has not been fully worked out. Professor Le Roy Andrews has made very valuable investigations and has indicated the synonymy for South and North American species, and has made some reference to species from other tropical regions. Fortunately he was able to examine the types in the Warnstorf Moss Herbarium at Berlin-Dahlem. This herbarium which was entirely destroyed in the last war (Dalby, 1957), included the types described by Warnstorf in *Sphagnologia Universalis* (1911). In the absence of types for reference, the excellent critical work done by Le Roy Andrews before the destruction of the herbarium must form the basis of present day *Sphagnum* studies.

In this paper an account is given of the Malaysian *Sphagna* in the Herbaria at Bogor, Indonesia, and at Singapore.

The classification of the genus in this paper closely follows that of Andrews (1936). A complete synonymy is not given but new synonyms are indicated. Other synonyms can be found in Warnstorf (1911).

Key to the Species

- 1a. Cortical cells of stem and branches without spiral thickenings; some, at least retort-shaped
Subgen: LITOPHLOEA 2.
2. Stem cortex cells all alike and all somewhat retort-shaped, branch leaves lacking a distinct border but with a resorption furrow Sect. MALACOSPHAGNUM
 1. *Sphagnum antarcticum*.
2. Stem cortex cells of two kinds, with retort cells only in the axils of leaves; branch leaves all bordered with one or more rows of narrow cells
Sect. ACISPHAGNUM 3.
3. Small delicate plant, shining and iridescent when dry. Branch leaves not fibrillose 7. *Sphagnum sericeum*.

3. Not iridescent. Fibres present in branch leaves. 4.
4. Stem leaves lingulate to triangular lingulate with rounded fimbriate, laciniate or eroded apex 5.
5. Stem leaves not fibrillose hyaline cells never septate 3. *Sphagnum cuspidatum*.
5. Stem leaves usually fibrillose in the centre, hyaline cells septate
4. *Sphagnum novo-guineense*.
4. Stem leaves triangular to triangular-ovate with a truncate tip 6.
6. Chlorophyll cells lying centrally, exposed on both sides or exposed only on the dorsal side. Branch leaves not squarrose 7.
7. Border of stem leaves broadened below
2. *Sphagnum cuspidatum*.
7. Border not broadened below 8.
8. Delicate aquatic plant, branch leaves at least 3.0 mm. long
6. *Sphagnum flaccidifolium*.
8. Fairly robust species, branch leaves less than 1.5 mm. long.
6. *Sphagnum subrecurvum*.
6. Chlorophyll cells lying exposed only on the ventral side. Dry tip of branch leaves squarrose 8. *Sphagnum junghuhnianum*.
- 1b. Cortical cells of stem and branches with spiral thickenings, not retort-shaped Subgen: INOPHLOEA 9.
2. Stem leaves very small, ovate or ovoid, about 500 μ long 9. *Sphagnum roseotinctum*.
2. Stem leaves at least 1.2 mm. long, lingulate to triangular 3.
3. Hyaline walls adjacent to chlorophyll cells in branch leaves densely papillose
12. *Sphagnum borneense*.
3. Hyaline cells not papillose 4.
4. Branch leaves with dorsal pseudopores
11. *Sphagnum beccarii*.
4. No dorsal pseudopores 10. *Sphagnum holttumii*.
- A. Subgenus **Litophloea** (Russ.) Andrews (1911)

I. Section MALACOSPHAGNUM C. Müll.

1. **Sphagnum antarcticum** Mitt. in Jour. Linn. Soc. IV (1859) 106; Bartr., (1942) 246.

Robust plant. *Main stem* cortex 2–4 cells thick, outer cells all more or less retort-shaped; wood cylinder distinct, solid, yellow to brown. *Stem leaves* triangular-lingulate to lingulate, 1.0–2.0 mm. long \times 0.7–1.1 mm. broad, apex rounded, eroso-fimbriate. *Branch leaves* broadly ovate, about 2.5 \times 1.4 mm., strongly imbricate, chlorophyll cells central, barrel-shaped in section, included between hyaline cells or free, hyaline cell-walls adjacent to chlorophyll cells smooth or papillose.

NEW GUINEA: Mount Wilhelmina, wet N. slope, burnt sub-alpine forest 3,400 m. (Brass & Myer-Drees 9737/BO.).

DISTRIBUTION: Australia, New Zealand, Stewart Island, Campbell Island.

This species, while typically a member of the small Malacosphagnum (Rigida) group differs from *S. compactum* D.C. in the relatively large stem leaves with their broad rounded, constantly fimbriate apex. The branch leaves have numerous dorsal pores at the commissures while the pseudopores, typical of *S. compactum*, are absent. The section of the branch leaves is similar to that of *S. compactum* with the chlorophyll cells included on both sides, in which feature it differs from *S. strictum* Sull. where the chlorophyll cells are exposed on the outer surface of the leaf.

II. Section ACISPHAGNUM C. Müll. emend Andrews (1911).

Series **Cuspidata** Schlieph

Chlorophyll cells of branch leaves exposed dorsally
or central in position.

2. **Sphagnum cuspidatum** Ehrh. in Hoffm., Deutsch. Fl. 2 (1796) 22 Bartr., (1942) 246.

Delicate to fairly robust, often aquatic, pale green to pale brown. *Cortex* 2–3 cells thick; wood cylinder distinct. *Stem leaves* triangular-ovate; apex slightly truncate, dentate not lacerate; with a strong border considerably broadened below; hyaline cells fibrillose. *Branch leaves* long lanceolate, involute; apex toothed; margin entire with a border about three cells thick; hyaline cells fibrillose with strongly ringed pores at ends and corners of cells (dorsal); chlorophyll cells of branch leaves trapezoid in section with broader exposure on outer side.

SUMATRA: Si Garang Garang, wet place in forest, 1,400 m. (Polak 154/BO.); Polok Magae (Polak 156/BO.); Si Gelapang, 1,400 m. (Polak 157/BO.); Benkoelen Sikintjan Belirang, 1,400 m. (Rappard

98/BO.); Gunong Koerintiju 1,800 m. (Brunnemeyer 9602/BO and 1079/BO.); Petanei Valley, 1,300 m. (Lorzing 8487/BO.); Tongging, Toba Lake (Lorzing 8072/BO.); Tapianoeli, 1,400 m. (Polak 154/BO.); Gunong Goh Lemboeh, Top Plateau, 3,000 m. (van Steenis 10171/BO.).

JAVA: Gunong Dieng (Rant Bogor-1656/BO.); loc. incert. (Moh Enoh 374/BO.).

BORNEO: Western Division Anjongan, North of Pontianak, sandy ground (Polak 157/BO.).

NEW GUINEA: Mount Wilhelmina, very wet place in bog, 3,450 m. (Brass & Myer-Drees 9758/BO.); Lake Habbema, common in bogs and lining edges of pools, 3,225 m. (Brass 9448/BO.).

DISTRIBUTION: North America, Europe, Asia.

The following numbers labelled in the Bogor herbarium as *S. subrecurvum* are definitely not this species. The stem leaves have a border strongly broadened below. I find no reason for not including them in *S. cuspidatum*:—

Brunnemeyer 9602; Rant (Bogor No. 1656); Toxopeus no number; Lorzing 8487; Lorzing 8072; Brunnemeyer 10479; Polak 154.

3. *Sphagnum cuspidatum* C. Müll. in *Linnaea* 38 (1874) 156.

Fairly robust. *Main stem* cortex 2–3 cells thick; wood cylinder not distinct. *Stem leaves* triangular-lingulate to lingulate, not fibrillose; apex rounded laciniate; border narrow, not broadened below. *Branch leaves* in five rows, ovate lanceolate with a very narrow border; apex truncate dentate; hyaline cells with numerous pores on the dorsal side; chlorophyll cells triangular in section, lying dorsally.

CELEBES: Enrekang, Sawito, 1,800 m. (De Jong 108/BO.); Menado-Posomeer, 2,000 m. (Boschproefstation 13/BO.).

DISTRIBUTION: India, Siam, Malaysia.

3 (a) var. *malaccense* (Warnst.) Warnst. (1911) 187; Dixon (1926), 2 (misprinted as *S. cuspidatum* var.).

Sphagnum malaccense Warnst. in *Hedwigia* 31 (1892) 175.

Striking pale brown colour when fresh. *Stem leaves* triangular-lingulate to spatulate 1.3–1.6 × 1.0 mm., not fibrillose; apex rounded, fimbriate; border indistinct. *Branch leaves* lanceolate about 1.3 × 0.5 with a border two to five cells thick. Apex narrowly truncate and split into four teeth.

CELEBES: Mamboeling by Mamas (De Froideville 159/BO.).

MALAYA: *Kedah*, Kedah Peak, common. ± 914 m., apparently commonest species (Holtum 14881/SING.) *Perak*: Gunong Batu Puteh, ± 2,100 m. (Wray 902, type, SING.). *Pahang*: Cameron Highlands (Henderson 17877b/SING.); ± 1368 m. (Holtum 23301/SING.); Gunong Batu Brinchang, abundant in forest near summit (Holtum 23530/SING. & BO.).

This variety is distinguished by its broad tongue-shaped or spatulate stem leaves, which may be fimbriate, not only on the

rounded apex, but also on the side margin. However this last is not a very constant feature.

3 (b) var. trengganuense Johnson var. nov.

Ab omnibus hujus speciei varietatibus hactenus cognitis caulibus flavo-bruneis, foliis caulinis partim fibrosis hoc taxon facile distinguitur.

Planta robusta, cum caule flavo-bruneo. Folia caulina triangulolingulata, partim fibrosa. Folia ramea plerumque 2 mm. longa, 0.6 mm. lata.

This variety differs from all the others hitherto described in the golden-brown stem and partly fibrous stem leaves. The plant is rather robust producing triangular-lingulate stem leaves. Its branch leaves are 2 mm. long, 0.6 mm. broad.

MALAYA: *Trengganu*: Gunong Padang, 4,000 ft. (Moyses & Kiah 31023, Holotypus in SING).

4. Sphagnum novo-guineense Fleischer & Warnst. in Warnst. (1911) 520.

Robust plant. *Main stem* cortex 2–3 cells thick distinct from the wood cylinder. *Stem leaves* triangular lingulate, about 1.3×1.0 mm.; apex rounded, a little eroded or eaten away; narrow border scarcely broadened below. Hyaline cells often septate and fibrillose in the centre of the leaf. *Branch leaves* broadly ovate-lanceolate; apex narrowly truncate, dentate, about 1.6×0.8 mm., with narrow border, pseudopores present on dorsal side; chlorophyll cells triangular in section exposed dorsally.

NEW GUINEA: Mt. Nellivig (Pulle 832/BO.); Mt. Goliath (De Koch 16/BO.).

5. Sphagnum flaccidifolium Dixon Ms. ex Johnson sp. nov.

A Sphagnum cuspidato, cui proxima, ramis flaccidis, foliis caulinis triangulis utrinque recto-marginatis (haud arcuatim marginatis), foliis rameis multo longioribus, semper anguste limbatis, cellulas chlorophyllosas in sectione eorum transversali liberis utrinque ferentibus haec species sat diversa.

Planta aquatilis. Caulis circa 1 mm. in diam., axi lignosus, epiderme 2–3 seriatim strata, manifeste diversa vestitus. *Folia* caulina magna, triangularia, recto-marginata, multifibrosa, circa 1.6 mm. longa, 1 mm. lata, apice cucullata et saepe bidentata, semper anguste uniformiterque limbata. *Folia ramea* perlonga, anguste lanceolata, 3–5 mm. longa, circa 0.5 mm. lata, anguste limbata, integerrima, apice truncata et 2–4 dentata, dorso poris interdum annulatis in cellularum medio instructa, in sectione transversali cellulis chlorophyllosis rectangularibus vel trapezoideis liberis utrinque disposita.

An aquatic plant. *Stem* 1 mm. diameter, woody in the axis, covered with 2-3 layered, well differentiated epidermis. *Stem leaves* large, triangular with straight sides, multifibrous about 1.6 mm. long, 1 mm. wide, cucullate and often bidentate at the apex, and always with a uniform narrow border. *Branch leaves* very long, narrowly lanceolate 3-5 mm. long, about 0.6 mm. wide, entire, having each a narrow border and a truncate 2-4 dentate apex, and provided dorsally in the middle of the cells with pores which are sometimes thickened with rings; rectangular to trapezoid chlorophyll cells being seen exposed equally on both sides in the transverse section of the branch leaves.

MALAYA: *Selangor*: Telok Forest Reserve, 7th Mile stone, Klang (Carrick 500, Holotypus in SING.); Telok Panglima Garang (Holtum 28317/SING. & BO.).

SUMATRA: Near Pakan Boraë (Holtum 28127/SING.).

The specific epithet was proposed on herbarium sheets by H. N. Dixon but, as far as I am aware, it has not been validly published before.

This species is remarkable in its flaccid branches and exceedingly long branch leaves. It is the only Malayan species found in the lowlands.

6. *Sphagnum subrecurvum* Warnst. in Allgem. Bot. Zeitschr. (1895) 134.

Fairly robust. *Main stem* cortex 2-3 cells thick with fairly distinct wood cylinder. *Stem leaves* ovate-triangular, 1.0×0.5 mm. to triangular 1.6×0.8 mm., all fibrillose, border present of equal width above and below. *Branch leaves* lanceolate, about 1.3×0.5 mm., apex narrowly truncate, dentate; with equal narrow border; pores minute, usually single; chlorophyll cells of branch leaves triangular in section, exposed only on dorsal side.

SUMATRA: Tapianoeli, Lantong Nihoeda (Polak 155/BO.); Dolak Margaoë (Polak 156/BO.); Si Gelapang (Polak 157/BO.); Danam Biloeloe (Jacobson 110/BO.); Hoetagindjang, Toba Lake (Ruttner in April 1929/BO.).

JAVA: Telaga Warna, 2,000 m. (van Steenis 4495 & 4545/BO.); Telaga Loemoe, (Bogor 2747/BO.); Telaga Tjibong, \pm 2,000 m. (van Steenis 4495/BO.); loc. incert. (Scröter, May 1927/BO.).

7. *Sphagnum sericeum* C. Müll. in Bot. Zeit. (1847) 481; Bartr., (1942) 246.

Small delicate plant, shining, iridescent when dry. *Main stem* cortex 2-3 cells thick; wood cylinder distinct, yellow to brown in colour. *Stem leaves* triangular; apex acute; narrow, finely toothed border; 1.1×0.7 mm.; no fibres. *Branch leaves* ovate to

oblong-lanceolate; 1.1×0.4 mm., acute apex, serrulate border, no fibres, chlorophyll cells trapezoid in section, both sides exposed, longest side ventral.

JAVA: Tjibeureum (Fleischer s.n./BO.); alt. 1,700 m. near Waterfalls (Meyer B-3,447/BO. & B-1,099/BO.; van Steenis 2,136/BO.); Tjikundul valley, alt. 1,700 m. on rocks (Meijer B-3,826/BO.); Gunong Lalak 2,000-2,200 m. (van Steenis s.n. in VI-1941/BO.).

NEW GUINEA: Bernard Camp by Idenburg river, alt. 2,100 m. (Brass 12175/BO.).

BORNEO: West Koetai, Kemoel, alt. 1,700 m. (Endert 4530/BO.).

MALAYA: *Pahang*: Gunong Tahan, alt. 1,500 m. by stream (Holttum 20911/SING.); Cameron Highlands (Holttum 23530/SING.).

DISTRIBUTION: Malaysia.

A very distinct species easily recognized by its delicate nature, the shining iridescence of the leaves when dry, and the complete absence of fibres. Andrew regards the loss of fibres as secondary; their partial loss being exhibited in aquatic forms of the *cuspidatum* and *subsecundum* type. There is no justification for the creation of a separate section (Sericea Warnst., 1911) for the two diverse species—*S. sericeum* and *S. macrophyllum*, merely because they resemble one another in their complete absence of fibres.

Series *Acutifolia*

Chlorophyll cells of branch leaves exposed ventrally.

8. *Sphagnum junghuhnianum* Dz. et Molkenb., in Verhandel. d. Kon. Akad Wetensch. Amsterdam (1854); Bryol. jav. 1 27. Bartr. (1946) 246.

S. gedeanum Dz. et Molkenb. in op. cit. (1854); Bryol. jav. 1. 28.

Most robust, usually not shining when dry, often tinged with pink, pale red or violet. *Main stem* cortex 2-3 cells thick, distinct from the woody cylinder. *Stem leaves* triangular about $1.8 \times 0.7-1.3$ mm., auricles present or absent, not fibrillose or few to numerous fibrils in hyaline cells, border indistinct or distinct, not broadened below; tip truncate, toothed, somewhat squarrose. *Branch leaves* lanceolate to ovate lanceolate, never in five rows, dry tips squarrose; $1.5-2.0 \times 0.4-0.8$ mm., fibres few or many; border very distinct; dorsal pores numerous near commissures; chlorophyll cells triangular in section, exposed ventrally.

SUMATRA: Penghoeloe Bao, 2,000 m. (Frey-Wyssling 41/BO.); Ganjelanden, Gunong Goh Lemboeh, 2,700 m., in mossy forest (van Steenis 10223/BO.).

JAVA: Tjibeureum, 1,700 m. wet rocky walls and waterfall (Meijer 3448/BO.); 1,700 m., on andesite rocks (van Steenis 1156/BO.); 1,800 m. (Fleischer 501/BO.); Tjibodas (Massart 1262/BO.); Tjipanas

(Fleischer in Aug. 1900/BO.); Gunong Patoeha, near Kawah Poetih, under trees, wet semi-shady places. (Verdoorn, Series 1 in 1930/BO.); 2,200–2,300 m. (van Steenis 4429, 6920 & 6921/BO.); Gunong Papan-dajan, Tegal, grassland 2,350 m., wet valley of small river (van Steenis 4291/BO.); rock valley of small river, 2,350 m. (van Steenis 4806/BO.); Priangan, Tjiparoegpoeg 2,350 m., valley of small river (van Steenis 4806a/BO.); Gunong Oengaran, 2,050 m. (van Leeuwen 1248/BO.); Gunong Ardjoemo, 2,600 m. (Bremekamp/BO.); Air Panas on slope by hot springs (Meijer B-3999/BO.).

CELEBES: Gunong Ngilatiki, East of Lindoe Lake, 2,355 m. (Bloembergen 3947/BO.); Gunong Bothian (Brunnemeyer 11968/BO.); Porema, 1,500 m. (Kjellberg 79/BO.).

NEW GUINEA: Mount Wilhelmina, wet slope, burnt subalpine forest, 3,400 m. (Brass & Myer-Drees 9738/BO.); Lake Habbema, 2,600 m., still water in stream (Brass 10897/BO.).

MALAYA: *Kedah*: Kedah Peak, \pm 914 m., (Holttum 14882a/SING.). *Kelantan*: Gunong Sitong, \pm 790 m., (Nur 12243/SING.). *Selangor*: Ulu Semangkok, (Ridley 277/SING.). *Malacca*: Gunong Ledang (= Mt. Ophir) (Ridley 221/SING.). *Pahang*: Gunong Batu Brinchang, \pm 1,758 m. in open near summit, (Holttum 23529/SING. & BO.); \pm 948–1,370 m., (Holttum 20918/SING.); Pine Tree Hill, \pm 1,463 m. (Holttum 21561/SING.); Gunong Tahan, 1,066 m. on ground on the ridge, (Holttum 20914 & 20915/SING.); 1,525 m. on ground in wood, (Holttum 20905/SING.); 1,827 m. (Wray & Robinson 5435/SING.); (Ridley in 1908/SING.); Cameron Highlands, 1,553 m. (Henderson 17877a/SING.).

DISTRIBUTION: Japan, Formosa, Malaysia, Himalaya.

After careful examination of all the specimens available to me, I am convinced that *S. gedeanum* Dz. et Mb. is not a distinct species.

Warnstorff regarded *S. gedeanum* as a variety of *S. junghuhnianum*. I venture to suggest that there is no grounds even for varietal distinction. The "gedeanum" features, i.e. presence of auricle, indistinctness of border and absence or paucity of spiral thickenings in the stem leaves do not necessarily occur together in the specimens and seem to vary independently. The presence of auricles is very sporadic and found in specimens consigned to both "species". In only five specimens did I find no trace of spiral thickenings of the hyaline cells in the stem leaves. From this extreme there is a complete range from a few cells with spiral thickenings near the apex to complete thickening of all hyaline cells except for the border (cf. Suzuki, 1956). The distinctness or otherwise of the border seemed more probably to be a function of the age of the specimen and possibly its habitat than a specific distinction. It seems that *S. junghuhnianum* is a widespread and variable species in Malaysia.

B. Subgenus **Inophloea** (Russ.) emend Andrews (1911)

9. Sphagnum roseotinctum Johnson sp. nov.

A Sphagnum beccarii, cui affinis, plantis partim roseis, cortice caulino multifibroso, foliis caulinis minoribus ovatisque haec species sat distincta.

Planta partim roseo-tincta. Caulis crassus, 500 μ in diam., axi lignosus, fusco-rubidus, cortice 3 strato, multi-fibroso, cum cellulis superficialibus externe uniporosis vestitus. Folia caulina ovata, parva, 500 μ longa, 250 μ lata, fibroso. Folia ramea ovata cucullata, 2 mm. longa, 0.7 mm. lata, cellulis chlorophyllosis anguste trapezoideis in sectione eorum transversali utrinque libere disposita.

Plant partly tinged rose. *Stem* thick, 500 μ in diameter, woody and dark red in the axis, covered with 3 layered, multifibrous cortex, which has the superficial cells provided externally with one pore each. *Stem leaves* ovate, small, 500 μ long, 250 μ wide, fibrous. *Branch leaves* ovate, cucullate, 2 mm. long, 0.7 mm. wide, with chlorophyll cells narrow trapezoid in section and free on both surfaces, but with greater exposure on the ventral side.

MALAYA: *Kelantan*: Gunong Sitong, on ridge 792 m. (Nur 12244/SING., holotypus). *Kedah*: Kedah Peak (Spare 1439 & 1430/SING.).

This species is clearly distinct from *S. beccarii* in the numerous fibres in the stem cortex and in the very small stem leaves.

10. Sphagnum holttumii Johnson sp. nov.

Sphagnum magellanico similis, sed foliis caulinis brevissime lingulatis, cellulis chlorophyllosis in sectione folii ramei transversali rectangulis utrinque vel in latere ventrali tantum liberis haec species sat diversa.

Epidermis caulina 3-strata, multifibrosa, cum cellulis superficialibus externe uniporosis. Folia caulina parva, lingulata, fibrosa, 2 mm. longa, 0.6 mm. lata, elliptico-ovata, apice cucullata, concava, foraminibus magna in cellularum angulis et prope commissuras instructa, cellulis chlorophyllosis in transverse sectione rectangulis, liberis ventre vel utrinque liberis praedita.

Stem epidermis three layered, multifibrous, with the superficial cells provided each with a single pore. *Stem leaves* small, lingulate, fibrous, 2 mm. long, 0.6 mm. wide, cucullate and concave at the apex, and provided with large pores at the cell angles and junctions chlorophyll cells in transverse section being exposed ventrally or on both sides.

MALAYA: *Pahang*: Gunong Tahan, alt. 1,500–2,000 m. in sandy and other places, and in the open or shady localities (Holttum 20906, holotypus in SING.; 20908; 20909; 20910; 20916 and 20919—all in SING.); *Cameron Highlands*, alt. 1,250 m. in swamp (Holttum 23300/SING.). *Kedah*: Kedah Peak (= Gunong Jerai), alt. 1,250 m. (Abdul Kadir 19771/SING.). *Johore*: Gunong Pantai, alt. 500 m. (Corner 23207/SING.).

This species differs from *S. magellanicum* in the shape and position of the chlorophyll cells and the shape of the stem leaves.

11. *Sphagnum beccarii* Hpe. in Nuovo Giorn. Bot. Ital. (1872) 278.

Sphagnum pauciporosum Warnst. in Hedwigia 39 (1900) 109; cf. Andrews (1951).

Robust species. *Stem* with cortex about three cells thick, fibres few. Outer cells with large single pore/cell. Wood cylinder distinct, chocolate brown, pith pale yellow, thick walled cells. *Branches* 1.2 cm. long, blunt, turgid. *Stem leaves* lingulate, 1.75×0.75 mm., spiral thickenings near to apex, fimbriate tip; numerous large dorsal pores median in hyaline cells, often almost equal to cell diameter, no border. *Branch leaves* wide imbricate, concave, about 1.72×1.5 mm., tip obtuse, cucullate, denticulate; ventral pores near cell walls; pseudopores present dorsally, chlorophyll cells trapezoid included dorsally.

SUMATRA: Gunong Kenieri, 3,200–3,300 m. (van Steenis 10256/BO.).

BORNEO: Bei Kenepei (Fleischer, Serie II-1899/BO.).

MALAYA: Pahang: Cameron Highlands, 1,548 m. (Henderson 17877c/SING.).

DISTRIBUTION: Malaysia.

In his paper Andrews (1951) "hesitates to suggest" that this species is synonymous with *S. erythrocalyx* or *S. leionotum* but points out several features of similarity with these South American species. There is little material available of *S. beccarii* for the detailed study needed to determine this point.

12. *Sphagnum borneense* Warnst. in Allgem. Bot. Zeitschr. (1895) 229.

Moderately robust. *Main stem* cortex fibrous, 3–4 cells thick, outer cells with 1–4 pores. *Stem leaves* triangular with dentate tip, about 1.3×0.5 mm., no fibres in hyaline cells. *Branch leaves* large, concave, rounded, cucullate, ovate to oval, 1.5×0.8 mm., chlorophyll cells very small triangular in section, included on dorsal side; hyaline walls adjacent to chlorophyll cells densely papillose.

BORNEO: Sarawak: Mount Santubong (Native collector 2236/BO.).

The specimen examined by Andrews came to Europe as packing material and Andrews doubts if it came from Borneo at all. The specimen at Bogor seems a perfectly genuine collection from Borneo. It is very like *S. papillosum*, but even more papillose.

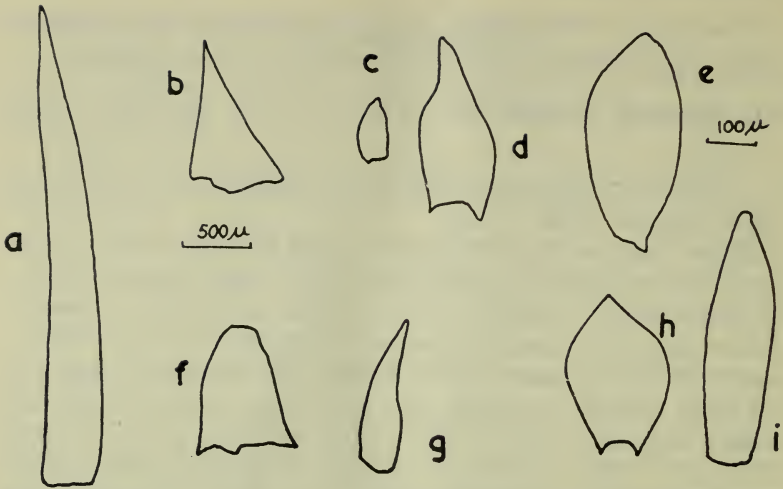


Fig. 1. *Folia*. *S. flaccidifolium*: a = folium rameum; b = folium caulinum. *S. roseotinctum*: c = folium caulinum; d = folium rameum; e = folium caulinum valde ampliatus. *S. cuspidatum* v. *trengganuense*: f = folium caulinum; g = folium rameum. *S. holtumii*: h = folium rameum; i = folium caulinum.

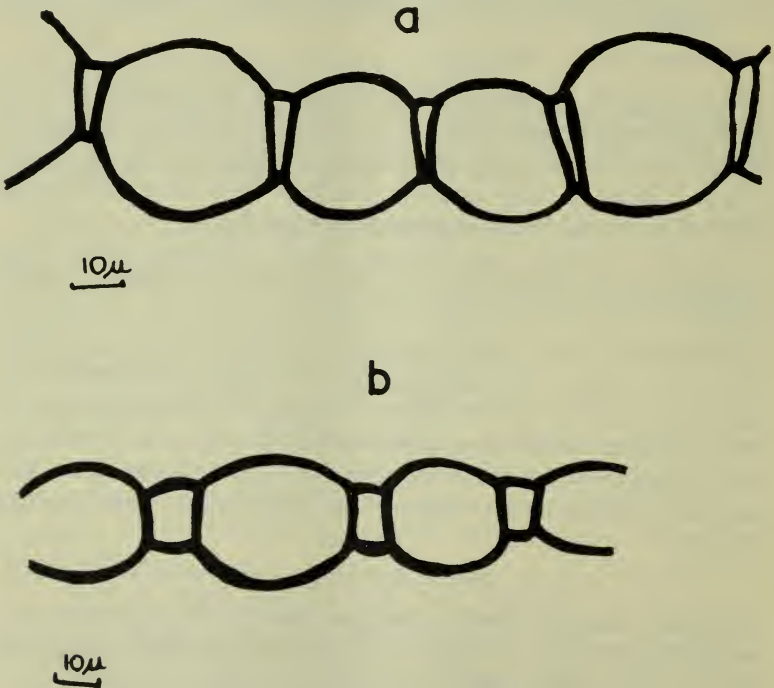


Fig. 2. Sections transversales. a, *S. roseotinctum*; t.s. folii ramei. b, *S. holtumii*; t.s. folii ramei.

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Cleome ciliata Schum. et Thonn. in Singapore

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AMONG THE many ecological problems awaiting solution in Singapore Island, is the rapid spread of introduced weeds on soil bared by land utilisation. In recent years *Cleome ciliata* Schum. et Thonn. has shown wide distribution, occurring as a weed of wasteland, manure heaps and in exposed situations along the drains of roadsides. This plant of tropical African origin (Hutchinson and Dalziel, 1927) is widely distributed both in tropical Africa and Jamaica. It was first collected in Singapore in 1927 and since then has spread rapidly over Singapore Island and is locally abundant in parts of the Federation of Malaya. In this paper some suggestions will be made as the reasons for its rapid spread and its successful colonisation of exposed sunny land. Other features of ecological interest will also be mentioned.

The Good Colonising Power of *Cleome ciliata* in Singapore

Studies of the autecology of this species showed that particular features of its morphology and life history gave it considerable selective advantage in colonising bare exposed soil in Singapore.

(a) Vegetative development

The root system is a spreading one which consists of lateral roots extending horizontally and forming a circular mat at a depth of 5–10 cm. from the surface. For a well grown plant which sprawls over an area of 120–160 cm. diameter, the root system will form a mat some 60 cm. in diameter. Growing in this particular way, the roots meet with little competition from other species of plants growing in the same habitat. For instance *Phyllanthus niuri*, *Euphorbia hirta*, *Oldenlandia corymbosa* and *Alternanthera speciosa* have tap root systems in which the central main root grows straight down to a depth well below that of the *Cleome ciliata* root zone. Shallowly rooted sedges and grasses do not penetrate below the first 6 cm. of soil. (Fig. 1).

The plant grows erect to a height of 30 cm. and then falls flat on the ground where it continues to grow and flower. Such flat sprawling plants have a good chance of survival in an exposed situation.

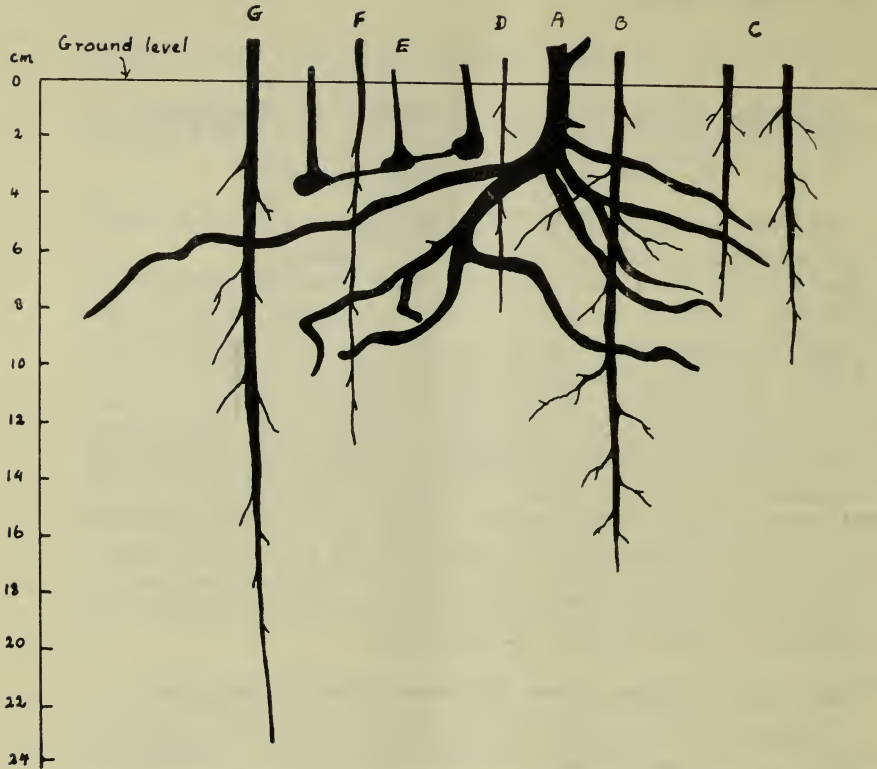


Fig. 1. Root systems of other herbaceous plants growing in association with that of *Cleome ciliata*; (A) *Cleome ciliata*; (B) *Alternanthera triandra*; (C) *Phyllanthus niuri*; (D) *Oldenlandia corymbosa*; (E) *Cyperus* spp.; (F) *Borreria latifolia*; (G) *Euphorbia hirta*.

(b) Reproduction

The flowers are distinctly dimorphous with respect to the ovaries of the mature flower. In the *normal ovary flower*, the mature ovary is almost as long as the filaments of the shortest pair of stamens (8.0–10.0 mm. long), about 1.0 mm. in diameter and bears a pink, papillose, sticky stigma. In the *short ovary flower*, the mature ovary is only 2–3 mm. long and 0.5 mm. in diameter. The stigma is green and undeveloped and no seed is set. (Fig. 2). Both types of ovary occur on the same plant and the ratio of normal ovary flower/short ovary flower varies from 1.1 to 2.0, i.e. there are always more normal ovary flowers than sterile short ovary flowers.

Artificial pollination experiments showed that while the pollen of both types of flowers was viable and successfully fertilised the normal ovary flowers; the short ovary flowers would not set seed either with pollen from flowers of its own type or with pollen from the normal ovary flowers.

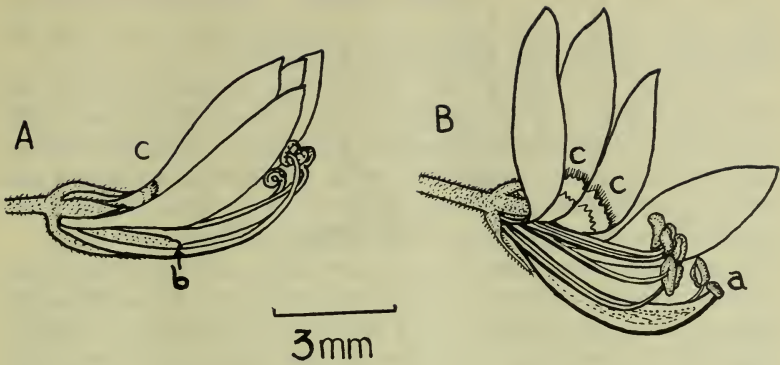


Fig. 2. Flowers of *Cleome ciliata*

A, Short ovary flower with abortive ovules and undeveloped stigma (b).

B, Normal ovary flower with fertile ovules and papillose stigma (a).

In A and B, "honey guides" are indicated (c).

In the field *Apis indica*, a honey bee, is a regular visitor to both types of flowers collecting nectar and pollen. Owing to the proximity of the lower pair of stamens and the stigma of the normal ovary flowers, self-pollination may also take place to a limited extent. The short ovary flowers seem simply to furnish additional supplies of pollen, so that fertilisation of the normal ovary flowers is assured. In the field it was observed that between 50 per cent and 71 per cent flowers set seed and only a few of normal ovary flowers failed to be fertilised.

The seeds are attached along the sutures formed by the two carpels of the fruit and average 50 seeds per pod. They are small and reniform with the embryo curled up with the sharp radicle end touching the cotyledons to form a disc-like structure. The seed coat is thick and transversely corrugated. On either side of the tip of the seed coat are two float-like structures called here "elaiosomes". The elaiosomes which are full of fatty substances, develop from the tips of the outer integuments from special cells differentiated before fertilisation. Three days after fertilisation these cells form a bunch-like structure which enlarge and appear as glistening structure as the mature seed turns from brown to black on ripening.

When the fruit is mature, it splits from below upwards forming two valves. Some seeds are shot out immediately while others are retained and later jerk out by movements of the plant in the wind,

or are carried away by ants. The succulent elaiosomes are particularly attractive to ants. They carry the seeds away and eat the elaiosomes leaving the seed scattered abroad.

The seeds are lighter than water. This is partly due to the corrugated seed coat which causes it to resist wetting; and partly to the fat content of the elaiosomes which act as flotation devices. Since one common habitat of *Cleome ciliata* is along drains and canals on Singapore Island it is quite probable that the seed find new habitats by dispersal for short distances in the water.

Experiments were done to test the viability and longevity of the seed of *Cleome ciliata*. It was found that fresh seed would not germinate in the dim light of a laboratory, but seeds, in similar germinators placed on a windowsill receiving at least two hours direct sunlight a day, germinated with a variable percentage germination according to the seed sample used. Air drying of the seed for 1-7 days does not apparently decrease the percentage germination of samples, but air drying for four months decreases it to 4 per cent.

This apparent marked effect of light is interesting since *Cleome ciliata* is essentially a plant of sunny wastelands and is never found deep in the forest, nor in shady situations. If seeds found their way to such a habitat they would fail to germinate. Removal of elaiosomes does not affect the percentage germination, therefore ant-dispersal is quite feasible.

(c) Establishment of seed

When seed of *Cleome ciliata* are sown thickly in a garden a good percentage germination is obtained, but not all the seedlings will survive. There is a marked effect of crowding resulting in the production of etiolated thin plants, producing flowers somewhat smaller than normal. In one experiment only 58 per cent plants had survived after 52 days.

Such overcrowding by plants of the same species is unlikely to occur in the field due to the diverse methods of seed dispersal which ensures a wide range of destination for seed produced by any one plant. Nevertheless *Cleome ciliata* meets competition from taller life-forms, colonising bare ground in the next stage of the succession. In the field it reacts rapidly showing etiolation of stems, yellowing of leaves, smaller flowers and fewer seeds. If a locality is completely covered with grasses such as *Ischaemum*; or with *Mimosa pudica* or *Cyperus* species *Cleome ciliata* never becomes established. Heavy shade from trees or scrub (e.g. *Adinandra dumosa*/*Wormia suffruticosa* scrub) stops the colonisation by this plant.

DISCUSSION

Cleome ciliata is particularly successful as a pioneer weed colonising bare ground. Its roots system is relatively shallow and does not tap the same zones as other pioneer weeds growing in the same vicinity. It has a very rapid growth and by its prostrate habit soon covers extensive areas of bare soil. It has prolific production of seeds which have a wide range of dormancy (from 10 to 126 days).

These are typical microbiotic seeds of a tropical climate (Crocker & Barton 1953). About 50 per cent flowers set seed. The other flowers are short ovary "pollen flowers" and have a sterile ovary. The seeds are dispersed by splitting of the pod, by being carried away in water currents of floodtide, or by ant-dispersal.

In very exposed situations the stem and adaxial leaf surface developed an erythrite red colour. The flower size was reduced and the number of seeds per fruit decreased. These effects which were not investigated further may well be due to a mineral deficiency.

The tender leaves and shoots are the favourite food of the larvae of a butterfly (*Appis libytheae olferna*). The Capparidaceae are often the food plants of the Pieridae to which family *Appis libytheae olferna* belongs (Corbet & Pendlebury, 1956). Although damage may be done to individual plants, the plants are far too numerous to be exterminated.

SUMMARY

1. *Cleome ciliata* Schum. and Thonn., 1828, a native of Tropical Africa was first collected in Singapore in 1927 and since then has spread throughout the Island and in the Federation of Malaya, growing in open waste-land and by roadsides.
2. The plant produces two types of ovaries:—"normal" ovary which is fertile; and "short" ovary which is abortive. Both types are produced on the same plant. All pollen produced is viable.
3. The seeds bear two, float-like structures, called here "elaiosomes" are not essential for germination of these seeds.
4. The elaiosomes play a double role in seed dispersal. They are partly responsible for the flotation of seeds; and they provide food for ants which scatter the seeds. The elaiosomes are not essential for germination of these seeds.

5. The percentage of germination of seed varies greatly but no germination was observed unless they were exposed to direct sunlight of at least 2 hours duration/day. This effect may be due either to true light sensitivity or to the effect of increased temperature.
6. The morphological development of the plant from germination to fruiting is traced.

ACKNOWLEDGEMENTS

The experiments and observations described in this paper were carried out by the junior author in connection with his course for the degree of B.Sc., with Honours in Botany. For this work the senior author acted as supervisor.

We wish to acknowledge the help and encouragement of Professor H. B. Gilliland, at whose suggestion this work was carried out. We have received the help and co-operation of members of the Departments of Chemistry, Physics, Geography and Zoology who have made our investigation a very interesting one. The Botanic Gardens' staff have given their unfailing assistance and support.

We wish to thank Professor H. G. Baker for his helpful criticism.

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OBITUARIES

Haji Mohamed Nur bin Mohamed Ghous, B.E.M.

MOHAMED NUR BIN MOHAMED GHOUS was born in Singapore "during Bulan Puasa" in 1898. This was before registration of births was a general practice and his birth appears to have been undocumented. In that year Puasa occurred during March. Later his birth was dated 22nd March, 1898.

His father was a Malacca Malay who travelled between Malacca and Singapore trading in cloth. His mother, Yang Chik binte Saman, was a Singapore Malay. They had four children, three boys and one girl.

Mohamed Nur's schooling was brief. He went first to the Kota Raja Malay School in Singapore. After that he attended the Lorong Pandan English School, a branch of the Government Victoria School.

He joined the Gardens service in 1911 or 1912 at the age of 13 or 14 years during the close of H. N. Ridley's directorship and was employed on collecting seed for distribution in Malaya and overseas. Much of this work was with hevea seeds for which the Gardens were the main source of supply.

After Ridley's retirement, I. H. Burkill was appointed Director. He arrived on 17th October, 1912, ten months after Ridley's departure. They had been months of less than standstill. The printed literature which had come into the office was in a heap on a table, thrown there as it arrived. In the herbarium the mounted plants were in their cabinets, but the cabinets were in no systematic arrangement. The Penang Gardens had been closed in mid-1910 and the land transferred to the Georgetown Municipality to make a water reservoir. The Penang herbarium had been transferred to Singapore. The sheets remained in the cabinets used in Penang, but no start had been made to incorporating it with the Singapore herbarium. Nor were the cabinets in any order, but simply stacked wherever there was room.

To set about sorting out the confusion, Burkill picked out Ahmad bin Hassan as Storekeeper and Mohamed Nur as Label Printer as from 1st January, 1913. The duties of this latter post were more varied than at present understood and Mohamed Nur had the run of the herbarium for his ability to label plants in the garden fitted

him for the same function in the herbarium. Thus began his association with the herbarium which was to continue for the rest of his life.

For the herbarium to be at all usable it had to be got into order. The cabinets were of miscellaneous sizes and did not block nicely, but by sorting them out the best use of space was achieved. This led of course to worse confusion in the sequence of families. Since all the herbarium sheets were in labelled folders (according to the Bentham and Hooker system), it was left to Mohamed Nur to rearrange them. Commenting on the ability he displayed in doing this, Burkill has said: "Nur means Light, and this is where he shone it". As science, whatever its context, is the pursuit of truth, it seems wholly appropriate to quote R. J. Wilkinson [A Malay-English Dictionary, 1955]: "**Nur** Ar. Light—whether the solar light by which men see, or the primal light that illumined chaos at the Creation, or the light of divine revelation that guides men to Truth". As Mohamed Nur was to give his life-work to the herbarium, and developed an innate perspicacity for botanical taxonomy, how appropriated was he named!

Nur's growing knowledge and an unusual habitual orderliness clearly pointed his career to greater responsibilities. On 1st September, 1916 he was promoted to become Plant Collector. His collecting was extensive and he held the post till the end of 1923, when the post of Herbarium and Museum Assistant having fallen vacant, he was appointed to it. I. H. Burkill, in recommending to Government his promotion wrote: "The subordinate whose name I put before you is singularly efficient and energetic, and is capable of higher work than that of plant collector. He has acquired a surprising knowledge of the latin names of Malayan plants, and by his methodical ways is calculated to keep the Museum and Herbarium in due order".

The post of Herbarium and Museum Assistant to which he came on 1st January, 1924 was held by him throughout the rest of his career. He retired on pension on 22nd March, 1953 on attaining the age of 55 years after over 40 years service which he was yet to extend by another 5½ years. At the time of his retirement he had acquired such a comprehensive knowledge of Malaysian plants, and there being no-one available to fill his late post, that after a break of one day as is required by regulations he was re-engaged in the same post. This he held to the day of his death, 7th November, 1958. During this time he saw the herbarium grow to be the fourth largest in Asia with a collection of about 400,000 specimens to which he personally had in no small measure contributed.

In the field, he visited most parts of Malaya; he also collected in Thailand, Sumatra and Rhio. In his earlier days he accompanied I. H. Burkill extensively over Malaya, and with Mohamed Haniff, Superintendent of the Penang Gardens, went to many places in the northern half of the peninsula, the most extensive expedition being made in January and February 1923 in Ulu Kelantan to the northern side of Gunong Tahan. After Holttum and Henderson had joined the Department in 1922 and 1924 respectively Mohamed Nur accompanied them on many expeditions between then and the war, from Langkawi and Perlis in the north to the southern end of the peninsula, from the coastal plains and the mountains of the west to the east coast and the off-shore islands of the Pahang/Johore group. He also went in charge of independent assignments and in October and November 1937 collected in Selangor for the Arnold Arboretum, U.S.A., in conjunction with the F.M.S. Department of Forests.

All his collecting is numbered in the field in the S.F.N. (Singapore Field Number) series and his collections are laid in the Singapore Herbarium with duplicates sent out to many other herbaria. A list of his major collecting trips is given at the end of this notice. On one of them he took the only known Malayan flowering specimen of *Bambusa pauciflora* Ridl. which he got on the ridge leading to the summit of Pine Tree Hill (4,780 ft.) on the Pahang-Selangor border.

Ridley's *Flora of the Malay Peninsula* was published between 1922 and 1925, the major part being out by 1924. With this as the standard record of the Malayan flora, the sheets in the Singapore Herbarium were rearranged in accordance with its sequence. This work naturally fell to Mohamed Nur and occupied him for much of 1924/25.

Immediately following on this Mohamed Nur undertook in 1926 the integration of the Perak Museum herbarium with the Singapore herbarium. And for several years leading up to 1928 he carried out various assignments for the F.M.S. Forest Department herbarium for which the F.M.S. Government gave him an honorarium. These services were in fact regularly rendered by Mohamed Nur right up to the time of his death and by the Gardens Department generally then and now as a part of the Department's fundamental purpose of studying the Malayan flora.

Mohamed Nur's contribution to the knowledge of the local flora is not marked by any list of publications. His efforts have been merged with and are contained in the publications of others to whom he rendered ready and competent assistance in undertaking

preliminary determinations of collected material. These determinations were made with an unusually gifted knack, but entirely lacking the substantial pedestal of scientific theory and precept, which of course he had never received. His ability to "spot" sterile material raised as much admiration as anxious doubts amongst the conventional, but so often could it be shown subsequently that he was usually right. Every generation produces a few men of genius, and here in a humble way was one of them.

In the field of botany as in other sciences recognition of merit is often acknowledged by co-workers by the use of personal names to label some object or phenomenon. Bestowing of personal names for new species or genera of plants is common and Mohamed Nur's name has been given to several species which are listed below. In a similar but official manner Government in recognition of his long and faithful service awarded him the British Empire Medal in 1956.

During his last few years of service he suffered increasingly from breathlessness, but he refused steadfastly to take life more easily. He maintained that if he stopped working he would quickly die. Since there was no immediate replacement for him and since he lived solely for his work it was to his and to the Gardens' advantage that he stayed in harness. Even during the Muslim fasting month (Bulan Puasa) of 1958, which period to younger men in the best of health is deemed a test of moral and physical endurance, he refused to consider any adjustment of his working hours. His objection was simple: he did not want to be different. But in fact he was different in so many ways of punctilious honesty towards his work. A single example will serve to show his faithfulness. During the final fortnight of the Japanese military onslaught against Singapore in 1942, when all was sudden death, chaos and confusion, and again in 1945 at the time of the collapse of the Japanese hegemony, the office attendance register shows that Mohamed Nur reported with regularity for work, and at the height of these periods of the subordinate staff only he and his life-long colleague 'Che Ahmad bin Hassan signed in.

In his private life there is little to record for his work was his life. On 9th September, 1919 he married 'Che Fatimah binte Ariffin, in his only marriage by which there were six children, three sons and three daughters, all of whom survive him. In 1949 he made the Hadj pilgrimage to Mecca and to other holy places of Arabia.

His death was quite sudden and peaceful on the evening of 7th November, 1958. He came to work as usual, but at midday collapsed and was taken home. There he ate a little, then settled down to sleep, and that was the end.

In botanical history there are many instances of father-son successions. This inheritance of similar interests and abilities would make an interesting genetical study, and here indeed is yet another. For the four years before Mohamed Nur's death his son, Mohamed Shah, had been working as a Plant Collector in the herbarium. During this time Mohamed Shah showed and developed the family trait of an untutored botanical taxonomic acumen. It must have been a satisfaction to the old man that his son was destined to follow his footsteps. Four months after his death Mohamed Shah was confirmed in the post.

Plants named after Mohamed Nur

<i>Dioscorea nurii</i>	.. Kunth in Engler's Pflanzenreich, IV—43, 1924 (Reduced to <i>D. kingii</i> Kunth).
<i>Begonia nurii</i>	.. Irmischer in Mitt. Inst. Bot. Hamburg 8, 1929.
<i>Cryptocoryne nurii</i>	.. Furtado in Gardens' Bull. S.S. 8, 1935.
<i>Daemonorops nurii</i>	.. Furtado in Gardens' Bull. Singapore 14, 1953.
<i>Ardisia nurii</i>	.. Furtado sp. nov. in this issue.

Mohamed Nur's major plant collecting expeditions

(No record is available of innumerable minor collecting trips and single day forays)

Date	Locality	Accompanying
1913–24 (annually, covering every month of the year except January)	Penang, Port Swettenham, occasionally to Klang	I. H. Burkill or alone
July 1914	Tampin, Negri Sembilan	—
June 1915	Pulau Tinggi, P. Tioman, Johore/Pahang	I. H. Burkill
November 1915	Pulau Terutau, S. Thailand	Md. Haniff
February 1917	Taiping Hill, Perak	Md. Haniff
December 1920	Salak & Sg. Siput, Perak	Md. Haniff
August 1921	Sibolangit, Sumatra East Coast	F. W. Foxworthy J. A. Lorzing
November 1921	P. Langkawi group, Kedah	Md. Haniff
June 1922	Tembeling, G. Tahan (south side) Pahang	Md. Haniff
s.d. 1922	G. Pulau, Johore	Kiah

<i>Date</i>	<i>Locality</i>	<i>Accompanying</i>
Jan./Feb. 1923	Sg. Kelantan, Sg. Labir, Gunong Tahan (north side), Bukit Temangan, Kuala Krai, Kelantan	Md. Haniff
Aug./Sept. 1923	Fraser's Hill, Selangor/Pahang	R. E. Holttum M. R. Henderson
November 1923	Gunong Angsi, Negri Sembilan	F. W. Foxworthy
December 1923	Bt. Tangga, Negri Sembilan	—
December 1923	Sg. Buloh Forest Reserve, Selangor	—
Feb./Mar. 1924	K. Lipis, Gelas Valley, Gua Nineh, G. Strong, Kelantan.	F. W. Foxworthy
November 1924	Serdang, Selangor	Md. Haniff
November 1924	Raub, Kuala Lipis, Pahang	I. H. Burkill & Md. Haniff
February 1926	G. Panti, Johore	R. E. Holttum
Apr./May 1927	P. Tioman, Pahang	M. R. Henderson
Oct./Nov. 1927	Pahang/Kelantan Boundary	M. R. Henderson
December 1927	G. Panti, Johore	R. E. Holttum
March 1928	G. Muntahak, Johore	R. E. Holttum
Aug./Sept. 1928	G. Tahan, Pahang/Kelantan	R. E. Holttum
April 1929	P. Tioman, Johore	M. R. Henderson
July/Aug. 1929	K. Tembeling, Pahang, Kelantan/ Pahang Boundary & Kuantan, Pahang	M. R. Henderson
November 1929	Perlis	M. R. Henderson
April 1930	Cameron Highlands, Pahang	R. E. Holttum
May/June 1930	Ipoh, Grik, Perak	M. R. Henderson
October 1930	Tasek Bera, Pahang	M. R. Henderson & Ngadiman
November 1930	Rhio Islands	—
April 1931	Mentakab, Tembeling, Pahang	R. E. Holttum
May/June 1931	Tembeling, Pahang/Kelantan	M. R. Henderson E. J. H. Corner & Ngadiman
October 1931	Bentong, Kuantan, Pahang	M. R. Henderson
November 1934	P. Langkawi, Kedah	M. R. Henderson
May 1936	Cameron Highlands, Pahang	R. E. Holttum
April 1937	Ringlet, Pahang	—
October 1937	Telok Forest Reserve, Klang Sg. Tinggi Forest Reserve K. Selan- gor, Ginting Simpah and Bt. Kanching, Selangor.	F.M.S. Forest Department collectors.

H.M.B.



Haji Mohamed Nur bin Mohamed
Ghous, B.E.M.



Ngadiman bin Haji Ismail

Ngadiman bin Haji Ismail

NGADIMAN was born on 14th March, 1904 at 7 Scotts Road, Singapore where his father was head gardener. He went to Tanglin Tinggi Malay School and passed out at Standard V, the top grade.

He joined the Gardens Service on 1st January, 1921 as a label printer and later worked as a gardener till 1929 when he was promoted to the post of Plant Collector. He went on three major collecting expeditions:

1930 to Tasek Bera, Pahang, with M. R. Henderson.

1931 to Tembeling, Pahang, and the Pahang/Kelantan border with M. R. Henderson, E. J. H. Corner and Mohamed Nur.

and 1937 to Fraser's Hill, Pahang, with E. J. H. Corner and Kiah.

Most of his collecting was done however with Corner locally on Singapore Island or in South Johore in single day expeditions easily staged from Singapore.

In rural Malaya, and particularly in Kelantan, the "berok" or pigtailed monkey (*Macacus nemestrina*) is often trained to pick ripe coconuts. In April 1937 while in Kelantan Corner bought a young berok and brought it back to Singapore with the object of training it to pick botanical specimens from the tree tops. So promising was it that Ngadiman was sent to Kelantan later in 1937 to find two more such monkeys, and to learn how to talk to them and how to train them. In his quest he was successful. Thus began an interesting and delightful incident in the history of Malayan botanical exploration.

Such an exercise requiring co-operation between man and monkey called for special gifts of patience and ingenuity. It was also not without danger. Both Corner and Ngadiman were savagely bitten by their "assistants"; on one occasion Ngadiman was off work for 17 days on a medical certificate for "monkey bite on forearms". But the exercise was such a success and the result in terms of cost as well as effort so relatively cheap that a fourth monkey was acquired shortly before the war. But for the disruption which the war brought, this aspect of botanical collecting would undoubtedly have been developed to its full potential.

After the war another attempt was made to train a berok and Ngadiman went to Kelantan again bringing back a young one. It grew however to be physically weak and with limitations of staff and restrictions of collection in the Federation of Malaya owing to the "emergency", the attempt has not again been repeated.

With the acquisition of these monkeys, Ngadiman was tied to their care and training. Soon after Corner had got his first one, Ngadiman accompanied Corner with it to Fraser's Hill with most encouraging results. When two others were bought Ngadiman would take one or the other out every day to the Bukit Timah forest for training, and thereby the botany of the hill became very considerably better known. In addition Ngadiman would take the monkeys out to help Corner in studying the flora of the fresh water swamp forest around Mawai and Sungei and Kuala Sedili.

One new species of plant has been called after him: *Eugenia ngadimaniana* Henderson in Gardens' Bulletin, Singapore 11, 1947.

As a result of Ngadiman's association with Corner over the collecting monkeys and Corner's keen interest in wildlife protection, it was natural that when botanical reserves, one of them the Bukit Timah forest, were gazetted and put under charge of the Botanic Gardens Department, Ngadiman should be connected with them. Daily exercising the monkeys at Bukit Timah, Ngadiman was available for supervision. He was appointed Ranger in 1937 and remained in charge of supervision of the reserves, firstly as Botanical Reserves, then from 1951 onwards as Nature Reserves till the time of his retirement when he held the rank of Head Ranger.

In mid-1956 advanced TB was diagnosed and the disease would not respond to treatment. He died on 24th September, 1958, at the age of 54 years.

Of his 11 children, two are employed in the Botanic Gardens to maintain the family connexion with botany. *H.M.B.*

Kwan Koriba

KWAN KORIBA was born at Aomori, in the north of Honshu, in the year 1882. As a boy he was educated in the Middle School of the neighbouring city of Hirosaki, to which he finally returned in 1954, and where he died, suddenly, on 15th December, 1957.

Koriba received his higher education at the University of Tokyo, where he graduated in 1907, taking his doctor's degree five years later. He was Professor at the University of Tohoku from 1915 to 1920, and then at the University of Kyoto. In 1942, at the age of 60, he retired from the latter post, and was appointed Director of the Botanic Gardens, Singapore, under the Japanese military administration. Returning to Japan early in 1946, he lived in retirement, continuing his botanical studies, until 1954, when he was requested to undertake the office of President of the University, in which office he continued until his death.

From his youth Koriba was interested in field botany, and in observing the behaviour of plants in nature; on such subjects he published several papers. He travelled extensively at various times, to Europe, North and South America, and nearer home to Micronesia and Java, taking the opportunities of such travel to widen his acquaintance with plant life. While at Tokyo, he began to devote himself to the study of environmental factors and their effects on plants, and in this utilized his considerable knowledge of physics; this work involved extensive research on transpiration and evaporation. He continued his interest in the relation of plant-behaviour to climate in Singapore, where he made records of the periodicity of growth and leaf-change in many kinds of trees. A summary of these observations has recently been published in Vol. 17 (1) of the *Gardens Bulletin*.

During his period of retirement from administrative duties, in 1946-54, he published two books, one on the forms of plants in relation to organization and function, and one on plant physiology and ecology. He planned a further book on the evolution of plants.

At Singapore he was given the rank of Brigadier-general, but wore the uniform of that rank only on ceremonial occasions. He devoted himself to his administrative duties and to his botanical studies. He was dependent on the military organization for funds and supplies of all kinds, and took every opportunity of securing such amenities as were possible for the gardens staff. On several occasions he took energetic action to prevent encroachment on the

Nature Reserves of Singapore, in which he took great interest. He was also greatly concerned that the herbarium and library at the Gardens should be maintained intact. To his single-minded devotion to botanical science the Singapore Botanic Gardens owes much.

He was a man that commanded respect by his simplicity of life and unfailing devotion to his duty, by his very broad scientific outlook, and also by his sympathetic understanding of human nature, an understanding that transcended racial boundaries, even in time of war and of privation. *R.E.H.*

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P. 363	line 31	For	in	: Read	is
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SINGAPORE

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18th May, 1960

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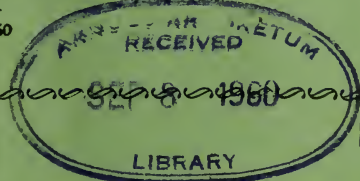
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I. H. BURKILL, M.A., F.L.S.
Born 18th May, 1870

*This photograph was taken in the garden of
his home in England early in his 90th year*

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I. H. Burkill in India

H. SANTAPAU, S.J., F.N.I.

FOR MANY YEARS I had been familiar with I. H. Burkill and the splendid work he had done during his time in India as an officer of the Botanical Survey of India; it was my privilege during an extended visit to Kew Herbarium in 1946-1948 to come to know him personally, and this almost daily contact deepened in me the esteem that I had conceived from the perusal of his writings.

It is not an easy matter to give in short a sketch of the Burkill I came to know and respect. In my opinion, and this seems to be the common opinion of those who know him well, I. H. Burkill is a charming gentleman of the good old school, always courteous and obliging, ever ready to extend a helping hand to an honest struggling botanist. In his work Burkill is one of the most meticulous and accurate botanists that it has been my fortune to meet in my life; in his papers and books every item is checked properly, every minutest and most insignificant detail is tested. Such accuracy at times might appear almost a waste of energy; but research workers are grateful that he has had the patience to delve into such minute details. As an example of his care, one of the first examples that came to my notice in Kew Herbarium, I might cite but one case. Burkill found that one of the Compositae of South America was known under the Spanish-American name of "Coronilla de oro" (meaning "The Little Golden Crown"); to Burkill it was not enough to find out what the particular plant was, but he did his best to ascertain why precisely such a plant was called by this name.

One of the reasons why he has been so accurate in his writings is that he has spent a long life carefully taking down notes on any point that at a later date might prove of interest. In a private letter of Nov. 27th, 1951, he tells me, for instance: "Someone, I forget who it was, put into print a statement that I was writing up a history of botany in India. That was not exactly true; but I was collecting material that would help towards a history . . . This collecting began when I was arranging the collectors in Prain's and my volume of *Dioscoreas*; and the data went into slips . . ."

This thoroughness, in fact, explains the extraordinary amount of information that one can derive from all Burkill's books and papers, even those written during his early years in Kew and India.

Biographical Data

I. H. Burkill was born on May 18th, 1870, near Leeds, Yorkshire in England; he was trained in Cambridge, where he graduated with B.A. Hons. in Natural Science from Caius College; I have no details of his university career, except that he obtained the Frank Smart Prize as a result of the performance at his final examination. Shortly after his graduation, he was appointed Assistant Curator, University Herbarium, Cambridge, a post that he held from 1891 to 1896; during that time he obtained his M.A. from Cambridge University. From 1897 to 1899 he was on the staff of the Royal Botanic Gardens, Kew, as Assistant in the Herbarium; from 1899 to 1900 he was Principal Assistant in the same Royal Botanic Gardens.

Burkill's service in India began in 1901, when on the recommendation of the authorities of the Royal Botanic Gardens, Kew, he was appointed Assistant Reporter on Economic Products to the Government of India, and was posted to the Indian Museum, Calcutta, under George Watt as the Reporter. Throughout his career in India, Burkill continued attached to the same office; in 1902 he was Officiating Reporter under Sir G. Watt; in 1907 he was still mentioned as Officiating Reporter, although Sir G. Watt had already retired. The Report of the Botanical Survey of India for the years 1911-1912 says: "The Director was absent on privilege leave from 21st April to 2nd July 1911, during which time Mr. I. H. Burkill officiated in addition to his substantive duties as Economic Botanist of the Botanical Survey of India. Up to 31st January 1912 Mr. Burkill was Assistant Reporter on Economic Products officiating as Reporter, and thereafter on the abolition of the Reportership became Economic Botanist to the Botanical

Survey, which post he held for the remainder of the year." This would seem to indicate that Burkill was Officiating Reporter from 1902 to 1912, although in some official reports he is put down as the Reporter from about 1908 onwards.

In the introduction to *The Botany of the Abor Expedition* Burkill himself writes: "It fell to me, in the middle of the Hot Weather of 1911, when acting as Director of the Botanical Survey of India, during the leave of Colonel A. T. Gage, to propose to the Government of India that a botanist should be told off to accompany the Abor Expedition; and to my gratification, after Colonel Gage's return, I was sent." (Italics my own).

When in 1954 I informed Burkill of my appointment as Chief Botanist to the Government of India, a new designation for the post of Director, Botanical Survey of India, he wrote and gave a number of details of the Calcutta he had known in his younger days; one interesting detail, for instance, is the following: "Opposite to you in St. Xavier's College is (or was) no. 47 Park Street in which I lived from 1901 to about 1909. The house belonged to the Nawab of Murshedabad and the old Nawab did not need a house in Calcutta; so some 5 of us chummed there. I used to hear sometimes the austerity call at 4.30 a.m. which woke St. Xavier's household . . ."

Burkill's Botanical Collecting Tours

During his time in the Indian Museum, Calcutta, as Officiating Reporter or as Reporter on Economic Products, Burkill spent much energy collecting information either in the field or through correspondents on important economic products of India. From various hints given by Burkill in his papers, I have been able to deduce the dates of some of his major collecting expeditions. Unfortunately due to pressure of work, I have not been able to go through the publications of the Botanical Survey of India in detail; I leave it to a future occasion to prepare a detailed list of all Burkill's exploration tours in India, as reported in the official documents of the Calcutta Garden and Museum.

The Sikkim Expedition of 1906. "Mr. Burkill . . . paid an autumn visit to Phallut in 1906 in search of Aconite tubers" (Kew Bull. 1907: 175). Burkill himself writes from Calcutta on October 15th, 1906: "I found my second trip to Phallut interesting and agreeable . . ." What the first trip was, I cannot tell with the information at my disposal. In the same account Burkill writes: "I amused myself by the wayside making flower pollination notes and am

now writing up a short paper . . ." Several papers, in fact, were published by Burkill on the subject, and this would indicate that he had made detailed excursions to many parts of India. His published notes on flower pollination concern flowers of the following areas: Bengal and Assam, North-West Himalayas, Simla Hills, Central Provinces and Berar, etc.

Journey into Nepal, 1907. An account of this trip is given by Burkill in *Rec. Bot. Surv. India* 4 (4): 59–140, 1910. The first paragraphs of the account state: "On November 28th, 1907, after marching along nearly one hundred miles of the Nepalese frontier between Jainagar and Raksal, I turned, with the permission of the Nepalese Darbar, into the kingdom of Nepal and reached Khatmandu by the usual route on December the second. Thence . . . I visited the Trisuli valley, in the neighbourhood of Naikot. I returned from Nepal to the plains by a route through Pherphing, which diversifies the first seventeen miles of the way. My dates almost coincide seasonally with the dates of Wallich's march to Khatmandu, and we seem, he and I, to have gathered at a period 87 years apart the same plants in the same spots . . . It is ill gleaning for novelties after a botanist with the keenness of Wallich; so I got no more than three species of *Impatiens* and apparently one of *Eriocaulon* . . ."

The *Notes from a Journey to Nepal*, based on the observations made in just a fortnight, cannot and do not claim to give an account of the flora of Nepal; "what is written . . . is, indeed, but a superficial account of the features of the vegetation between Raksal and the Himalaya of Central Nepal as far back as 35 miles in a straight line from the skirts of the plains and not higher than 7,000 ft. There was but one excuse for writing it, i.e., the great want of knowledge of the Botany of that part of the chain." This account has always been of particular interest to me personally, and lately this interest has been enhanced by the fact that one of my students has been doing research for several years in an area of Nepal that includes the whole part visited by Burkill and previously by Wallich. Burkill in his *Notes* lists about 400 genera of plants collected in his short trip, and this, to say the least, is by no means a negligible result.

The Botany of the Abor Expedition. As stated above, it was at Burkill's suggestion that a botanist was assigned to the expeditionary force that went into the Abor Hills; it was certainly lucky for us, his successors, that Burkill was selected for the job. His account is one of the most carefully complete papers that have been published for any botanical expedition of the last two hundred

years in India with the exception of Hooker's Himalayan journeys. Burkill and his two collectors remained attached to the expeditionary force from November 29th, 1911, till March 11th, 1912.

The methods of work followed by Burkill during this trip were determined by the type of terrain and by the fact that for the safety of the botanists they had to betake themselves to one of the camps before nightfall. "The plants low in the natural system of classification could be of little use to me in my particular object, because their geographic distribution is yet so little known. I collected them as I was able . . . Material of tall trees was collected by the aid of a shot gun. An aneroid barometer and a camera went with me everywhere; and for a time I had wet and dry bulb thermometers in camp, though to little good effect . . . To obtain as many plants in flower as possible, I moved backwards and forwards along the line, and I stationed my experienced collector about two marches behind me, that I might have a pair of eyes on the watch for that which had not been in flower when I passed. Having a collector behind me gave another advantage, for thereby there was an economy in transport, as it was easy to send to him down the line by the food supply coolies half-dried plants for finishing; but the carrying up the line of full supplies of drying paper over two marches that could be avoided, was a consideration. It was at all times necessary to keep the weight of the collections down, and under these circumstances my Diary was made to serve as much as possible. It became a record of 8,000 observations supplementing the notes with the specimens." Much living material was sent directly from the field to Calcutta and thence to Darjeeling; dried plants were also sent, when ready, to Calcutta, where Col. Gage placed them in the hands of assistants for a preliminary examination. The final study of the materials collected by Burkill on this occasion was only made prior to the publication of the report in 1924. The *Botany of the Abor Expedition* is an excellent account, a model of how such expeditions should be organised, collecting done and materials studied; the presentation of the results is remarkable for conciseness and completeness.

Chapters on the History of Botany in India. Although this work has only been published recently, long after the retirement of Mr. Burkill from India, it forms, as it were, the crown of the work that Burkill has done for Indian botany. In November 23rd, 1951, I wrote to Burkill from Bombay: "Next August we are celebrating the publication of the 50th volume of our Journal of the Bombay Natural History Society. At a recent meeting of the Committee

I was requested to ask you for a contribution for the August number of the journal. The subject mentioned was a sort of Biographical Index of "Indian" botanists, i.e., of British and foreign botanists that have worked in India from the beginning of the XIXth Century onwards . . . As for the length of the Index, no limit has been set . . ." Burkill's answer was generous in the extreme: "You shall have all that I can give you" (27th Nov. 1951). "I propose to separate from my slip index all the names of botanists in India which belong to those deserving of mention in the proposed account of Botany in India 1800 forward. When I have done that I will see if I can find time to write an account and I will communicate with you." (16th Dec. 1951). On Sept. 18, 1952, he writes again: "I assure you most appropriately the work I am doing on the history of Indian Botany is absorbing my energies . . . My undertaking is larger than I expected; but I am getting on with it." Finally on March 25th, 1953, he could write that the MS of the first chapter had been posted to Bombay. Later on when asking about chapter 2, I received the following answer: "I shall get down to part 2 as soon as I can. At the moment I am entwined by African *Dioscoreas*. When last year something went wrong with my inside-machinery and I could not get over to Kew or to the libraries in London, I lost way. But I am able to get about again—at any rate I get over to Kew; and I am in better fettle on the eve of 84 than I was on the eve of 83." Chapter 2 was finally ready for the press in August 1956. At that time I wrote to Burkill: "From all over India and beyond I have heard great appreciation of your first chapter, with requests that when the series is over, it may be published in book form." Lately, at the beginning of this year, 1960, I had a letter from Burkill's son, Mr. H. M. Burkill of Singapore, in which the son writes: "I would like to add that I arrived back here from a visit to England but 4 days ago, and I left my father in good health. He was busily engaged in typing the final text of Chapter 3 of his *History of Botany in India*."

Burkill and Dioscorea. Burkill's publications, as may be seen from the list appended to this short paper, deal mainly with economic products; only a few give accounts of botanical trips in India. The genus *Dioscorea* has always held a special attraction for him; the yams have been known in India for centuries as important food plants; it is only natural that the Reporter on Economic Products would sooner or later devote his attention to *Dioscorea*. His first paper on the subject was published in Calcutta in 1904; later on he became associated with Colonel, later Sir, David Prain in a revision of the Asiatic species of this important

genus; several papers were published jointly with Prain. The crowning glory of the Dioscorea work is *An Account of the Genus Dioscorea* published in four large volumes in the Annals of the Royal Botanic Gardens, Calcutta in 1936 and 1938. Burkill today stands out as the greatest authority on the Dioscorea family; this is why he has been chosen to write on the Dioscoreaceae for the *Flora Malesiana*; he is now engaged in the last stages of the preparation of an account of the Dioscoreas of Africa and Madagascar.

Conclusion

Burkill was appointed Director of the Botanic Gardens, Singapore, on 10th September, 1912; he left Calcutta on leave in the middle of April, 1912; his Indian service was officially terminated at the end of his leave on the 16th October, 1912.

On the occasion of his 90th birthday, we, Indian botanists, wish to associate ourselves with gratitude to the homage that the Singapore Botanic Gardens are preparing for this happy day. May his life and bright intellectual powers be spared for many more years to come, so that he may continue to shed his light over the world and be an example to us all.

Appendix

Some of Burkill's Publications on Indian Botany

1904. A note upon the use of *Marsdenia* in the Rajmahal Hills. *Agric. Ledg.* 8: 113-114, 1904.
Manihot utilisima.—The Tapioca Plant: its history, cultivation and uses. A review of existing information. *Ibid.* 10: 123-148, illust. 1904.
Bixa orellana.—The Annatto-dye plant. *Ibid.* 12: 177-187, 1904.
On *Dioscorea deltoidea*, Wall., *Dioscorea quinqueloba*, Thunb., and their allies. *Journ. Asiat. Soc. Bengal* n.s. 73 (II): Suppl. 1-11, 1904.
1906. A parasite upon a parasite,—A *Viscum* apparently *V. articulatum*, Burm., on *Loranthus vestitus*, Wall., on *Quercus incana*, Roxb. *Journ. & Proc. Asiat. Soc. Bengal*, n.s. 2: 299-302, 1906.
Gentianacearum Species Asiaticas novas descripsit I. H. Burkill sequentes. Ibid. 2: 309-327, 1906.

On *Swertia angustifolia*, Ham., and its Allies. *Ibid.* 2: 363–381, 1906.

Notes on the pollination of flowers in India.

Note No. 1. The pollination of *Thunbergia grandiflora*, Roxb., in Calcutta. *Ibid.* 2: 511–514, ff. 1–3, 1906.

Note No. 2. The pollination of *Corchorus* in Bengal and Assam. *Ibid.* 2: 515–520, 1906.

Note No. 3. The mechanism of six flowers of the North-West Himalaya. *Ibid.* 2: 521–525, t. 1, 1906.

Gossypium obtusifolium, Roxburgh. *Mem. Agric. Dept. India* (Bot. ser.) 1 (4): 1–10, t. 1, 1906.

Psophocarpus tetragonolobus. (Goa Bean).—Goa beans in India. *Agric. Ledg.* 4: 51–64, 1906.

1907. Notes on the pollination of flowers in India.

Note No. 4. On cotton in Behar. *Journ. & Proc. Asiat. Soc. Bengal*, n.s. 3: 517–526, 1907.

Alpine notes from Sikkim. *Kew Bull.* 1907: 92–94.

On *Gentiana coronata*, Royle. *Journ. & Proc. Asiat. Soc. Bengal*, n.s. 3: 149–168, ff. 1–9, 1907.

Anguilicarpus—a new genus of the Cruciferae. *Ibid.* 3: 559–561, ff. 1–6, 1907.

A note on *Impatiens balsamina*, Linn., as a dye-plant. *Ibid.* 3: 565–566, 1907.

1908. Notes on the pollination of flowers in India.

Note No. 5. Some autumn observations in the Sikkim Himalayas. *Ibid.* 4: 179–195, ff. 1–8, 1908.

Note No. 6. The Spring flora in the Simla Hills. *Ibid.* 4: 197–231, ff. 1–16, 1908.

1909. *A Working List of the Flowering Plants of Baluchistan*, Calcutta.

On *Coptis*. *Journ. & Proc. Asiat. Soc. Bengal* n.s. 5: 73–88, ff. 1–20, 1909.

First notes on *Cymbopogon Martini*, Stapf. *Ibid.* 5: 89–93, ff. 1–6, 1909.

1910. Notes on the pollination of flowers in India.

Note No. 7. A few observations made in the Central Provinces and Behar. *Ibid.* 6: 101–107, ff. 1–3, 1910.

Notes from a journey to Nepal. *Rec. Bot. Surv. India* 4: map, 59–140, 1910.

1911. The polarity of the bulbils of *Dioscorea bulbifera*, Linn. *Journ. & Proc. Asiat. Soc. Bengal* n.s. 7: 467-469, ff. 1-2, 1911.

Literature on the races of Rice in India. Compiled in the Office of the Reporter on Economic Products to the Government of India. *Agric. Ledg.* 16: 1-594, 1911.

Determination of the Prickly Pears now wild in India. *Rec. Bot. Surv. India* 4: 287-322, map, 1911.

1916. Notes on the Pollination of flowers in India.

Note No. 8. Miscellanea. *Journ. & Proc. Asiat. Soc. Bengal* n.s. 12: 239-265, ff. 1-10, 1916.

1924. The Botany of the Abor Expedition. *Rec. Bot. Surv. India* 10: 1-154, 1924; 155-420, tt. 1-10, 1925.

1954. Chapters on the History of Botany in India. I. From the beginning to the middle of Wallich's service. *Journ. Bombay Nat. Hist. Soc.* 51: 846-878, 1954.

1956. Chapters . . . II. The Advances, and in particular the plant collecting, of the thirties and forties of the 19th century. *Ibid.* 54: 42-86, 1956.

Burkill, I. H. & R. S. Finlow

1907. The Races of Jute. *Agric. Ledg.* 6: 41-137, f. 1, 1907.

On three varieties of *Corchorus capsularis*, Linn. which are eaten. *Journ. & Proc. Asiat. Soc. Bengal.* n.s. 3: 633-638, ff. 1-7, 1907.

1911. *Corchorus capsularis* var. *oocarpus*—a new variety of the common jute plant. *Ibid.* 7: 465-466, ff. 1-2, 1911.

Burkill, I. H. & D. Prain

1908. *Dioscorearum novarum descriptiones quaedam.* *Ibid.* 4: 447-457, 1908.

1914. A synopsis of the *Dioscoreas* of the Old World, Africa excluded, with descriptions of new species and varieties. *Ibid.* 10: 5-41, 1914.

1919. *Dioscorea sativa.* *Kew Bull.* 1919: 339-375.

1926. *Ad Dioscorearum orientalium Historias commentarii.* *Kew Bull.* 1926: 118-120.

1936. An Account of the genus *Dioscorea.* *Ann. Roy. Bot. Gard. Calcutta* 14: 1-528, tt. 1-150, 1936 & 1938.

I. H. Burkill in Malaya

C. X. FURTADO AND R. E. HOLTUM

ONLY A FEW years ago there was discussed in the *Gardens' Bulletin* the extensive pioneer work done by the late Mr. H. N. Ridley not only in showing that *Hevea brasiliensis* could be grown in Asia for the commercial production of rubber but also in laying stable foundations for the development of the several scientific departments for investigating the problems connected with fauna, flora, agriculture and forestry of Malaya. In view of this great work by Mr. Ridley, it might seem that his successor, Mr. Isaac Henry Burkill, would have little to do but follow on established lines. However, though we may not be able to do full justice to the subject, there are weighty reasons to consider the work of Mr. Burkill quite unique in its way; and it was work carried out, like Ridley's under many difficulties.

When Ridley retired from the service in 1912 and even before Burkill took the charge of the Gardens Department, the different departments which Ridley had helped to found, dissociated their connection with the Gardens' Department in order to work entirely as independent units in Malaya. Then the World War I (1914-1918) rendered impossible the execution of several projects because of the difficulties of recruiting properly trained staff, also because of lack of funds. Further, though the agricultural and the forestry departments were mainly for the Malay States, they had jurisdiction over the agricultural and forestry sections in the Straits Settlements, while the authority of the Gardens' Department was restricted to the official gardens within the Straits Settlements, so that the Gardens in the Malay States were placed under the Malayan Agricultural Departments. Difficulties in the Straits Settlements were mounting not only owing to lack of staff and finance but also to lack of appreciation of the value of purely botanical work; and perhaps this is the main reason why, soon after World War I, the area in which the arboretum was established and a good deal of acclimatisation work was being done on fruit trees and other economic plants and where rubber industry was born was taken away from the Gardens Department in order to establish Raffles College—the precursor of the University of Malaya, Faculties of Arts and Science.

But Burkill came here with an experience in India, where at the time, because of the limited availability of trained staff, one had to use one's skill to make a scientific undertaking a success. A rapid survey must have shown to Burkill that, if the Gardens' Department was to survive, it must become a centre for research of systematic botany; and for this purpose the first thing needed was to re-organise the whole herbarium and library so as to become less dependent on the workers and herbaria in India and England. Hitherto Ridley had worked in co-operation with the different specialists in India, England, Italy and Germany. The correspondence and his visits to Europe had helped him to describe his many new species and genera and write several papers. This extensive work had not given him time to organise adequately the herbarium and the library in Singapore; and perhaps because of the danger of termites and other vermin important specimens or types were sent to the workers in Kew, Calcutta and elsewhere, so that Singapore lacked many of the types or authentic material from Ridley's own collections. Further, since many specimens in the herbarium had no identifications written on their labels even when sorted, they were liable to be misplaced in the course of using the herbarium or mending the sheets. When working the *Flora of the Malay Peninsula I-V* (1922-25) Ridley used mainly the duplicate specimens he had sent to Kew, so that most of the specimens in the Singapore Herbarium still remained unlabelled.

Burkill therefore set himself immediately to the task of naming the specimens and indicating appropriately those cited in the large floristic works on Malaya, *The Materials for a Flora of the Malayan Peninsula: Dicotyledons* Vols. I-V by King and later assisted and continued by Gamble (1889-1915) and *Monocotyledons* by Ridley, Vols. I-III (1907), and later in Ridley's *Flora of the Malay Peninsula I-V* (1922-25). Further he organised collection trips to Malaya, Sumatra, Java and Sarawak in order to enrich the Singapore herbarium and also to send duplicate specimens to other institutions, so that such duplicates might be compared with types or authentic material in other institutions. Thus about 20,000 specimens were added by way of the collection in the jungles, the duplicates of which were distributed to several herbaria interested in Malaysian systematics and almost an equal number was received in exchange or as gifts, in addition to acquiring a set of Elmer's collection in Borneo and the Philippines. Further several hundreds of specimens of the plants cultivated in the Gardens were made in order to form a herbarium of the Gardens' plants.

It was at this time that Burkill introduced the system of numbering the specimens in the field rather than in the herbarium; for when numbered in the field, one can be sure that the different specimens bearing the same number are from the same collection, whereas, when numbered in the herbarium, specimens from different collections sometimes become mixed together so that the duplicates bearing the same number may not be specifically or varietally identical. The system of numbering the specimens in the field seemed to be so interesting that many foreign botanists who visited the Singapore herbarium often begged a specimen field label to take away with them for adapting it to their conditions.

It was in the course of this re-organization of the herbarium and the library that Burkill laid the foundation for his monumental work, *A Dictionary of the Economic Products of the Malay Peninsula* 2 vols. 2402 pp., elaborated and published in 1935, after his retirement in England. The work of re-organizing the herbarium provided also vernacular names and some information which had to be completed by making a further inquiry among the local people and by consulting the reports of research workers in Malaya, Indonesia, Philippines, India and elsewhere on the plants found in Malaya. The results thus collated were no doubt later incorporated in the Dictionary, but sometimes they formed the subject of special papers in the *Gardens' Bulletin*. Thus Burkill compiled a list of all the persons who had contributed specimens to the Gardens' Herbarium with details of their travels, and this together with the names of other persons who had contributed Malayan plants to other herbaria in the world, formed the subject of a paper with biographical sketches of the collectors published in the *Gardens Bulletin* IV (1927) 113–202, with the following title: *Botanical Collectors, Collections and Collecting Places in the Malay Peninsula: A review of the work so far done towards a knowledge of plantgeography of Malaya*. An inquiry into the simples and crude drugs of Malaya led Burkill to enlist the co-operation of the authorities who could competently work out the collections or manuscripts studied by him. Thus the specimens of Chinese drugs collected by Burkill were worked out by David Hooper and published in *Gardens' Bulletin* Vol. VI Part 1 (1929) 1–163. The prescriptions collected from the Malays by Burkill and Mohammed Haniff were issued as "*Malay Village Medicine*" the Malay names being associated with the botanical names of the plants by Burkill himself, and issued in *Gardens' Bulletin* VI (1930) 165–321. The manuscript book of "*The Medical Book of Malayan Medicine*", translated by Inche Ismail Munshi, possibly in Penang circa 1886,

was edited by Burkill who gave the botanical determination of the plants, while medical notes were supplied by J. D. Gimlette, who had worked widely on the Malayan medical terminology. (Gard. Bull. VI, 1930 pp. 323-474).

The undertaking to write an account about the Economic Products of Malaya led Burkill to make a survey of the efforts made to acclimatize foreign plants in Malaya. This involved not only culling information from the different published reports but also noting and sorting out the old manuscript records of every plant or seed that was introduced in the Botanic Gardens, which was generally the place to which plants newly introduced into Malaya were sent. The records were classified and made accessible in the herbarium under their respective genus and thence were worked out for the Dictionary.

The inquiry as to success or failure of the introduced plants necessitated a census of all the plants that existed in the Botanic Gardens and in its economic section which is now extinct. Thus the herbarium of the plants in cultivation came into the existence providing often valuable information of the success of plants that were introduced and cultivated in Malaya. Since there were then separate agricultural and forestry departments, the library exchanges and purchases had to be revised so as to make the institution more useful for its specialized purpose of the study of systematic botany. At the same time the Gardens' periodical which had hitherto been *The Agricultural Bulletin of the Straits and Federated Malay States*, was continued with the changed title "*The Gardens' Bulletin, Straits Settlements*". This change in the title was also necessary since the Malayan Agricultural Department had started a new periodical called "*The Agricultural Bulletin of the Federated Malay States*", causing thereby much confusion among the foreign public who, at the time, knew very little of Malayan geography and much less of Malayan political divisions.

The development of the Gardens' Department as the systematic centre for Malayan botany and the difficulties of enlisting the services of the botanical institutions in India and England, then suffering from shortage of staff, soon showed that several aspects of research work in the Malayan departments concerned with forestry, agriculture, rubber, malaria, food-stuffs of man and animals, and other subjects could not be carried on without making frequent calls upon the services of the Gardens' Department. An attempt was therefore made to establish a separate systematic research centre in Perak using Wray's herbarium as the basis, but

it proved a failure, because no systematist can provide the services needed by research institutions without a properly organized herbarium and library. Even police cases can be delayed or be misdirected if plants suspected as poisons are not properly identified.

While continuing to co-operate, so far as he was able, with the Malayan Departments of Agriculture and Forestry, Burkill opposed proposals for union of the Botanic Gardens, S.S., with either of these departments. He further insisted on the importance of a herbarium being associated with a garden, where plants could be studied in cultivation, as well as on the necessity of ample opportunity for field study of native plants. When the Research division of the Forestry Department was established, it became evident that that Department was dependent on the herbarium at the Botanic Gardens for a great amount of important information concerning the forest plants of Malaya. Dr. F. W. Foxworthy, the first Forest Research Officer, made frequent visits to Singapore, and collaborated in a study of the seedlings of *Dipterocarps* which Burkill had started: cf. *Journ. Str. Br. Roy. Asiat. Soc.* 75 (1917) 43-48; 76 (1917) 161-167; 79 (1918) 39-44; 81 (1920) 1-4 and 49-76; 86 (1922) 281-284 and 285-291; *Journ. Malay. Br. Roy. Asiat. Soc.* I (1923) 218-222, and with Foxworthy in *Journ. Str. Br. Roy. Asiat. Soc.* 86 (1922) 271-280.

A proposal was made for the moving of the headquarters of the Gardens Department to Kuala Lumpur, in order that it might be closely associated with the Forest Research Institute (with the possibility of a common library of books and journals on plant taxonomy), and about the time of Burkill's retirement a committee was appointed to make a recommendations to effect this change. But, though there was agreement in principle as to the desirability of the committee's proposals, the Federal Government decided that the cost of new buildings would be too great, and the matter was shelved, later to be completely abandoned; and the Straits Settlements continued to bear the whole cost of what was in effect a Malayan botanical service. The effectiveness of this service was increased during the last years of Burkill's directorship by the addition of two plant taxonomists and one graduate field officer (Holttum, Henderson and Furtado respectively) and a library assistant to the Gardens staff.

Though working under a great handicap, Burkill showed how a trained botanist can use his time in making systematic and biological observations on the many plants that are grown in a

garden and also utilize the facilities available for growing plants to clear certain doubts regarding their botanical affinities, dietetic value, etc. Thus the first two or three volumes of the Gardens' Bulletin contain a large number of notes regarding insect pests, abnormalities, new varieties of orchids, flowering peculiarities of many plants growing in the Gardens, digests of old records on rubber and on the history of the Gardens in Malaya, and observations on the Yams (*Dioscorea* spp.) grown in the Gardens where he had gathered them from different parts of the world in order to prosecute his studies begun in Calcutta in the company of Dr. (later Sir) David Prain. The following articles might be mentioned since they show the keenness and the breadth of the studies: "*The Positions of the Agricultural Industries in the Straits Settlements in 1913*" (Gard. Bull. I, 1914 pp. 213-235); "*The Treatment to which the Para-Rubber Trees of the Botanic Gardens, Singapore, have been subjected*" (Gard. Bull. I, 1915, pp. 248-295); "*Gordonia*" (Journ. Str. Br. Roy. Asiat. Soc. 76 (1917) 133-159); "*The Establishment of the Botanic Gardens, Singapore*" (Gard. Bull. II, 1918, pp. 55-72); "*The Second Phase in the History of the Botanic Gardens, Singapore*" (Gard. Bull. II, 1918 pp. 93-108); "*The Composition of a Piece of Well-drained Singapore Secondary Jungle Thirty Years Old*" (Gard. Bull. II, 1919 pp. 145-157); "*Some Notes on the Pollination of Flowers in the Botanic Gardens, Singapore, and in other Parts of the Peninsula*" (Gard. Bull. II, 1919 pp. 165-176); "*The Genus Gordonia in the Philippine Islands*" (Philipp. Journ. Sci. XV, 1919 pp. 475-478); "*A List of Oriental Vernacular Names of the Genus Dioscorea*" (Gard. Bull. II, 1924 pp. 121-244).

However Burkill was only for a short space of 13 years in Malaya; and during this period he was busy collecting material for his monumental work of "*A Dictionary of the Economic Products of the Malay Peninsula*". Naturally these notes and observations had to be worked out in England where he had an access to better library and herbarium facilities and whence he helped, after his retirement, the Gardens' Herbarium to name many of the foreign and other plants that were grown in the Gardens. Each of his articles in the Dictionary is replete with information about the history of the plant, its products, vernacular names, uses, chemical composition of the drug or poison if known, etc. In addition to work on the Dictionary, other studies begun in Singapore or Calcutta were completed in England. Thus "*An Account of the genus Dioscorea in the East*" was published by Prain and Burkill in four

large volumes (two of which are plates), in the *Annals of the Botanic Gardens, Calcutta* in 1937 and 1939. The following papers might also be mentioned: "*The Chinese Mustards in the Malay Peninsula*" (Gard. Bull. V, 1930 pp. 99-117); "*An Enumeration of the Species of Paramignya, Atalantia and Citrus, found in Malaya*" (Gard. Bull. V, 1931 pp. 212-223); "*Notes on Gluta*" (Gard. Bull. V, 1931 pp. 224-230); "*The rise and decline of the Greater Yam in the service of man*" (Avanc. Sci. Lond. VII 1950 pp. 443-448).

Also it may be noted that in addition to many species, at least three genera have been named in honour of Mr. I. H. Burkill, namely, *Burkillia*, West and West, Protococcaceae (1907), *Burkillia* Ridley, Leguminosae (1925) and *Burkillianthus* Swingle, Rutaceae (1938).

Phellodendron, a genus of trees new to the Malayan flora (Rutaceae)

By C. G. G. J. VAN STEENIS

Flora Malesiana Foundation, Leyden

FOR SOME TIME I have been defeated in identifying a sheet from the Malay Peninsula with decussate, pinnate, exstipular leaves and choripetalous, 5-merous, male flowers. It would seem that the choice was so much narrowed by these characters, that identification would have been easy. And though it is now certain, that it belongs to *Phellodendron* of the Rutaceae, it remains still remarkable that the leaves of this genus do not show the distinct pellucid glands which are so typical for rutaceous plants. There are indeed minute, pin-like pellucid glands (crystal cells?) in the parenchyma but of essentially smaller size than is usual in Rutaceae. It is true that Sprague (Kew Bull. 1920, 231) and Engler (Pfl. Fam. ed. 2, 19a 1931, 298) mention the occurrence of a large pellucid gland near each of the shallow leaf-crenations, but this appears to be frequently indistinct in the sheets of the genus preserved in the Rijksherbarium. See also Blenk, Flora 67 (1884) 278.

Phellodendron burkillii n.sp.—Fig. 1.

Arbor, 18 m. alta, c. 35 cm. diam. Ramuli, foliorum raches, petioluli et inflorescentiae axes laterales primarii appresse puberuli. Folia 4-6-jugata, foliolis oblique ovato-oblongis ad sublanceolatis, acuminatis, acumine longo angusto saepe falcato, 6-10 × 2-3 cm., subtus in costae parte inferiore puberulis, ceterum glabris. Corymbus axibus conspicue decussatis, multiflorus, c. 10-12 cm. longus, 15-20 cm. latus. Flores subglabri. Calycis lobi. 1/3 mm., triangulares. Petala c. 2½ × 1 mm., intus ad venam medianam pilis paucis retrorsis suffulta. Filamenta in parte inferiore pilis longis patentibus munita. Ovarium glabrum. Styli pilis erectis parcissime pubescentes.

Typus: KEP 78904, L.

Tree 18 m. tall, 35 cm. diam. Twigs with very few lenticels, pithy, as the petioles, leaf-rachis, and inflorescencal stalks puberulous, terete, but flattened at the nodes. Leaves decussate, with

4-6 pairs of leaflets, c. 20-30 cm. long; leaflets c. 4-6 pairs, dull, \pm glaucous underneath, obliquely ovate-oblong to sublanceolate, long- and narrow-, often falcate-acuminate, 6-10 by 2-3 cm, base cuneate and on the acroscopical side often \pm rounded, ultimate base short-decurrent into the petiolule; nerves c. 6-8 pairs, inconspicuous, as the very dense venation not or obscurely prominent; margin obsolete crenate, in the crenations often an obsolete, pellucid dot; petiole 3-6 cm; petiolules c. 3 mm. Terminal corymb wide (c. 15-20 cm.), c. 10-12 cm. high, richly branched and with numerous flowers. Calyx c. 1 mm. diam., $\frac{1}{2}$ mm. high, the lobes acute-deltoid. Mature buds broad-elliptic almost globular, 2 mm. long. Petals oblong-elliptic, the margins very narrowly imbricate, c. $2\frac{1}{2}$ times as long as wide, boat-shaped, c. $2\frac{3}{4}$ by 1 mm., tip thickened, retrorse, glabrous but for some appressed, retrorse hairs on the midrib within. Stamens 5, erect in bud, the filaments considerably lengthening during anthesis and becoming longer than the anthers (c. 2- $2\frac{1}{2}$ mm.), the lower half with scattered, patent, long hairs; anthers free in the lower half and \pm sagittate, basifixed, acute-oblong, c. $1\frac{3}{4}$ mm. long. Ovary in δ rudimentary, 5-angled, c. $\frac{1}{2}$ mm. high, glabrous, with 5 erect, appressed styles $\frac{1}{2}$ mm. high, with a few appressed-erect hairs.

MALAY PENINSULA. Kedah: Enggang Forest Reserve, Sik, KEP 78904 (L, type, KEP, K, SING, distributed as *Micromelum pubescens* Bl.), low-lying ground, bark smooth, grey-green, flowers greenish-white, July 12, 1956.

The closest ally of this species seems to be *P. macrophyllum* Dode from East Szechuan, China (Bull. Soc. Bot. Fr. 55, 1908, 648) which is, however, clearly specifically distinct, as appeared from an examination of the type which was kindly loaned to me by the Director of the Paris Herbarium. The differential characters are that it has 2-4-jugate leaves (in the type sheet 2-jugate); leaflets large, 10-15 (-20) by 5-8 (-9) cm., broad-elliptic, abruptly acuminate, pubescent beneath on the main rib, venation and intervenium, with a much coarser venation than in *P. burkillii*, without marginal glandular dots, but with very numerous dots of microscopic size and scattered large pellucid dots (as yet unknown in the genus); inflorescence with very thick, lenticellate dark-coloured peduncle and axis; flowers very dense; mature buds 3 mm.; calyx 1 mm. high. Petals 3 by $1\frac{1}{3}$ mm. Styles patent long-villose. Fruit globular, 10 by 9 mm.

The genus is a truly East Asian—one of Sino-Japanese distribution, north to Manchuria, south to Formosa.



Phellodendron burkillii Steen. a, Flowering twig, $\times 2/5$. b, flower. c, stamen. d, pistil, all $\times 6$ (after KEP 78904, L.).
—*Phellodendron macrophyllum* Dode. e, flower. f, stamen. g, pistil, all $\times 6$ (after Farges 1284, P.).

If such temperate to subtemperate ligneous genera occur in the South-east Asian tropics they are generally found in the montane zone, as for example in *Pentaphylax*, *Osmanthus*, *Camellia*, *Anneslea*, *Distylium*, *Schoepfia*, *Pistacia* (in Luzon), etc. This is not always the case, as of *Acer*, which belongs in this group, two lowland localities have been recorded in addition to dozens in the montane zone.

There is as far as I know one temperate to subtemperate ligneous genus which only occurs in the lowland in Malaya and that is *Pistacia malayana* Henderson; this shows an ecologically similar behaviour as this new record of *Phellodendron*.

Vegetative characters distinguishing the various groups of ferns included in *Dryopteris* of Christensen's *Index Filicum*, and other ferns of similar habit and sori

By R. E. HOLTUM

IN A SERIES of papers beginning in 1907, mainly on American species, Christensen himself showed a way in which natural groups within *Dryopteris sens. lat.* of his *Index Filicum* could be distinguished, the significant diagnostic features being provided by hairs and scales on the fronds. Though he never published a formal conspectus of the whole group, he continued to develop his ideas (see Christensen 1938). Ching's series of papers on *Dryopteris* and other genera of China, published from the year 1933 onwards, carried the general investigation much further, dealing with the ferns of Asia not considered in Christensen's earlier work. Ching also used the characters (both external and internal) shown by a cross-section of the rachis, and the relation of rachis to pinna. The use of this last kind of character was developed further by me, and is most fully set forth, with some illustrations, in my book on the ferns of Malaya (1954). In trying to understand more clearly the limits of some of the genera concerned, I have been much impressed by the significance of these characters, and to clarify my thinking I have attempted a concise comparative presentation of them, as set forth at the end of the present paper. It appears to me that Ching did not pursue effectively the line of thought which he himself indicated when showing the distinction between rachis-characters of *Ctenitis* and *Dryopteris (sens. strict.)*; if he had done so, he would not have suggested that *Athyrium* and *Thelypteris* are closely related, nor that *Rumohra adiantiformis* belongs to the same genus as the *Dryopteroid* ferns which he associated with it.

I have been especially impressed by the importance of the external shape of the rachis, and the way in which this shape is modified when a pinna-rachis (or a simple pinna) is attached to it. These characters are extremely uniform in genera which, as judged by other characters, are seen to be natural ones, and I believe that all the more highly evolved genera have each a particular rachis-form. When however one looks at *Dennstaedtia*, *Hypolepis*

and related genera, which have various primitive characters and seem to be survivors of a very basic group, one finds less uniformity, and I believe that in this group one can see the beginnings of both the *Tectaria* and *Dryopteris* rachis-characters, now so strongly differentiated in these two more highly evolved genera. I believe that the limits of the genera *Dennstaedtia* and *Hypolepis* are not at present clearly defined, and that a further study of these genera, with rachis-characters (as well as other factors) in mind, may yield significant results.

There is a sharp distinction between the kind of grooved rachis shown by *Dryopteris* proper (the groove opened to admit the groove of a pinna-rachis) and on the other hand the kind of rachis which, even if it has a median groove, does not open its groove to admit a pinna-rachis groove. In ferns showing the second of these alternatives, as for example the *Thelypteroid* ferns, the main rachis and the costae of pinnae are grooved on the upper surface, but the groove of the rachis does not open to admit the groove the costa (the latter is in fact usually not grooved at its base). In *Tectaria* and *Ctenitis* there is no median groove in the upper surface of rachis or of costae of pinnae, though in *Pleocnemia* (Holttum 1951) there is a slight median groove. *Ctenitis* and *Tectaria* are characterized also by the short multicellular hairs pointed out by Christensen (he called them *Ctenitis*-hairs). But there are genera which have the rachis-form of *Dryopteris* and hairs not much different from those of *Ctenitis* (e.g. *Stenolepia* v.A.v.R.).

A quite distinct kind of rachis is found in *Davallia* and some other genera. Here the middle of the upper surface of the rachis is raised, and on either side of this raised median band, in all smaller rachises, is a slight groove, the outer edge of the groove forming a very firm narrow wing; the thickened edge of the lamina of a leaflet is decurrent on this wing, the raised midrib of the leaflet joining the side of the raised median band of the upper surface of the rachis. An almost exactly similar arrangement occurs in *Pteridrys* (Ching & C.Chr. 1934), but in rhizome this genus is very different from *Davallia*. An indication of how this arrangement of the rachis may develop in the *Tectaria* group of genera is given by *Lastreopsis* Ching (united with *Ctenitis* by Copeland; recently distinguished, with a list of species, by Miss Tindale). In *Lastreopsis* the thickened lower edge of the lamina of a leaflet is decurrent on the rachis-wing, but this wing is usually much more lateral on the rachis than in *Pteridrys*.

The *Davallia* type of rachis is shown by *Rumohra adiantiformis* (Forst.) Ching, and this same species also has a dorsiventral

rhizome of *Davallia* type, so that a sterile plant of *R. adiantiformis* might well be identified as *Davallia*. The spores of this species also are like those of *Davallia*, not like those of *Dryopteris* and *Polystichum* (Harris 1955, pl. 7, f. 2). It seems to me therefore proved that Ching and Copeland were mistaken in associating species allied to *Dryopteris* and *Polystichum* with *Rumohra*. For these latter species, I have used the name *Polystichopsis*, but I am not at all satisfied that they form a natural group, and I believe that the matter needs further investigation. Furthermore, Mr. C. V. Morton has pointed out to me that the generic name *Polystichopsis* was first used in a different sense, and he is elsewhere proposing another name.

In the following conspectus I have not attempted to distinguish the genera of the *Thelypteroid* group, because I believe that more study is needed to establish clearly their distinctive characters. Everybody admits that a distinction between *Thelypteris* (or *Lastrea*) and *Cyclosorus* on the characters of free or anastomosing veins is a quite unnatural one. One could include all species in one genus, but then subgenera would need to be distinguished. For example, *Lastrea oreopteris* is surely very different from *Thelypteris palustris*, and both are very different from the group of species to which *Thelypteris brunnea* (Wall.) Ching belongs. Cytological evidence (Manton, Manton & Sledge) indicates that some species with free veins are more closely related to *Cyclosorus* than to other free-veined species, and probably such species should be united to *Cyclosorus*; but other morphological characters need to be established.

As regards the genera of the *Tectaria* group, it seems to me that *Ctenitopsis* Ching should be united to *Tectaria*, not to *Ctenitis* as in Copeland's *Genera Filicum*. Just as a division between *Thelypteris* and *Cyclosorus* on whether veins are free or not is unnatural, so also is a division between *Tectaria* and *Ctenitopsis*. The series of forms included in *Dryopteris dissecta* (Forst.) O. Ktze, which belong to *Ctenitopsis*, have exactly the frond-form of some species of *Tectaria*. Perhaps *Ctenitis* itself needs further subdivision, allowing some sections of it to be associated with *Tectaria*. I formerly attempted to distinguish *Heterogonium* from *Tectaria* on frond-form (I see no other practicable distinction) but now I am not sure whether this group should have generic separation. *Aspidium boryanum* Willd. (included by Copeland in *Ctenitis*) resembles *Ctenitis* rather than *Dryopteris* in external form of the rachis, but differs from both in the vascular anatomy of the stipe. I believe that this species (with some others which are closely

related to it) is nearer to *Athyrium* than to *Ctenitis*, but quite distinct from *Athyrium*, in which genus I placed it in my book on the ferns of Malaya (p. 567); in so doing I unfortunately made the mistake of referring to it specimens which are in fact *Athyrium*. Later (1959) I proposed a new generic name *Parathyrium* for *Aspidium boryanum* Willd. and its allies, but this was antedated by *Dryoathyrium* Ching (1941), based on the same type species.

In the following conspectus, *Gymnocarpium* (sensu Ching 1933) is shown as belonging to the *Dryopteris* group, not with *Thelypteris* (*Lastrea*) where Copeland placed it (1947, p. 137), and cytological evidence confirms this position. *Dryopteris phegopteris* (L.) Chr., on the other hand, belongs to the *Thelypteris* group. I believe that Copeland overlooked both hairs and rachis-characters when he wrote of these two that "their separation by reasonable generic definition is hardly possible". Similarly, I believe that the conspectus shows a clear separation between *Athyrium* and the *Thelypteris* group (on hairs, scales and rachis-characters), though both Ching and Copeland held that they were so closely allied as to be hardly separable in formal terms.

Cornopteris Nakai was based on a species like *Diplazium* and *Athyrium* in rachis-characters but lacking an indusium. *Hemionitis opaca* Don (in *Dryopteris* in the original *Index Filicum* of Christensen, transferred later to *Diplazium* by Christ) is very closely related to the type species of *Cornopteris*, and other species have been noted by Ching. Madame Tardieu-Blot however has added to the genus *Cornopteris* some of the species of the alliance of *Aspidium boryanum* Willd. (1956, 1958); the distinction between true *Cornopteris* and these species is shown in the present conspectus.

The genus *Hypodematium* has abundant needle-like unicellular hairs on its fronds, resembling in this the *Thelypteroid* ferns. Its scales however are quite different from those of *Thelypteris*, and I do not think that *Hypodematium* is of the *Thelypteris* alliance; on the other hand, I am not sure that it really belongs with the *Tectaria* group of genera.

Rhizome not dorsiventral (leaves and roots equally all round);
wing of pinna-rachis, if present, thin like the lamina, except
in *Pteridrys* and *Lastreopsis*

Main rachis lacking a median groove on upper surface; or if
grooved, the groove not open to admit grooves of pinna-
rachises; rachis sometimes winged, the wing joining the
edge of the lamina of leaflets, not the edge of the costa of a
leaflet

Hairs on upper surface of rachis multiseptate, usually very short; scales lacking superficial hairs or glands

Several separate vascular bundles throughout the stipe

Tectaria group

A tooth present at the base of each sinus between lobes of the lamina

Veins free; vascular bundles in stipe in a simple ring

Pteridrys

Veins anastomosing; vascular bundles in more complex arrangement

Pleocnemia

Arcypteris

No tooth present in sinus between two lobes of lamina

Basal basicopic vein of a vein-group springing directly from the costa, not from the costule which bears the other veins of the group; or veins much anastomosing

Tectaria

(incl. *Ctenitopsis*)

Basal basicopic vein of a vein-group springing from the costule; veins always free

Indusium peltate; hairs on rachis few, mainly near junction of rachis and pinnae on upper surface

Dryopolystichum

Indusium reniform; hairs many throughout rachis

Decurrent wing of lamina not thickened

Ctenitis

Decurrent wing of lamina thickened

Lastreopsis

One U-shaped bundle in the stipe (2 bundles near base)

Dryoathyrium

Hairs on upper surface of rachis unicellular, more or less needle-like; two vascular bundles in base of stipe, uniting upwards to one of U-shape

Scales lacking superficial hairs or glands, confined to swollen bases of stipes

Hypodematium

Scales bearing superficial glands or hairs, not confined to base of stipe which is not swollen **Thelypteris group**

Main rachis with median groove in upper surface, this groove open to admit grooves of pinna-rachises; raised edge of a pinna-rachis groove joined to side of pinnule-costa groove, edge of pinnule-lamina decurrent on pinna-rachis as a lateral wing

Multicellular hairs, of a kind quite different from scales, lacking; groove of rachis quite smooth within

Dryopteris-group

Several vascular bundles in stipe

Dryopteris
Polystichum
"Polystichopsis"

Two vascular bundles in stipe

Gymnocarpium

Multicellular hairs, quite different from scales, often present; groove of rachis papillate within; some sori elongate and asymmetric or unilateral; two vascular bundles at base of stipe

Athyrium group

Sori indusiate

Athyrium

Sori not indusiate

Cornopteris

Rhizome dorsiventral (roots from lower surface, leaves from upper surface); pinna-rachis bearing a firm wing, edge of lamina thickened at base and decurrent on the rachis-wing; midrib of pinna raised, not grooved

Rumohra (*s. str.*)

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Taxonomic Notes on *Ficus* Linn., Asia and Australasia

I. SUBGEN. UROSTIGMA (GASP.) MIQ.

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Summary

NEW SECTIONS, subsections, series and subseries.—sect. *Urostigma* ser. *Superbae* Corner, ser. *Caulobotryeae* (Miq.) Corner, ser. *Orthoneuræ* Corner.—sect. *Leucogyne* Corner.—sect. *Conosycea* (Miq.) Corner subsect. *Conosycea* ser. *Drupaceae* Corner, subser. *Indicae* Corner, subser. *Zygotricheae* Corner, subser. *Crassirameae* Corner; subsect. *Dicityoneuron* Corner ser. *Glaberrimae* Corner, ser. *Dubiae* Corner, ser. *Subvalidae* (Miq.) Corner, ser. *Perforatae* Corner; subsect. *Benjamina* (Miq.) Corner ser. *Callophylleae* Corner; sect. *Malvanthera* Corner ser. *Malvanthereae* Corner, subser. *Eubracteatae* Corner, subser. *Platypodeae* Corner, subser. *Hesperidiiformes* Corner, ser. *Cyclanthereae* Corner.—sect. *Galoglychia* (Gasp.) Endl. (subgen. *Bibracteatae* Mildbr. et Burr.).

Earlier specific epithets.—*F. virens* Ait. (*F. infectoria* sensu Roxb., *F. lacur* auct., non verae), *F. costata* Ait. (*F. caudiculata* Trim.), *F. depressa* Bl. (*F. pruniformis* Bl.), *F. drupacea* Thunb. (*F. pilosa* Reinw.), *F. crassiramea* Miq. (*F. procera* auct., non Bl.), *F. sundaica* Bl. (*F. indica* sensu King, non Linn. which is reduced to *F. benghalensis* Linn.), *F. retusa* Linn. (*F. truncata* Miq.), *F. pellucido-punctata* Griff. (*F. gelderi* Miq.), *F. piscoarpa* Bl. (*F. microstoma* Wall. ex King), *F. subcordata* Bl. (*F. garciniifolia* Miq.), *F. microcarpa* Linn. f. (*F. retusa*, *F. nitida*, *F. retusa* var. *nitida* auct., non verae).

New names for later homonyms.—*F. hookeriana* Corner (*F. hookeri* Miq.), *F. subsecta* Corner (*F. procera* Bl.), *F. maclelandi* King var. *rhododendrifolia* Corner (*F. rhododendrifolia* Miq.), *F. curtipes* Corner (*F. obtusifolia* Roxb.), *F. subpuberula* Corner (*F. puberula* Miq.).

New species.—*F. subgelderi* Corner et v. *rigida* Corner, *F. paracamptophylla* Corner, *F. delosyce* Corner et var. *obtusa* Corner, *F. spatulifolia* Corner et var. *annamensis* Corner, v. *substipitata*

Corner, *F. calcicola* Corner, *F. episima* Corner, *F. tristaniifolia* Corner, *F. palaquiiifolia* Corner, *F. polygramma* Corner, *F. benjaminoides* Corner, *F. patellata* Corner, *F. triradiata* Corner et var. *sessilicarpa* Corner, *F. augusta* Corner.

New varieties.—*F. superba* Miq. v. *alongensis* (Gagnep.) Corner, v. *henneana* (Miq.) Corner; *F. concinna* Miq. v. *subsessilis* Corner; *F. virens* Ait. v. *sublanceolata* (Miq.) Corner, v. *glabella* (Bl.) Corner; *F. caulocarpa* Miq. v. *dasycarpa* Corner; *F. prolixa* Forst. f. v. *subcordata* Corner; *F. arnottiana* Miq. v. *subcostata* Corner; *F. drupacea* Thunb. v. *auranticarpa* (Elm.) Corner, v. *glabrata* Corner, v. *pedicellata* Corner, v. *pubescens* (Roth) Corner (*F. mysorensis* Heyne); *F. cucurbitina* King v. *eubracteata* Corner; *F. cordatula* Merr. v. *sericea* (C. B. Robinson) Corner; *F. pubilimba* Merr. v. *ovata* Corner; *F. stupenda* Miq. v. *minor* Corner; *F. crassiramea* Miq. v. *brevicupulata* Corner, v. *celebica* Corner v. *clementis* (Merr.) Corner, v. *patellifera* (Warb.) Corner; *F. forstenii* Miq. v. *pacifica* (Elm.) Corner, v. *umbobracteata* (Elm.) Corner, v. *villosa* Corner; *F. glaberrima* Bl. v. *bracteata* Corner, v. *siamensis* Corner; *F. sundaica* Bl. v. *beccariana* (King) Corner; *F. lowii* King v. *borneensis* Corner, v. *minor* Corner; *F. sumatrana* Miq. v. *circumscissa* Corner, v. *microsyce* Corner, v. *subsumatrana* (Gagnep.) Corner; *F. retusa* Linn. v. *borneensis* Corner; *F. binnendykii* Miq. v. *coriacea* Corner, v. *cupulata* Corner, v. *latifolia* Corner; *F. subcordata* Bl. v. *malayana* Corner; *F. benjamina* Linn. v. *bracteata* Corner; *F. callophylla* Bl. v. *leytensis* Corner, v. *malayana* Corner, v. *minor* Corner; *F. microcarpa* Linn. f. v. *microcarpa* f. *pubescens* Corner, v. *eubracteata* Corner, v. *hillii* (Bailey) Corner, v. *latifolia* (Miq.) Corner, v. *naumanni* (Engl.) Corner, v. *saffordii* (Merr.) Corner; *F. glandifera* Summerh. v. *brachysyce* Corner; *F. leucotricha* Miq. v. *megacarpa* F.v.M. ex Corner, v. *sessilis* Corner; *F. obliqua* Forst. f. v. *petiolaris* (Benth.) Corner, v. *puberula* (Benth.) Corner; *F. hesperidiiformis* King v. *myrmekiocarpa* (Summerh.) Corner; *F. xylosyca* Diels v. *cylindrocarpa* (Diels) Corner.

Mixtae compositae.—*F. caulobotrya* Miq., *F. onusta* Wall. ex Miq. (see under *F. globosa* Bl.).

In recent works on the classification of *Ficus* insufficient attention has been given to the names of subdivisions made by Miquel. These must be typified and re-introduced with minimum of disturbance, but a pre-requisite is a full understanding of all his

species. The last to attempt this was King (1887–88), and he was obliged to leave many uncertain. Since 1950 I have worked on the revision of the Asiatic and Australasian species, using the large collection of the Singapore Herbarium as the study-collection, and, with the indispensable assistance of the herbaria of Leiden, Utrecht, Bogor, and Kew (for many of Miquel's types are in the Hooker Herbarium), I have succeeded in recognising every taxon described by Miquel from *forma* to *genus*. This series of papers gives the bare taxonomic results: botanical appreciation must await full publication. I should add that, until one can identify leaves in particular from microscopic structure, it is commonly impossible to identify many types. Hence I acknowledge with gratitude my apprenticeship through the Singapore herbarium and my progress through the courtesy of the Directors and staff of the herbaria of Europe, Asia, New Guinea, and Australia, namely of the British Museum, Kew, Edinburgh, Paris, Florence, Leiden, Utrecht, Copenhagen, Berlin, Calcutta, Bogor, Manila, Lae, Brisbane, and Adelaide. Thus I have studied over twenty thousand collections, not counting the abundant duplicates. Further, in special matters, I have received great help from the herbaria of Stockholm, Uppsala, Geneva, Turin, Caen, the Arnold Arboretum, the New York Botanic Garden, and the Smithsonian Institution. The funds for this work have come mainly from the Cambridge Botany School, but also from the Leverhulme Trust, the Nuffield Foundation, and the Royal Society. To all these persons and institutions, and to the many field-botanists who have joined the quest, I express my gratitude. Taxonomy, of course, is a means to an end, and what I have in mind is the evolution of tropical forest as seen through one of its major constituents.

subgen. *Urostigma* (Gasp.) Miq.

Ann. Mus. Bot. Lugd. Bat. 3 (1867) 285.—*Urostigma* Gasp. Parl. Giorn. Bot. 2 (1844) 214; Ann. Sci Nat. ser. 3, 3 (1845) 343.—sect. *Urostigma* (Gasp.) Endl. Gen. Pl. 4, 2 (1847) 35. Lectotype—*F. religiosa* Linn.

Gasparrini listed seven species without indication of a type. Endlicher, in reducing the genus to a section, cited merely *F. religiosa* Linn. and *F. glaucophylla* Desf., which had not been mentioned by Gasparrini. Hence I take *F. religiosa* as the lectotype and it has always served as a typical member of the taxon *Urostigma*.

sect. **Urostigma**.—Figs with interleaving apical bracts. Male flowers generally ostiolar. Ovaries entirely red-brown or in the upper half. Cystoliths only on the lower side of the lamina. Petiole often articulate to the lamina. Lectotype—*F. religiosa* Linn.

I divide this into four series.

1. ser. **Religosae** Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 287.—*Urostigma* Gasp. ser. *Religiosa* Miq. Fl. Ind. Bat. 1, 2 (1859) 332.—Fig sessile (except *F. verruculosa* Warb., Africa): basal bracts persistent: internal bristles none, or few and minute. Lamina without hypodermis. Type—*F. religiosa* Linn.

2. ser. **Superbae** Corner ser. nov.—Receptacula pedunculata (raro sessilia), bracteis basalibus caducis, setis internis nullis v. paucis minutisque. Lamina hypoderme deficiens. Typus—*F. superba* Miq.

3. ser. **Caulobotryae** (Miq.) Corner comb. nov.—*Urostigama* Gasp. ser. *Caulobotrya* Miq. Fl. Ind. Bat. 1, 2 (1859) 334.—Fig sessile or pedunculate: basal bracts persistent: internal bristles abundant, chaffy-vesicular, white. Lamina without hypodermis. Lectotype—*F. caulocarpa* Miq.

Miquel gave *Urostigma superbum* Miq., *U. caulocarpum* Miq., and *U. stipulosum* Miq. for this series. The last two are the same and the first I exclude as ser. *Superbae*.

4. ser. **Orhoneurae** Corner ser. nov.—Receptacula sessilia v. pedunculata, bracteis basalibus persistentibus, setis internis nullis. Flores masculi dispersi. Petiolus non v. vix articulatus. Lamina superne hypoderme unistratoso, cuticula inferiori gyroso-plicata, praedita. Typus—*F. orhoneura* Lévl. et Vant.

sect. **Leucogyne** Corner sect. nov.—Receptacula sessilia, bracteis apicalibus interpositis. Flores masculi dispersi. Ovaria albida, haud rubromaculata. Lamina superne hypoderme 1–2-stratoso, cystolithis solum pagina superiori, praedita. Petiolus haud v. vix articulatus. Typus—*F. rumphii* Bl.

This section includes *F. rumphii*, so often mistaken for *F. religiosa*, and *F. tsiela* Roxb., which is close. Possibly *F. menabeensis* H. Perr. (Madagascar) belongs here, but I am unable to place this species satisfactorily.

sect. **Conosycea** (Miq.) Corner comb. nov.—*Urostigama* Gasp. sect. *Conosycea* Miq. Fl. Ind. Bat. 1, 2 (1859) 349.—Figs sessile or pedunculate, apical bracts interleaving. Male flowers disperse. Ovaries white with a red mark at the base, at least on the stylar side, or the lower half red. Petiole not articulate. Lamina

generally with an upper hypodermis, cystoliths on both sides or only on the upperside, rarely none. Lectotype—*F. annulata* Bl.

This section was based on eleven species, namely *U. altissimum* (Bl.) Miq., *U. excelsum* Miq. (= *F. tinctoria* Forst. f., subgen. *Ficus* sect *Sycidium* Miq.), *U. bicornis* Miq. (= *F. drupacea* Thunb.), *U. conocarpum* Miq. (= *F. annulata* Bl.), *U. pilosum* (Reinw.) Miq. (= *F. drupacea* Thunb.), *U. giganteum* Miq. (= *F. stupenda* Miq.), *U. pruniforme* (Bl.) Miq. (= *F. depressa* Bl.), *U. depressum* (Bl.) Miq., *U. benghalense* (Linn.) Miq., *U. annulatum* (Bl.) Miq., and *U. xylophyllum* Miq. I select *F. annulata* Bl. as the lectotype because it is named twice, because its close ally *F. depressa* Bl. is named twice, because it is well-known and a good representative of this major section, and because it has the conoid fig. Miquel did not use the section later. I recognise three subsections with several series and subseries, as follows.

A. subsect. **Conosycea**.—Venation with intercostals. Type—*F. annulata* Bl.

1. ser. **Validae** Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 285.—*Urostigma* Gasp. ser. *Valida* Miq. Fl. Ind. Bat. 1, 2 (1859) 334.—Fig pedunculate, ripening green, brown, or brownish orange. Lectotype—*Urostigma valida* (Bl.) Miq. (= *F. annulata* Bl.).

I choose this type because Miquel obviously chose the name from this species. It occurs, also, as *U. flavescens* (Bl.) Miq., and its ally *F. globosa* occurs twice also, as *U. globosum* (Bl.) Miq. and *U. manok* Miq. Further, this choice gives the lectotype of sect. *Conosycea* the position also of lectotype of a series.

2. ser. **Drupaceae** Corner ser. nov.—Receptacula sessilia v. pedicellata, haud pedunculata, maturitae lutea, aurantiaca, dein rubra. Typus—*F. drupacea* Thunb. (= *F. pilosa* Reinw.).

a. subser. **Drupaceae**.—Receptacula ellipsoidea, oblonga v. pyriformi-pedicellata, bracteis basalibus plerumque conditis, apicalibus plerumque gibbosis. Lamina costis basalibus haud elongatis, cystolithis amphigenis. Typus—*F. drupacea* Thunb.

b. subser. **Indicae** Corner subser. nov.—Receptacula subglobosa v. ellipsoidea, bracteis basalibus plerumque conspicuis, apicalibus disco plano instructis. Lamina nervulis reticulatis ad paginas ambas leviter elevatis (sicco), cystolithis solum ad paginam superiorem v. nullis. Typus—*F. benghalensis* Linn.

c. subser. **Zygotricheae** Corner subser. nov.—Receptacula subglobosa, ut in subser. *Indicae*. Cystolitha amphigena. Pili brunnei copiosi, microscopice binati. Typus—*F. consociata* Bl.

The microscopically twinned hairs are characteristic of *F. con-sociata* and its close ally *F. bracteata* Wall.

d. subser. **Crassirameae** Corner subser. nov.—Receptacula sub-globosa, oblonga, v. pyriformia, ut in subser. *Indicae*. Cystolitha amphigena. Pili hyalini v. nulli, haud binati. Typus—*F. crassiramea* Miq.

B. subsect. **Dictyoneuron** Corner subsect. nov.—Lamina inter-costis subparallelis deficiens, costis primariis multo majus evolutis quam costis secundariis; cystolithis amphigenis, raro nullis. Typus—*F. sundaica* Bl. (= *F. indica* sensu King, vide infra).

1. ser. **Glaberrimae** Corner ser. nov.—Receptacula pedunculata, bracteis basalibus parvis v. nullis, ostiola non pertuso. Typus—*F. glaberrima* Bl.

2. ser. **Dubiae** Corner ser. nov.—Receptacula pedicellata, haud pedunculata, bracteis basalibus parvis v. minutis, ostiolo haud per-tuso. Typus—*F. dubia* Wall. ex King.

3. ser. **Subvalidae** (Miq.) Corner comb. nov.—*Urostigma* Gasp. ser. *Subvalida* Miq. Fl. Ind. Bat. 1, 2 (1859) 339. Fig sessile: basal bracts well-developed: apical bracts in a disc, not perforate. Typus—*F. sundaica* Bl.

This group was described under *Urostigma* Gasp. in series-form and 19 species were ascribed to it. I dispose these species as follows:—

a. subgen. *Sycomoros*:—*U. lucescens* Bl. (= *F. racemosa* Linn. var. *elongata* King);

b. subgen. *Pharmacosycea*:—*U. hasseltii* Miq. (= *F. pubinervis* Bl.);

c. subgen. *Ficus* sect. *Sycidium*:—*U. virgatum* Reinw. ex Bl. (= *F. virgata* Reinw. ex Bl.);

d. subgen. *Urostigma*:—

(i) sect. *Conosycea* Miq. subsect. *Conosycea* ser. *Drupaceae* Corner subser. *Crassirameae* Corner:—*U. crassirameum* Miq.;

(ii) sect. *Conosycea* Miq. subsect. *Dictyoneuron* Corner:—*U. sundaicum* Bl., *U. glaberrimum* Bl., *U. sumatranum* Miq., *U. binnendykii* Miq., *U. zollingerianum* Miq. (= *F. sumatrana* Miq.), *U. peracutum* Miq. (= *F. binnendykii* Miq.), *U. pseudorubrum* Miq. (= *F. sundaica* Bl.);

(iii) sect. *Conosycea* Miq. subsect. *Benjamina* Miq. ser. *Callophylleae* Corner:—*U. clusoides* Miq. (= *F. callophylla* Bl.);

(iv) sect. *Urostigma*:—*U. infectorium* sensu Miq. (= *F. virens* Ait.), *U. canaliculatum* Miq. (= *F. virens* Ait. var. *glabella* Bl.), *U. glabellum* (Bl.) Miq. (= *F. virens* Ait. var. *glabella* Bl.), *U. moritzianum* Miq. (= *F. virens* Ait. var. *glabella* Bl.), *U. timorensis* Miq. (= *F. virens* Ait.), *U. concinnum* Miq., *U. parvifolium* Miq. (= *F. concinna* Miq.).

Clearly the name should be used for one of the two larger groups d (ii) or (iv), but d (iv) is already covered by the simultaneous *Urostigma* Gasp. ser. *Caulobotrya* Miq. Therefore, I assign it to d (ii) as sect. *Conosycea* subsect. *Dictyoneuron* ser. *Subvalidae* with *F. sundaica* Bl. as the type-species.

4. ser. **Perforatae** Corner ser. nov.—Receptacula sessilia, bracteis basalibus bene evolutis, ostiolo pertuso, bracteis apicalibus parvis non in discum planum instructis. Typus—*F. pisocarpa* Bl. (= *F. microstoma* Wall. ex Miq.).

C. subsect. **Benjamina** (Miq.) Corner comb. nov.—*Urostigma* Gasp. ser. *Benjamina* Miq. Fl. Ind. Bat. 1, 2 (1859) 344.—Venation without intercostals, the secondary lateral nerves almost or quite as strongly developed as the primary. Fig sessile, rarely pedunculate or pedicellate. Type—*F. benjamina* Linn.

1. ser. **Benjamineae** Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 287.—Leaves subdistichous, thinly coriaceous, drying grey-green to light brown: nerves distinctly raised on both sides (dried): basal nerves not elongate. Type—*F. benjamina* Linn.

2. ser. **Callophyllae** Corner ser. nov.—Folia spiraliter vel subdistiche disposita, sicco fusca v. fuscobrunnea, saepe coriacea: petiolo saepe nigro: costis basalibus saepe elongatis. Typus—*F. callophylla* Bl.

sect. **Stilpnophyllum** Endl. Gen. Pl. 4, 2 (1847) 35. Typus—*F. elastica* Roxb.

sect. **Malvanthera** Corner sect. nov.—Receptacula ostiolo bilabiato vel triradiato, bracteis apicalibus internisque inflexis (haud interpositis), bracteis basalibus 2–3 saepe caducis, praedita. Flores masculi dispersi: antheris unilocularis, saepe reniformibus, aut longitudinaliter crescentiforme dehiscentibus aut transversaliter. Ovarium aut liberum basim versus rubromaculatum aut plus minus in receptaculo immersum et apicem versus rubrum: stigmatibus bifido v. simplo. Costae primariae et secundariae ut in *F. elastica* quasi aequaliter evolutae, intercostis nullis. Typus—*F. macrophylla* Desf.

This section resembles in the inflexed apical and internal bracts the African sect. *Galoglychia* (= *Bibracteatae*), but differs in the unilocular anther with two, not four, pollen-sacs. It consists of 19

species of Eastern Malaysia and Australia. I distinguish two series and four subseries.

1. ser. **Malvanthereae** Corner ser. nov.—Anthera reniformia. longitudinaliter crescentiforme dehiscentia. Typus—*F. macrophylla* Desf.

a. subser. **Eubracteatae** Corner subser. nov.—Bracteae basales 3, magnae, persistentes. Receptacula sessilia v. breviter pedunculata, ostiolo triradiato. Ovarium liberum, stigmati simplici. Typus—*F. triradiata* Corner sp. nov. (vide infra).

b. subser. **Malvanthereae**.—Bracteae basales 2 (? 3). mox caducae, magnae. Receptacula pedunculata. Ovarium in receptaculo semi-immersum, stigmati simplici v. breviter bifido. Typus—*F. macrophylla* Desf.

c. subser. **Platypodeae** Corner subser. nov.—Bracteae basales 2 v. 3, magnae, caducae. Receptacula pedunculata v. sessilia, 6–13 mm. lata (sicco). Ovarium liberum, stigmati simplici. Lamina saepe parva (2–16 × 1.5–7.5 cm.), costis secundariis saepe minus evolutis. Typus—*F. platypoda* A. Cunn. ex Miq.

d. subser. **Hesperidiiformes** Corner subser. nov.—Ut in subser. *Malvanthereae* sed bracteis basalibus 3 parvis, persistentibus. Typus—*F. hesperidiiformis* King.

2. ser. **Cyclanthereae** Corner ser. nov.—Anthera depressoglobosa, transversaliter dehiscentia. Ovarium in receptaculo semi-immersum, stigmati bifido. Receptacula magna, oblonga, bracteis 3 parvis subcaducis praedita. Typus—*F. sterrocarpa* Diels.

The stamen resembles that of *Brosimum alicastrum* Sw. and is unique in the genus.

sect. **Galoglychia** (Gasp.) Endl. Gen. Pl. 4, 2 (1847) 35.—*Galoglychia* Gasp. Parl. Giorn. Bot. 2 (1844) 217; Ann. Sci. Nat. ser. 3, 3 (1845) 346.—*Ficus* Linn. subgen. *Bibracteatae* Mildbr. et Burr. Engl. Bot. Jahrb. 46 (1912) 175.

This section was based on *F. galactophora* Ten. and *F. saussureana* DC., which are clearly African species of subgen. *Bibracteatae*, and possibly identical. In view of the great diversity of the Asiatic species of subgen. *Urostigma* and the parallel development of sect. *Malvanthera* compared with the African *Bibracteatae*, I cannot recognise this as a subgenus, and I treat the African group as a section of subgen. *Urostigma*.

sect. **Americana** Miq. Hook. Lond. J. Bot. 6 (1847) 525 (ut *Americanae*); Mildbr. et Burr. Engl. Bot. Jahrb. 46 (1912) 169.

This section is near both sect. *Urostigma* and sect. *Conosycea*, but it differs in the two, generally connate, basal bracts. The ovary has a red mark at the base and the cystoliths are generally amphigenous: thus the section is nearer to *Conosycea*. The species are entirely American.

sect. *Urostigma*

F. *superba* Miq. var. ***alongensis*** (Gagn.) Corner comb. nov.—*F. alongensis* Gagn. Lec. Notul. Syst. 4 (1927) 84.

This differs only in the small ovate-rotund lamina and short petiole, and it appears to be a xerophytic form.

F. *superba* Miq. var. ***henneana*** (Miq.) Corner comb. nov.—*F. henneana* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 216.—*F. gracilipes* Bailey, Dept. Agr. Brisb. Bot. Bull. 3 (1891) 16.—*F. parkinsoni* Hiern, J. Bot. (1901) 1.—*F. pritzelii* Warb. Fedde Rep. 1 (1905) 74. Except for the axillary position of the fig and, perhaps, the smaller leaves, I can find no distinction from *F. superba* which extends from Indo-China and Malaya along the Lesser Sunda Islands to Timor. Hence this may well be its state in Australia.

F. *concinna* Miq. var. ***subsessilis*** Corner var. nov.—*F. subpedunculata* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 217, 286 (haud 293).—Receptacula sessilia v. breviter pedunculata (0.5 mm.), bracteis basalibus caducis. N.E. India, Chekiang, Yunnan, Kwangtung.

Griffith 4589, 4590 (mixed with typical *F. concinna*); Henry 9122, 9965 (Yunnan); R. C. Ching 1917 (Chekiang, *typus*-herb. Kew.); F. A. McClure 280 (C.C.C. 64, 1961, Kwangtung); Bodinier 1027 (Macao).

At first perplexing, it is soon seen that, if there were a normal peduncle, these collections would belong to *F. concinna*. Ching 1917, McClure 280, and Bodinier 1027 are var. *concinna* with almost sessile fig. Griffith 4590 is the type of *F. subpedunculata* Miq.: it has sessile figs at Leiden, but normally pedunculate figs at Kew. Henry 9122 and 9965, as well as the Leiden specimen of Griffith 4590, have more coriaceous leaves with the veins not or scarcely raised above, and the lateral nerves at a wider angle. Henry 9122 has, also, a rounded to subcordate base to the lamina and approaches *F. cardiophylla* Merr. (fewer costas, longer basal nerves).

F. *virens* Ait. Hort. Kew. 3 (1789) 451.—*F. infectoria* Willd. sensu Roxb. Fl. Ind. 3 (1832) 551.—*Urostigma infectorium* Miq. Zoll. Syst. Verz. (1854) 90.—*F. infectoria* (Miq.) Miq. Ann.

Mus. Bot. Lugd. Bat. 3 (1867) 264, 286; King, Ann. R. Bot. Gard. Calc. 1 (1887) 60, pl. 75.—*F. lacur* auct., non vera.—This is the earliest name for the common banyan of India which has the articulate lamina, and which extends through Malaysia to Australia (*F. cunninghamii*) and to South Africa as the complex of *F. ingens* Miq. *F. virens* was based on a plant grown at Kew, of which there is a sterile specimen (the type) at the British Museum. This specimen is labelled *F. virens* Ait. in pencil and is one of a complete set of named specimens representing exactly those described by Aiton: hence there is no doubt of its validity. But Aiton referred it to the West Indies, evidently in the belief that it represented the plant figured as "Sloane Jam. 2 p. 140 t. 223" which is quoted after the description. The reference to Sloane's plant is, however, erroneous. Thus this name has been overlooked by students of Asiatic botany.

F. virens Ait. var. **sublanceolata** (Miq.) Corner comb. nov.—*F. saxophila* Bl. var. *sublanceolata* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 260.—*F. caulobotrya* (Miq.) Miq. var. *fraseri* Miq. id. 287.—*F. virens* has numerous leaf-forms, to which varietal names may be given, when they are better known, but I find so much variation in herbarium-material, even on the same specimen, that I have been unable to recognise any such categories. However, two varieties can usefully be distinguished on the fig, whether pedunculate or sessile. As the type of *F. virens* is a sterile sapling and there is no mention of the fig in the original description, it is necessary to adopt the earliest varietal name, but Miquel published simultaneously (1867) names for each variety. *F. infectoria* (Miq.) Miq. var. *aegeiophylla* (Miq.) Miq. refers to the pedunculate fig. while *F. saxophila* Bl. var. *sublanceolata* Miq. and *F. caulobotrya* (Miq.) Miq. var. *fraseri* (Miq.) Miq. refer to the sessile fig. I propose to use the name var. *sublanceolata* Miq. for the sessile fig, and thus to take var. *virens* as representing the pedunculate fig. The decision is arbitrary, for both kinds occur in India and neighbouring countries, from whence the Kew-plant must have come.

F. virens Ait. var. **glabella** (Bl.) Corner comb. nov.—*F. glabella* Bl. Bijdr. (1825) 452.—This is the state with elliptic to obovate lamina, cuneate leaf-base, shorter petiole, and more or less sessile figs on short woody burrs on the twigs behind the leaves. It is the common state of the species in the rain-forests of Sundaland from lower Thailand and Sumatra to Borneo, where var.

virens and var. *sublanceolata* rarely occur and, then, chiefly on headlands and dry places. At the periphery of its range it grades into var. *sublanceolata*. Hence I cannot maintain it as a species.

F. caulocarpa Miq. var. **dasycarpa** Corner var. nov.—*F. argentea* Blanco sensu Merrill, Sp. Blanc. (1918) 129; Philip. J. Sci. 20 (1922) 368; Sata, Monogr. Ficus (1944) 216.—Receptacula et pedunculi dense albo-villosi: bracteis basalibus 1–1.5 mm. longis, glabris. Philippines (Luzon, Mindoro).

Bur. Sci. 39732 (Mindoro, Paluan); PNH 4788 (Luzon, Zambales prov., Mt. Pinatubo, *typus*—Manila).

This was identified by Merrill as *F. argentea* Blanco, which is a thoroughly dubious species, Merrill having first suggested that it was *F. ruficaulis* Merr. Neither fits Blanco's description.

F. prolixa Forst. f. var. **subcordata** Corner var. nov.—Lamina ovato-elliptica, ad basin cordata, subcordata, v. late cuneata. —15 × 8 cm.: nervis primariis utrinsecus 5–8, basalibus elongatis 4–1/3 laminae: petiolo plus minus appanato. Ins. Caroline, Mariannas, Fanning.

Caroline Isl.—Fosberg 25479, E.Y. Hosaka 3231, (Ulithi Atoll). Mariannas—Fosberg 24972, 25004, 25112, (Rota); Fosberg 24731, 24758, Hosaka 2862, (Tinian); Fosberg 25221, 31278, 31791, Hosaka 2962, (Saipan); Anderson 123, 192, Fosberg 25302, 25331, 32620, 35333 (*typus*), 35515, 35518, 35630, 35631, (Guam); Fosberg 31684 (Alamagan); Anderson 508, 521, Fosberg 31392, (Pagan). Fanning—J.T. Arundel 14 (sterile, herb. Kew.).

This has the scattered male flowers of *F. prolixa*, though the more or less cordate leaf suggests *F. virens*. It is possible that the two species intergrade in the Carolines, where some collections (as Fosberg 25479) have so few scattered male flowers that the distinction seems trivial. Specimens with ovate-cordate leaves have not been recorded from the main range of *F. prolixa* in Polynesia.

F. hookeriana Corner nom. nov.—*F. hookeri* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 215, 286 (non Sweet, 1827).—This belongs in ser. *Orthoneuræ*.

F. caulobotrya Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 287.—*Urostigma caulobotryum* Miq. Hook. Lond. J. Bot. 6 (1847) 568.—This is a mixture of leaves of *F. tsjahela* Burm. f. and figs of *F. arnottiana* Miq. Such is the state of the type-number (Wight 26) at Utrecht, Leiden, and Edinburgh (three sheets). It is clearly a *mixtum compositum* of mounting the material, and the name can be dismissed.

sect. *Conosycea* (Miq.) Corner subsect.

Conosycea ser. *Validae* Miq.

F. arnottiana Miq. var. *subcostata* Corner v. nov.—Lamina sub-
acuta vel obtusa. Receptacula 10 mm. lata, maturitate rubra:
pedunculo 5–8 mm. longo. Cuticula circum stomata plicato-
striata. Himalaya.

Duthie 23939 (Gahrwal); Gamble 23030 (Jehree); Polunin,
Sykes, et Williams 4145 (Nepal, Melcham, c. 7000 ped. alt.,
typus—herb. Br. Mus.).

This has the larger fig and more striate leaf-cuticle of *F. costata*
Ait. (v. *infra*), but the ovate-cordate lamina with few lateral ner-
ves, prominent basal nerves, and long petiole of *F. arnottiana*. It
lies outside the geographical range of both and, as an intermediate,
needs further study. Compare, also, *F. glaberrima* Bl. var. *siamen-
sis* Corner (v. *infra*).

F. costata Ait. Hort Kew. 3 (1789) 452.—*F. venusta* Kth. et
Bouch. Ind. Sem. Hort. Berol. (1846) 16.—*F. caudiculata*
Trim. J. Bot. 23 (1885) 243.—*F. mooniana* King, Ann. R. Bot.
Gard. Calc. 1 (1887) 57, pl. 69.—*Urostigma wightianum* Miq.
var. *majus* Thw. En. Pl. Ceyl. (1864) 265.

F. costata was said to come from the East Indies, and, according
to Index Kewensis, from the Nicobar Islands. No such plant has
since been recorded from the Nicobars, and I find that the type at
the British Museum agrees in leaf, venation, and microscopic
structure with *F. caudiculata* and *F. mooniana* of Ceylon. The type
is clearly a sapling with large leaves and is sterile. There is also a
specimen in the Herb. Martyn (Cambridge University Herbarium)
named *F. costata* which agrees so well with the type that it may
have come from the same plant cultivated at Kew. The cystoliths
only on the upperside of the lamina, the plicate cuticle, and the
upper hypodermal layer are distinctive microscopic characters in
the Asiatic species of this alliance. *F. venusta* was said to have
come from Cuba, but no such leaf has been found again in the
Cuban flora and the type-specimen at Berlin agrees exactly with
the specimen of *F. costata* at Cambridge.

There is some discrepancy, however, in the length of the petiole.
In the type of *F. costata* the petiole is long, up to 9 cm., and the
lamina is ovate-cordate to elliptic with subcordate base. The spe-
cimen in Herb. Martyn has the elliptic lamina with subcordate
base but shorter petiole 1.2–5.5 cm. long. In *F. caudiculata* the
lamina is elliptic with narrowly subcordate to cuneate base and
short petiole 1.3–3 cm. long. But a specimen from Indo-China
(Ch. d'Alleizette, environs de Tourane, 2.vi.09), which I cannot in

any way distinguish from *F. caudiculata*, has the petiole —7 cm. long. Further, King's plate of *F. mooniana* shows a petiole intermediate between the short petiole of *F. caudiculata* and the longer petiole. Hence I assume that the long petiole and ovate-cordate leaf must be the sapling form, which reduces to the elliptic leaf with subcordate to cuneate base and short petiole on the upper twigs of mature trees.

F. depressa Bl. Cat. Gewass. Buitzg. (1823) 35; Bijdr. (1825) 450.—*F. pruniformis* Bl. Bijdr. (1825) 451.—Blume confused this originally with specimens of *F. magnoliifolia* Bl., several sheets of which are named *F. depressa* in Blume's hand at Leiden. In 1825, he divided *F. depressa* into *F. pruniformis* Bl. and *F. magnoliifolia* Bl. without explanation. I reserve the name *F. depressa* in the sense of *F. pruniformis*. The type-sheets of all three species are well-preserved at Leiden, and that of *F. pruniformis* is identical with the lectotype of *F. depressa*.

F. globosa Bl. Bijdr. (1825) 449.—*Urostigma onustum* Miq., Hook Lond. J. Bot. 6 (1847) 575.—*F. onusta* Wall. ex Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 285.—The type-sheet in Herb. Hook at Kew consists of (a) two leaves and a twig with two figs of *F. pisocarpa* Bl. (= *F. microstoma* Wall. ex King), and (b) five leaves with two figs of *F. globosa* Bl. The sheet in the Wallich-herbarium at Kew is entirely *F. globosa* Bl. W. B. Hemsley wrote on the sheet in Herb. Hook. that Miquel's description corresponded with the *F. pisocarpa*-element. On studying Miquel's description, however, it is clear to me that he described the leaves of *F. globosa* and the figs of *F. pisocarpa*. Thus the species is a mixture, and I assign it to *F. globosa*.

sect. *Conosycea* (Miq.) Corner subsect. *Conosycea* ser.

Drupaceae Corner

F. drupacea Thunb. Diss. Ficus (1786) 6, 11.—*F. pilosa* Reinw. ex Bl. Bijdr. (1825) 446.—Examination of Thunberg's type has shown that this is the well-known *F. pilosa* from Java.

var. **auranticarpa** (Elm.) Corner comb. nov.—*F. auranticarpa* Elm. Leaf. Philip. Bot. 9 (1937) 3454.—Bracteis basalibus glabris 2–3 × 3–5 mm., non conditis. Luzon (Elmer 17186, typus). Celebes (Beccari s.n., Kandari: R. Ist. Fir. 9347, 9347A).

var. **glabrata** Corner v. nov.—Stipulae et nodi ultimi brunneo-pilosae, praeterea glabra. Bracteae basales 0.5–1 mm. longae, crescentiformes, margine ciliolato. Setae internae nullae v. sparsae. Malaysia, Ins. Solomon.

Kangeen Archipelago:—Backer 167, 26956, 27147, 29766 (det. *F. altissima*). Sumbawa:—Herb. Lugd. Bat. 293 (det. *F. annulata*). Soemba:—Iboet 103, 280 (det. *F. altissima*). Flores:—Elbert 4320. Alor:—O. Jaag 767, 892. Timor Laut:—Forbes 3371 (typus, herb. Br. Mus.). Solomon Isl.:—Guppy 116 (Shortland Isl.).

Glabrescent forms of var. *drupacea* have persistently brown hairy basal bracts.

var. **pedicellata** Corner v. nov.—Ut var. *glabrata* sed receptacula super bracteas basales pedicello 3–4 mm. longo praedita: setis internis brunneis, –1 mm. longis, copiosis. Nova Guinea (NGF 8557, Western Highlands, Jimmi Valley, Tagan River, 2400 ped. alt., typus herb. Lae).

F. cordatulae Merr. proximans.

var. **pubescens** (Roth) Corner comb. nov.—*F. mysorensis* Heyne ex Roth, et var. *pubescens* Roth, in Roehm. et Schult. Syst. Veg. 1 (1817) 508.—I cannot distinguish *F. mysorensis* from the large and varied complex of *F. drupacea*.

F. cucurbitina King var. **eubracteata** Corner v. nov.—Bracteae basales 5–7 × 10–13 mm., conspicuae, obtusae, glabrae v. marginibus ciliolatis. Ins. Philippines (PNH 14352, Samar, Catarman, Mt. Cansayo, typus herb. Manila).

In v. *cucurbitina* bracteae basales pusillae, 0.3–1 mm. longae, sub receptaculo conditae.

F. cordatula Merr. var. **sericea** (C. B. Robinson) Corner comb. nov.—*F. sericea* C. B. Robinson, Philip. J. Sci. Bot. 6 (1911) 319.—This is merely a form of *F. cordatula* with villous or tomentose twigs, stipules, and receptacles.

sect. **Conosycea** (Miq.) Corner subsect. **Conosycea**
ser. **Indicae** Corner

F. benghalensis Linn. Sp. Pl. (1753) 1059; C. Hegard, Amoen. Acad. 1 (1749) 217; Miquel, Hook. Lond. J. Bot. 6 (1847) 571, 572; King, Ann. R. Bot. Gard. Calc. 1 (1887) 18, 19.—*F. indica* Linn. Sp. Pl. (1753) 1060; emend. Lamarck, Enc. Bot. 2, pt. 2 (1788) 494; Smith, Rees Cycl. 14 (1810) n.41; Roxburgh, Hort. Beng. (1814) 65; B. Hamilton, Tr. Linn. Soc. 13 (1822) 489; non sensu King, Ann. R. Bot. Gard. Calc. 1 (1887) 38, 40.—*F. cotoneaeifolia* Vahl, En. Pl. 2 (1806) 189; non sensu Alston, The Kandy Flora (1938) 34.—*F. cotonifolia* Stokes, Bot. Mat. Med. 4 (1812) 355.—I have reduced *F. indica* Linn. to *F. benghalensis* Linn. because, as shown below.

they are synonymous. Roxburgh and Buchanan Hamilton long ago advised the converse, but their advice has never been accepted and to reinforce it now in view of the general agreement about *F. benghalensis* and the long current misuse of *F. indica* sensu King would be confusing. For this species, *F. indica* sensu King, I have substituted *F. sundaica* Bl. (v. *infra*).

The name *F. indica* comes from the great Indian banyan of ancient and mediaeval reference, namely "Ficus indica Theophrasti" (Tabern., Hist. p. 1370) and "Ficus indica foliis mali cotoneae . . ." (Bauhin, Pinax, p. 457). All this is explained by Cornelius Hegard. It can refer only to the species known as *F. benghalensis*, which is based on Rheede's description and illustration (Hort. Mal. 1, t.28, "Peralu"). Unfortunately, the poor wood-cuts of Clusius, Tabernaemontanus, and Bauhin, which showed a pointed and narrower leaf, lead the early botanists to suppose in their ignorance that there were two species of such great banyan in India, and the name *F. indica* Linn. was given to this fiction. Linneus believed that the banyan figured as "Katou-alou" by Rheede (Hort. Mal. 3, t. 57) represented this *F. indica* and cited it as well. King has shown, however, that Katou-alou is *F. mysorensis* Heyne, which I call *F. drupacea* Thunb. var. *pubescens* (Roth Corner (v. *supra*)). Thus, the bad woodcut and the mis-reference of Katou-alou fostered the belief in two great Indian banyans.

Then, as *F. indica* var. β , Linneus (1753) gave "Tsiela" (Rheede, Hort. Mal. 3, t. 63) and references to American plants. In 1763 (Sp. Pl. ed. 2, 1514-1515), he added to var. β the "Varinga latifolia" of Rumphius (Herb. Amb. 3, t. 84). Lamarck perceived the error of including var. β under *F. indica*, and excluded it, thereby definitely emending *F. indica* as consisting of

- (i) the references to Bauhin, Tournefort, Clusius, and Tabernaemontanus (= *F. benghalensis* Linn.),
- (ii) Katou-alou of Rheede (= *F. mysorensis* Heyne),
- (iii) Madagascan collections (? identification),
- (iv) *F. vasta* Forsk.,
- (v) A plant grown at Paris in the "Jardin du Roi" (which, according to the specimen in the Lamarckian herbarium, is *F. tsiela* Roxb.).

Of these five components, the first and second are elements of the original circumscription, but the second has since been excluded as *F. mysorensis*; the others must be excluded as erroneous. Hence one is back at the original definition which is to be identified with *F. benghalensis*. This was the opinion of King, but

he endeavoured to maintain the name for "Varinga latifolia" of Rumphius, though this was not part of the original circumscription and was definitely excluded by Lamarck. King's use is further complicated by his attempt to identify this *Varinga latifolia*.

The species, described and figured by King as *F. indica*, is a common strangling fig spread from Assam to Borneo. It does not occur in central India and it does not develop pillar-roots, as the great Indian banyan does, and hence it cannot be the *F. indica* of history. It does not occur, too, in the Moluccas, so it cannot be the "Varinga latifolia". Further, Rumphius described the fig as ellipsoid, which Lamarck noted, and which lead Merrill (Interpr. Rumphius Herb. Amb., p. 194) to identify "Varinga latifolia" with *F. gelderi* Miq. or *F. altissima* Bl., though neither of these occur in the Moluccas. Personally, I think that "Varinga latifolia" is the glabrescent state of *F. drupacea* Thunb. (*F. pilosa* Reinw.) which is common in the Moluccas, where Rumphius could hardly have missed it. Miquel had already given various names to the plant intended by King as *F. indica*, but the earliest name that I can find is *F. sundaica* Bl.

F. cotoneaeifolia Vahl seems to have been intended as a new name for *F. indica* Lam., which is really *F. indica* Linn. emend. Lam., but the name was treated by King as a new species and so used by Alston. I base my conclusion on these considerations:—

- (i) Vahl saw no specimen,
- (ii) He cited merely the Asiatic references given for *F. indica* and var. β by Linneus in 1763, which are the Lamarckian references,
- (iii) He cited Lamarck's emendation of *F. indica*,
- (iv) He described *F. indica* Linn. six pages later (p. 195), basing his interpretation of it on the Linnean var. β , as shown by the citation of "Tsiela" of Rheede, "Varinga latifolia" of Rumphius,
- (v) He seems to have been thoroughly confused for he also cited "Varinga latifolia" under *F. cotoneaeifolia*.

Smith (1810) promptly recognised *F. cotoneaeifolia* as superfluous and reduced it to *F. indica* Linn. In contrast, King interpreted *F. cotoneaeifolia* by reference to "Katou-alou" of Rheede, which he showed to be *F. mysorensis*, and Alston substituted *F. cotoneaeifolia* for *F. mysorensis*. There is, however, no evidence that "Katou-alou" was an essential part of the original circumscriptions of Linneus, Lamarck, or Vahl. Certainly they did not describe *F. mysorensis*. Further, as the specific epithet *indica* came from the early pre-Linnean authors, so *cotoneaeifolia* clearly came

from Bauhin's "*Ficus indica foliis mali cotoneae . . .*" I conclude the Smith was right and that Katou-alou was merely an erroneous reference. A specimens in Vahl's herbarium is named "*F. ? cotoneaeifolia Vahl*", but it is *F. tsiela* Roxb., which was also cited by Vahl under *F. cotoneaeifolia* as "*Tsiela*" of Rheede. Lamarck, also, cited *Tsiela* under *F. indica*. This does not mean that they interpreted their species on *Tsiela*, but that they did not understand the banyans of India and tried to fit the species known to Rheede into the erroneous concept of *F. indica*.

F. pubilimba Merr. var. **ovata** Corner v. nov.—Glabra. Lamina 6–12 × 4–9.5 cm., ovata, breviter et obtuse subacuminata, basi cordato vel rotundato-subtruncato; costis basalibus 1/3–½ laminae elongatis. Malaya (Waterfall Gardens, Penang, leg. Flippance Oct. 1932, typus herb. Singapore).

This is known only from a single tree, still thriving, in the Penang Waterfall Gardens. The Province Wellesley Fig (Corner, *Wayside Trees of Malaya*, p. 680) is typical *F. pubilimba* Merr., which has the more or less elliptic leaf with cuneate base.

sect. Conosycea (Miq.) Corner subsect. **Conosycea**
ser. Crassirameae Corner

F. stupenda Miq. var. **minor** Corner v. nov.—Ramuli 7–10 mm. crassi. Lamina 8–24 × 6–10.5 cm., basim versus rotundata v. late cuneata. Receptacula 30 × 22 mm., oblongo-ellipsoidea, bracteis apicalibus in discum planum 5 mm. latum instructis: bracteis basalibus 5–10 × 10–14 mm., obtusis. Flores minores, masculi 2–6 mm. longi. Johore, Singapore, Brunei, North Borneo.

Singapore:—Kelsall s.n., Chan Chu Kang, Nov. 1889; Good-enough 3399, Bukit Timah, Nov. 1887 (typus, herb. Singapore). Johore:—Sing. F.n. 37027, Mawai-Jemaluang Road, 17th mile, May 1940. Brunei:—Brun. 5325, Ulu Belalong. North Borneo:—Clemens 27132, Tenompok (ut *Artocarpus*); Elmer 21054, Tawao; For. Dept. A4712, Kinabatangan, Bt. Garam.

F. crassirameae Miq. proximans sed bracteis basalibus brevioribus et vix induratis.

F. crassiramea Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 286.—*Urostigma crassirameum* Miq. Pl. Jungh. (1851) 48.—*F. procera* Bl. var. *crassiramea* (Miq.) King, Ann. R. Bot. Gard. Calc. 1 (1887) 36, pl. 41.—*F. procera* auct., non vera.—As explained under *F. subsecta* Corner, *F. procera* Bl. has been mistakenly identified with *F. crassiramea* Miq., which is common and widely distributed in Malaysia.

var. **brevicupulata** Corner v. nov.—Receptacula 16–19 × 13–15 mm., subcylindrica, bracteis apicalibus in discum planum 4–5 mm. latum instructis; bracteis basalibus 5–7 × 7–12 mm., crassis, subcupulatis. Celebes, Obi.

Celebes:—Kjellberg 1300, Poehara, Moeara Sampara; 2245, Tabaramo. Obi:—Exp. v. Hulstyn 111 (typus, herb. Leiden).

var. **celebica** Corner v. nov.—Receptacula 27–28 × 20 mm., subcylindrica, bracteis basalibus 15–18 mm. longi. Celebes (Minahassa, Koorders 19126, 19160, et 19334, typus herb. Leiden).

var. **clementis** (Merr.) Corner comb. nov.—*F. clementis* Merr. Philip. J. Sci. Bot. 3 (1908) 130.—Receptacula 15–22 × 12–17 mm., bracteis basalibus 8–14 mm. longis. Ins. Philippine.

Clemens 421, 703 (typus); Elmer 10952; Merrill 1935; Bur. Sci. 19495; PNH 1985; Coll. Agr. Laguna 513, 547.

var. **patellifera** (Warb.) Corner comb. nov.—*F. patellifera* Warb. in K. Schum. et Laut. Nachtr. Fl. Schutzgeb. (1905) 241.—Receptacula 12–14 mm. lata, subglobosa, bracteis apicalibus in discum planum 3 mm. latum instructis; bracteis basalibus 5–8 × 10–15 mm. Nova Guinea.

Schlechter 14161, Ranu coast (typus, herb. Berlin); Kanehira et Hatusima 12838, Nabire, Neth. New Guinea; Brass 3857, Terr. N. Guinea, Central Div., Ononge Road, Dieni; Brass 24182, Milne Bay, Peria Creek; Brass 28085, Sudest Island, Rambuso; NGF 1723, Lae.

F. forstenii Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 214, 285.—

F. palawanensis Merr. Govt. Lab. Publ. Philip. 29 (1905) 11.

var. **pacifica** (Elm.) Corner comb. nov.—*F. pacifica* Elm. Leaf. Philip. Bot. 9 (1937) 3460.

Lamina elliptico-obovata, breviter subacuminata, basi cuneato; costis basalibus $1/3$ – $1/2$ laminae elongatis. Malaya, Ins. Philippine.

Malaya:—King's Collector 6376 (Perak, Larut). Philippines:—Elmer 7460, 9370, 14463, 16401; Merrill 4032; Wenzel 3022; Bur. Sci. 26345, 76378; PNH 2050, 3673, 9066. (Elmer 14463, 16401, syntypes).

var. **umbobracteata** (Elm.) Corner comb. nov.—*F. umbobracteata* Elm. Leaf. Philip. Bot. 4 (1911) 1247.—Receptacula 25–32 × 18–22 mm., bracteis apicalibus gibbosis, bracteis basalibus 7–9 mm. longis. Mindanao (Elmer 11956 typus, 14117).

var. **villosa** Corner v. nov.—Ramuli, stipulae, petioli, laminae pagina inferior, bracteaque basales pilis erectis (0.5 mm. longis) villosi. Receptacula 20–22 × 18–20 mm., bracteis basalibus 8–11 × 9–12 mm. Malaya, Borneo.

Malaya:—Corner s.n. Perak, Kroh, July 1936. Borneo:—Endert 3344, W. Koetai, pr. L. Petah (typus, herb. Leiden); For. Dept. B.N.B. A1073, Elopura, Sandakan; A3498, Lahad Datu, Kertam Kechil River; Sing. F.n. 19235, Banguay Isl.

F. subsecta Corner nom. nov.—*F. procera* Bl. Bijdr. (1825) 445, non Salisb. (1796).—*F. procera* Bl. has been consistently misidentified with *F. crassiramea* Miq. since King's monograph. Dried leaves of *F. procera* never show the characteristic shallow pitting of the areolae on the underside of the lamina as occurs in *F. crassiramea*, and there are constant differences in fig and venation. Blume's type is well-preserved at Leiden.

var. **depressa** Corner v. nov.—Receptacula 13–14 × 17–19 mm., depresso-globosa. Sumatra (Bünnemeyer 9089, G. Koerintji, typus herb. Leiden).

F. subgelderi Corner sp. nov.—Corner, Wayside Trees, Malaya (1940) pl. 208 (ut *F. indica*).—Arbor magna, epiphytica, suffocans, radicibus columnaribus deficientibus; cortice albido-griseo; foliis subdistichis. Ramuli, petioli, stipulae, bractee basales, et costae paginae inferioris pilis erectis brevibus sparsim puberuli v. subvillosi. Ramuli 3–5 mm. crassi. Lamina 4–16 × 1.5–7 cm., anguste obovata v. elliptica, acuminata, basi cuneato, rigide coriacea: costis lateralibus utrinsecus 3–6 (–7), intercostis 2–3 vix bene evolutis, subtus elevatis: costis basalibus utrinsecus 1, 1/3–1/2 laminae elongatis: petiole 5–32 mm. longo. Receptacula axillaria, binata, sessilia, maturitate e flava rubescencia, 13–16 × 10.5–13 mm., ellipsoidea v. breviter oblonga, bracteis apicalibus 2–3 in discum planum 3 mm. latum instructis: bracteis basalibus 6–7.5 × 7–8.5 late ovatis, obtusis, puberulis v. subtomentosis: setis internis nullis. Tepala 2 (mascula), 3 (feminea), libera, in floribus masculis et cecidiphoris valde indurata. Flores masculi sessilia v. breviter pedicellata: anthero angusto, valde exserto. Stomata superficialia. Malaya, Borneo.

var. **subgelderi**.

Malaya:—King's Coll. s.n., Perak; For. Dept. 12712, Ampang Reserve, Selangor; Derry 1211, Nyalas, Malacca; Kepong F. n. 71309, Kluang, Johore; Ridley s.n., Sept. 1890, et 5621, Bukit Timah, Singapore; Sing. F. n. 29224 (typus, herb. Singapore) et Ridley s.n., June 1898, Government Hill, Singapore.

Borneo:—Bur. Sci. (Manila) 1989, Sarawak; Brunei 226, S. Belait; H. Low s.n., 1867, Labuan (herb. Beccari, R.Ist. Fir.

9150A); For. Dept. B.N.B. 2323, Sandakan; Whitmore 583, Kalabakan, W. Tawao; Kostermans 4179, Balikpapan, S. Wain, et 6616, Samarinda, L. Djanan.

F. pellucido-punctatae Griff. (*F. gelderi* Miq) et *F. sundaicae* Bl. (*F. indica* auct.) persimilis sed ostiolo non pertuso, intercostis transversis satis distincta.

var. **rigida** Corner v. nov.—*Urostigma rigidum* Miq. Hook. Lond. J. Bot. 6 (1847) 578.—*F. rigida* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 286, non Jack (1822).—Folia spiraliter disposita. Glabra v. stipulae bracteaeque puberulae. Lamina 8–20 × 3–8 cm., basi subcordato v. cuneato: intercostis 3–8. Receptacula 10–14 mm. lata, globosa, plus minus depressa, disco plano 5 mm. lato praedita; bracteis basalibus 5–6 × 4–5 mm., v. 6–8 × 8–9 mm. Tepala vix indurata. Flores masculi bene pedicellati. Cambodia, Cochinchina, Thailand, Malaya, Sumatra, Java, Borneo.

Cambodia:—Poilane 14769, Nord Kampat. Cochinchina:—Fleury 29911, Mt. de Nui Chua Chang, prov. Bienhou; Poilane 21309, km. 58 route col. n. 20, prov. Bienhou; Poilane 21513, Dinh Quan, km. 46 route col. n. 20, prov. Bienhou. Thailand:—Kerr 2743, Ban Pe, Ragawang; Kerr 16558, Kawchang, Ranaung; Kerr 17440. Talang, Puket; J. Schmidt 140, Koh Chang (det. *F. consociata*); RFD 6232, Kaw Kut, Trat. Malaya:—Hb. Hook, Penang (typus *F. rigidae* Miq, et var. *rigidae* Corner); Philips s.n., 1824, Penang; Scortechini 194b, Perak; Wray 2530, Perak; Sing. F.N. 22344, Pahang; Sing. F.n. 23899, 30791, Sedili River, Johore; Wallich 4570E, Singapore (ut *F. longifolia* Ham. ined.). Sumatra:—Buwalda 6483, 6766, Indragiri; Grasshof 147, Lematang Oeloe; NIFS bb 22450; ?Teysmann 727, Batang Baroes. Java:—Koorders 9179, 9380, 20669, 23090, 24612, 38480, 38773, 38811, 39384; Forbes 530; Jacobs 4818; Bakh. v.d. Brink 6063; Korthals 39. Borneo:—Hewitt 6, Kuching.

F. paracamptophylla Corner sp. nov.—Valde scandens, foliis spiraliter dispositis, radicibus gracilibus pendentibus subsparsis, trunco 4 cm. crasso, haud suffocans. Glabra v. petiolo et laminae pagina inferiori puberula. Ramuli 5–9 mm. crassi. Stipulae 10–80 × 9–20 mm., brunnescentes, oblongo-lanceolatae, persistentes. Lamina 10–26 × 3.5–9.5 cm., oblongo-elliptica, subacuminata v. breviter et acute acuminata, ad basim subcordata v. cuneato-rotundata, valde coriacea: costis lateralibus utrinsecus 6–9, subtus vix elevatis, intercostis 1–4, saepe subscalariformibus: costis basalibus utrinsecus 1 (–3), $\frac{1}{4}$ – $\frac{1}{2}$ laminae elongatis: petiolo 15–30 × 3–6 mm., sicco fusco-brunneo. Receptacula axillaria, sessilia, binata, 13–16 × 13–17 mm.

(vivo, 20–25 mm.), ellipsoidea v. subconica, bracteis apicalibus 3 in discum planum 3–5 mm. latum, haud perforatum, instructis: bracteis basalibus 4–7 \times 5–9 mm., obtusis v. subacutis, appresse puberulis. Flores masculi copiosi, tepalis 2. Flores cecidiophori pedicellati, tepalis 2–3; feminei sessiles, tepalis 3. Borneo, in silvis inter arbores insinuans, haud rara.

F. acamptophyllum Miq. simulans sed major, stipulis non caducis, receptaculi apice non pertuso.

Anderson 9092, Sarawak, Bau, Seburan, et 9103, Semengoh Forest (typus, herb. Kuching); Corner s.n. Sarawak, Bako National Park; Brunei 5323, Ulu Temburong; Kostermans 4027, Balik Papan; Main (Exp. Polak) 2119, Indonesian Borneo, Pulow, Kudala tas Djonkong; Nieuwenhuis 1425, Indonesian Borneo, Bloe-oe; Sinclair 9352, Sandakan, Sepilok Forest.

sect. *Conosycea* (Miq.) Corner subsect. *Dictyoneuron* Corner ser. *Glaberrimae* Corner

F. glaberrima Bl. var. *bracteata* Corner v. nov.—*F. travancorica* King, Ann. R. Bot. Gard. Calc. 1 (1887) 28.—*F. lawesii* King, J. As. Soc. Beng. 55 (1887) 403.—*F. adamii* Elm. Leaf. Philip. Bot. 4 (1911) 1258 (ut *F. adamsii* laps. cal.).—*F. villamilii* Merr. ex Sata, Monogr. (1944) 183.—Bractee basales (ad apicem pedunculi) 0.5–1.5 mm. longae, crescentiformes: bractee apicales saepe incrassatae. Flores cecidiophori plerumque sessiles. India, Borneo, Philippines (Luzon, Mindanao), Nova Guinea.

India:—Barber 6006, Anamalais; Beddome 7509, Travancore. Borneo:—Kostermans 4918, E. Koetai, Sangkulirang Isl.; Purseglove 5183, Sarawak, S. Mayeng, Tau range. Philippines:—Bur. Sci. 22821, 28100; Elmer 11177, 14029, 18284; For. Bur. 26361; PNH 9480, 10623; Coll. Agr. Laguna 510. New Guinea:—Aet et Idjan 738, 843, Jappen-Biak; Docters v. Leeuwen 10055, Rouffaer River; Forber 85, Sogeri; Hoogland 3748, Terr. N. Guinea, Northern Div., Garara, Popondetta-Cape Killerton Road (typus, herb. Lae); Hoogland 4634, North Div., Tufi subdistr., Budi; NGF 5216, 7423, Morobe, Bulolo; NGF 9067, Lae.

Var. *glaberrima* has no basal bracts. The so-called figs of *F. lawesii* (Forbes 85) are abnormal galls.

var. *siamensis* Corner v. nov.—Lamina 5–9.5 \times 3–7.5 cm., late elliptica, breviter acuminata, basi rotundato v. subcordato: costis lateralibus utrinsecus 5–9, intercostis 1–4 vix distinctis: costis basalibus haud elongatis: petiolo 10–30 mm. longo. Receptacula 8

mm. lata, peduculo 10–15 mm. longo: bracteis basalibus 3, 1–2 mm. longis, obovatis, subacutis, caducis: bracteis apicalibus parvis, gibbosis. Cuticula circum stomata et cystolitha plicato-striata. Thailand, in collibus calcareis.

Kerr 2428, Hin Hap, Saraburi (typus, herb. Br. Mus.); Kerr 3021, Kao Sung, Paknampo; Kerr 9756, Krabin, Kao Sakan; Nielsen 651, Koh Sichang.

This needs more collection because it may be a new species. It relates *F. arnottiana*, *F. costata*, and *F. glaberrima*. It has the short basal nerves, short petiole, and the fig of *F. glaberrima*, but the apical bracts, the caducous basal bracts, the rounded subcordate leaf-base, the tendency to intercostal veining, and the striate cuticle of *F. arnottiana*. From *F. costata* it differs in the short lamina with few lateral nerves and intercostals, the small fig with caducous basal bracts, and the less plicate cuticle. The three species suggest an ancient complex of the Asiatic mainland.

sect. *Conosycea* (Miq.) Corner subsect. *Dictyoneuron* Corner
ser. *Validae* (Miq.) Corner

F. sundaica Bl. Bijdr. (1825) 450.—*F. indica* sensu King, Ann. R. Bot. Gard. Calc. 1 (1887) 39, pl. 45.—This is, as King suggested, the same as the species for which he sought to maintain the name *F. indica* Linn. (see *F. benghalensis*, above). Blume's specimen is sterile but the venation and sunken stomata leave no doubt: further, this common *Ficus* is not represented among others of his from Java.

var. **beccariana** (King) Corner comb. nov.—*F. korthalsii* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 215, 286.—*F. korthalsii* Miq. var. *beccariana* King, Ann. R. Bot. Gard. Calc. 1 (1887) 23, pl. 35A.—This variety is distinguished by the oblong or obovoid fig with more unbonate disc of apical bracts. It often has a shorter leaf and, when sterile, may be impossible to distinguish from *F. pellucido-punctata* Griff (v. *infra*). Intermediates with v. *sundaica* occur.

F. lowii King var. **borneensis** Corner v. nov.—Receptacula minora, 13–14 mm. lata, haud umbonata, bracteis apicalibus in discum planum 3 mm. latum instructis. Lamina minus coriacea, costis ad paginas ambas leviter elevatis, costis basalibus $\frac{1}{4}$ – $\frac{1}{3}$ laminae elongatis. Glabra. Borneo (Kostermans 9758, G. Mentawir, Balik Papan; typus, herb. Bogor).

var. **minor** Corner v. nov.—Receptacula 10 mm. lata, haud umbonata, bracteis apicalibus in discum planum 3 mm. latum instructis. Ramuli et stipulae pubescentes. Lamina rigide coriacea.

costis basalibus $1/3-1/2$ laminae elongatis. Malaya (Ridley 16176, Wray's Camp, G. Tahan, Pahang, typus herb. Singapore).

F. lowii is a rare species of Perak and these two collections indicate that it must have a greater range and variability in the mountains.

F. sumatrana Miq. var **circumscissa** Corner.—*F. acamptophylla* sensu King, Ann. R. Bot. Gard. Calc. (1887) 40, pr. p. Kunstler.—Stipulae dense sericeae v. subtomentosae. Lamina rigide coriacea, valde acuminata. Receptacula 8–10 mm. lata, plus minus depresso-globosa, circum discum apicalem (2–3 mm. latum) irregulariter circumscissa. Malaya.

Perak:—For. Dept. 39338, Piah For. Res.; Kunstler 4055 (Larut), 6106 (Gopeng), 10922 (Ulu Bubong); Ridley 10264, Dindings; Wray 3788, Upper Perak. Trengganu:—Sing. F.n. 30357 (typus, herb. Singapore) et 30713, Bt. Kajang, Kemaman. Johore:—Sing. F. n. 29937, Sedili River.

Haud *F. acamptophylla* Miq, forsan species nova.

var. **microsyce** Corner v. nov.—Receptacula parva, 4–6 mm. lata (5–7 mm., vivo), disco apicali 2 mm. lato, bracteis basalibus $1.5-3 \times 2-3$ mm. Malaya, Sumatra, Java, Borneo, Celebes, Philippines.

Malaya:—Curtis 3515, Pangkor, Perak; Ridley 13478, Sedenah, Johore; Sing. F.n. 32241, Sedili River, Johore (typus, herb. Singapore). Sumatra:—Bangham 804, L. Tawar. Java:—Zollinger 1225. Borneo:—Endert 3216, W. Koetai; Clemens 26827, 26828, Kinabalu; For. Dept. B.N.B. A4703, 10119, Kinabatangan. Celebes:—Kjellberg 733, Kendari, Poehara. Philippines:—Elmer 12386, Sibuyan (det. *F. indica*); Williams 226, Lamao River; Coll. Agr. Laguna 611, Mt. Makiling.

F. binnendykii Miq. similis sed receptaculis non pertusis.

var. **subsumatrana** (Gagnep.) Corner comb. nov.—*F. subsumatrana* Gagnep. Lec. Notul Syst. 4 (1927) 96.—Receptacula 7–10 mm. lata, bracteis basalibus 4–7 (–9) \times 5–8 mm. semi-tecta, disco apicali 3–4 mm. lato. Indochina, Malaya, Sumatra, Borneo.

Annam:—Poilane 1294 et 10786 (syntypes), 22415, 24034, 24159, 24475, 24487, 24605, 24670, 24683. Cochinchina:—Poilane 19523. Malaya:—Burn Murdoch s.n., Feb. 1904, Semangko Pass, Selangor. Sumatra:—Lorzing 5451, Sibolangit (det. *F. indica*). Borneo:—Hallier s.n., Liang Gagang (Herb. Hort. Bot. Bog. 3065); Kostermans 6994, Samarinda.

F. binnendykii Miq. var. *cupulata* Corner (v. *infra*) similis, sed receptaculis non pertusis.

F. delosyce Corner sp. nov.—Arbor magna, epiphytica, suffocans, cortice brunneo-carneo, foliis subdistichis, glabra v. receptaculis puberulis. Ramuli 1–3 mm. crassi. Stipulae breves. Lamina 2.5–8.5 × 1.2–4 cm., elliptica, raro obovata, subacuta v. breviter acuminata, basi cuneato, tenue coriacea: costis lateralibus utrinsecus 3–5, intercostis nullis, basalibus 1 et $1/3 - \frac{1}{2}$ laminae elongatis: petiolo 6–13 mm. longo, gracili. Receptacula axillaria, binata, sessilia, 7–14 × 6–8 mm., ellipsoideo-fusiformia, saepe sparsim puberula, bracteis apicalibus subconicis: bracteis basalibus 2–3.5 × 2–2.5 mm., ovato-oblongis, subacutis, angustis: setis internis nullis. Tepala 2 v. 3, libera. Flores sessiles v. pedicellati.

var. **delosyce**

Malaya, Brunei, in silvis paludosis.

Singapore:—Sing. F.n. 37364, McRitchie Reservoir. Johore:—Sing. F.n. 21337, 28178, 28607, (typus, herb. Singapore), 36800, Sedili River; Ridley 13267, Tempayan River. Selangor:—Sing. F.n. 30774, Pengkalan Kempas; 34033, Telok Reserve; 34143, S. Tinggi; Burkill 1020, S. Buloh; Cons. For. 4870, Kuala Lumpur. Negri Sembilan:—Ridley s.n., G. Angsi, Feb. 1904. Brunei:—S5858, Seria; Brun. 5375, S. Belait.

var. **obtusa** Corner v. nov.—Lamina rotundato-obtusa. v. subacuta. Borneo.

For. Dept. B.N.B. 2449, A3286, A3581, Sandakan; 4319, Tawao; Kostermans 5681, Indonesian Borneo, E. Koetai, S. Susuk (typus, herb. Bogor).

F. spathulifoliae Corner (v. *infra*) affinis sed costis paucis, receptaculis ellipsoideo-fusiformibus, bracteis basalibus parvis distincta.

F. spathulifolia Corner sp. nov.—Arbor mediocris, epiphytica, vix suffocans, glabra v. stipulis puberulis, foliis spiraliter dispositis. Ramuli 3–5 mm. crassi. Stipulae breves. Lamina 4–8 × 2–4 cm., anguste obovata v. spathulata, obtusa v. obtuse subacuminata, basi cuneato, rigide coriacea, crassiuscula: costis lateralibus utrinsecus 3–7, vix conspicuis, intercostis nullis: costis basalibus utrinsecus 1, $\frac{1}{4} - \frac{1}{2}$ laminae elongatis: petiolo 8–15 × 2–2.5 mm., applanato. Receptacula axillaria, binata, sessilia, 6–8 × 6–7 mm., subglobosa v. subobovoidea, umbonata, bracteis apicalibus 2 obtusis in discum convexum 3 mm. latum instructis: bracteis basalibus 3–4 × 4–5 mm., ovatis, obtusis: setis internis nullis. Tepala 2–3, libera. Flores masculi pedicellati, feminei et cecidiophori sessiles.

var. *spathulifolia*

Malaya (Selangor), Sarawak, Brunei, in silvis paludosis. Selangor:—Sing. F.n. 33970, Bt. Changgang, Klang (typus, herb. Singapore); 34022, Telok Reserve, Klang. Sarawak:—Anderson 9044, 9232, Binatang: W. M. A. Brooke 8778, Kelepu: Bur. Sci. 239; For. Dept. 7933, 8008, S. Kelepu, P. Bruit; Sing. F.n. 35686, Manga Temulan. Brunei:—S5862, Seria.

var. *annamensis* Corner v. nov.—Ramuli 2–3 mm. crassi. Lamina -10×5.2 cm., acuminata, apice subacuto: costis lateralibus utrinsecus 4–6. Bractee basales minores, $1.5-2 \times 2-3$ mm. (-3×4 mm., Poilane 23462). Tepala mascula praesertim 2. Annam, in silvis monticolis.

Poilane 22104, 22142 (typus, herb. Paris), 23462, 23749, prov. Haut-Douaïi, 1,000–1,200 m. alt.

var. *substipitata* Corner v. nov.—Ut v. *spathulifolia* sed receptaculis breviter pedicellatis, bracteis basalibus 1.5–2.5 mm. longis pedicellum obscurantibus. North Borneo.

For. Dept. B.N.B. A440, Sandakan (typus, herb. Kew); A1567, Tawao.

Species lamina parva obtusa paucinervosa, receptaculis parvis umbonatis, valde distincta, sed in v. *annamense* *F. delosyce* Corner approximans.

F. maclellandi King var. *rhododendrifolia* Corner v. nov.—*F. rhododendrifolia* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 286, non Kunth et Bouch. (1847).—Glabra, raro lamina in juventute laxa pilosa. Bractee basales 3, 2–3 mm. longae, vix conditae. Himalayas, Khasia, Chittagong, North Burma, Pegu, Yunnan, in silvis monticolis.

India:—Brandis s.n., W. Duars; G. Mann s.n., Assam; Masters s.n., Assam (typus, herb. Kew); Hooker s.n., Khasia et Chittagong; Schlick s.n., Khasia. Burma:—K. Ward 20427, Sumpra Bum (det. *F. benjamina*); Kurz 3135, Pegu. Yunnan:—Y. Tsiang 12332.

A var. *maclellandi* vix distincta sed adhuc raro collecta.

F. calcicola Corner sp. nov.—Arbor parva, epiphytica v. terricola. foliis laxa spiraliter dispositis. Ramuli, petioli, stipulae, costarum mediarum partes inferiores, bracteeque basales pilis brunneis piloso-tomentosi. Ramuli 2–3 mm. crassi. Stipulae -5 mm. longae. Lamina $5-13 \times 2.7-5.5$ cm., elliptica v. obovata, breviter et obtuse v. subacuta acuminata, basi cuneato, coriacea: costis lateralibus utrinsecus 5–7 (–8), vix elevatis, intercostis transversis 2–5: costis basalibus utrinsecus 1, $\frac{1}{4}$ – $\frac{1}{3}$ laminae

elongatis: petiolo 7–22 mm. Receptacula axillaria, binata, sessilia, 7–10 mm. lata, subpyriformia v. subglobosa, glabra, bracteis apicalibus subprojicientibus in discum 2 mm. latum instructis: bracteis basalibus 1–2.5 mm. longis, ovatis, acutis, appresse brunneo-pilosis: setis internis paucis, brunneis, v. nullis. Tepala 3, raro 2 in floribus masculis vel 4 in femineis. Flores masculi sparsi, breviter pedicellati, cecidiophoris breviores. Burma, Thailand, Malaya, in collibus calcareis.

Malaya:—Burkill 6283, Tambun, Ipoh; Ridley 8518, 15th mile Pahang track, Selangor; Kepong F. n. 37426, Kanching, Selangor; Sing. F.n. 34388, Kanching (typus, herb. Singapore). Thailand:—Kerr 130, 2394, Saraburi; 240, Prachuap; 2498, Sam Roi Yawt; 11376, Chumpawn; 19843, Krabin; Marcan 1738, Ratburi. Burma:—Abdul Hak 22, Upper Burma, det. *F. nitida*.

F. microcarpae similis, sed pilis brunneis intercostisque differt: forsan *F. maclellandi* affinis.

F. retusa Linn. Mant. (1767) 129; J. E. Smith, Rees Cycl. 14 (1810) n. 62.—*Urostigma retusum* (Linn.) Miq. Hook. Lond. J. Bot. 6 (1847) 581.—*U. truncatum* Miq. Zoll. Syst. Verz. (1854) 91, 97.—*F. truncata* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 262, 286, non Vahl; King, Ann. R. Bot. Gard. Calc. 1 (1887) 41, pl. 48.—This name has been erroneously used for *F. microcarpa* Linn. f. (v. *infra*). The type of *F. retusa* in the Linnean herbarium, represented by a single good specimen, is without doubt the species known as *F. truncata* Miq. Linneus ascribed the specimen to India, where the species does not occur, but there is no locality on the sheet, and the specimen agrees exactly with the Javanese state of *F. truncata*; hence, I assume that it must have come from Java. As *F. truncata* is a later homonym, a new name must be found for it and the only solution is to accept this disagreeable discovery.

var. **borneensis** Corner v. nov.—Lamina acute acuminata, tenue v. valde coriacea, costis superne valde impressis, inferne prominentibus: costis lateralibus utrinsecus 6–8, basalibus vix elongatis. Bractee basales 3–5 × 3–7 mm., 1/3–½ receptaculi obscurantes. Tepala 2–3. Borneo, in silvis frequens.

Hallier 1020b, 1074, S. Sambas (1074, typus, herb. Leiden); Kepong F.n. 80258, Beaufort, North Borneo; Main 1930, Danu Pontoelok; Meijer 2463, 2582, Tarakan; Teysmann 7122, Blitong; Corner s.n., 1959, Kuching.

A speciminibus javanicis varietatis *retusae* valde distincta, sed malayana intermedia.

sect. *Conosycea* (Miq.) Corner subsect. *Dictyoneuron* Corner
ser. *Perforatae* Corner

F. pellucido-punctata Griff. Notul. 4 (1854) 394; Ic. Pl. As. 4 (1854) t. 554. Syn.—*F. gelderi* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 216, 287.—*F. indica* Linn. var. *gelderi* (Miq.) King, Ann. R. Bot. Gard. Calc. 1 (1887) 39, pl. 45.—Griffith's description and illustration of the ellipsoid fig with umbilicate and half-open orifice shows that it is the same as *F. gelderi*. It is represented at Kew by Griffith 4636, named *F. pellucido-punctata* Griff., but of uncertain origin. Griffith gave Assam (Gowahatti) in his description, but the species has not been collected again from Assam. Herb. Helfer 4636 (Tenasserim and Andamans), also named *F. pellucido-punctata*, is *F. sun-daica* Bl. (= *F. indica* Linn. sensu King).

F. episima Corner sp. nov.—*F. pellucido-punctatae* affinis, sed lamina disimillima. Ramuli 3–3.5 mm. crassi. Stipulae –20 mm. longae. Lamina 6–10 × 3.2–6 cm., elliptica v. obovata, apice obtuse rotundato v. subacuto, basi cuneato, rigide coriacea, crassiuscula: costis lateralibus utrinsecus 3–5, basalibus $\frac{1}{2}$ – $\frac{2}{3}$ laminae elongatis: petiolo 12–20 mm. longo. Receptacula axillaria, binata, sessilia, –15 × 12 mm., late ellipsoidea, subtruncata, ostiolo pertuso: bracteis basalibus 3–4.5 mm. longis, ovatis, subacutis. Mindanao.

Elmer 11314, Mt. Apo (det. *F. retusa*); PNH 10045, Mt. Kantanglad, Bukidnon; 10269, Surigao (typus, herb. Manila).

F. pisocarpa Bl. Bijdr. (1825) 454.—*F. microstoma* Wall. ex King, Ann. R. Bot. Gard. Calc. 1 (1887) 38, pl. 44.—This uncommon species of Lower Thailand, Malaya, Java, and Borneo, is close to *F. pellucido-punctata*. There is no specimen named *F. pisocarpa* by Blume at Leiden, but there are three which he must have seen, namely one collected by Reinwardt, another by Blume himself, and the third labelled "H.L.B. 43 Gedeh", which is the type-locality of *F. pisocarpa*. These sheets were un-named, but they are the same as *F. microstoma*, which fits well with Blume's description, particularly "fructibus pisiformibus . . . sessilibus plano-umbilicatis". No other Javanese banyan fits this description and, as *F. microstoma* is the one species as yet unaccounted for among Blume's names, I have no hesitation, after working through the Malaysian banyans, in identifying it with *F. microstoma*.

King misinterpreted *F. pisocarpa* by identifying it with Kunstler 3555, which is *F. caulocarpa* Miq, having stipitate figs, not plano-umbilicate, and different leaves.

F. binnendykii Miq. var. **coriacea** Corner v. nov.—*Urostigma tjiela* Miq. Hook. Lond. J. Bot. 6 (1847) 580, pr. p. Cuming 1931.—Lamina 4–11 × 2–5 cm., anguste v. late elliptica, lanceolata, rigide coriacea, crassiuscula, venis obscuris: costis lateralibus utrinsecus 3–5, basalibus 1/3–½ laminae elongatis. Bracteae basales 2.5–4 mm. longae. Annam, Malaya, Bangka, Sarawak, Brunei, Luzon.

Annam:—Poilane 32798, Nui Dai Ding, prov. Koutum. Malaya:—Singapore, Burkill 2031, Langlasse 313, 328, Ridley 3402, 5639, 5640, 6459, 9219, 10382, 10808, 12203, 14155, Sinclair 4917, Sing. F.n. 33560; Johore, Ridley 12162, 13267, Sing. F.n. 36562; Malacca, Cons. For. 2061; Perak, Cons. For. 2313, King's coll. 6106, 10505, Scortechini 310, 322, 1051, Sing. F.n. 31655 (typus, herb. Singapore). Bangka:—Kostermans et Anta 172, 534, 1076. Sarawak:—Clemens 22318, Mt. Matang. Brunei:—Brun. 542, Andulau. Luzon:—Bur. Sci. 22275, Cuming 1931.

F. sumatranae persimilis sed ostiolo pertuso, bracteis basalibus parvis.

var. **cupulata** Corner v. nov.—Ut. var. *binnendykii* sed bracteae basales 4–6 × 5–8 mm., 1/3–½ receptaculi obscurantes. Lamina plus minus coriacea. Celebes.

Kjellberg 2769, Matano (typus, herb. Stockholm); 2823, Sorvako.

var. **latifolia** Corner v. nov.—Ut var. *binnendykii* sed lamina 6–13 × 4–6.5 cm., late elliptica v. ovato-elliptica, basi rotundato v. late cuneato: costis lateralibus utrinsecus 3–4. Borneo.

Beccari 3353, Pontianak, det. *F. cycloneura* (typus, herb. Florence); San. 17172, Tawao; Teysmann 7111, Kapoeas, det *F. cycloneura*.

sect. Conosycea (Miq.) Corner subsect. Benjamina Miq.
ser. Benjamineae Miq.

F. subcordata Bl. Bijdr. (1825) 440.—*F. garciniifolia* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 218, 287.—*F. calophylloides* Elm. Leaf. Philip. Bot. 4 (1911) 1246.—*F. acrorrhyncha* Summerh. J. Arn. Arb. 13 (1932) 98.—*F. fairchildii* Backer, Blumea 6 (1947–8) 306.—*Urostigma balicum* Miq., *U. subcordatum* (Bl.) Miq. Fl. Ind. Bat. 1, 2 (1859) 348, 349.—This is an uncommon, but wide-spread, species from Tonkin to New Hebrides, yet I can see but slight differences in the size of leaf and fig in the collections (35 in all), and I have compared the types. Reinwardt 1338 (Timor) is the original *F. subcordata* Bl., labelled “arbor elegans ante domum in villa Koepang

Timoriensium". The specimen at Utrecht is labelled "F. subcordata. Timor" by Reinwardt; that at Leiden is labelled both by Blume and Miquel and bears the note "Zipp. ?". Both are sterile, but the venation, cystoliths, and sunken stomata clinch the identity with *F. garciniifolia*, the type of which also came from Timor (de Vriese, Koepang).

var. **malayana** Corner v. nov.—Receptacula majora, 35–50 × 20–25 mm., subcylindrica: bracteis basalibus annulato-conjunctis, annulo 0.5–1 mm. lato, integro vel obscure sublobato. Flores masculi pauci, pedicellis 1.5–5 mm. longis. Malaya, North Borneo.

Malaya:—Curtis s.n., May 1902, road to Gap, Selangor (typus, herb. Singapore); For. Dept. 6547, Kampong Bahru, Kuala Lumpur. Borneo:—San. 4365, Mt. Trus, Keningau distr.

F. benjamina Linn. var. **bracteata** Corner v. nov.—Bracteeae basales 2–3 × 2.5–4 mm., haud conditae. Cochinchina, Celebes, Morotai, Sumbawa, Timor, Philippines, New Guinea, New Britain.

Cochinchina:—Poilane 17349, Budop. Celebes:—Kjellberg 1386 (Eurekang), 1669 (Makule), 2290 (Timampoe). Morotai:—Kostermans 780, 807, 1514. Sumbawa:—Elbert 3997, 4087. Timor:—Forbes 3796. Philippines (Luzon, Negros, Batan, Mindoro):—Bur. Sci. 80168, 80300; Coll. Agr. Laguna 508, 557, 568; Cuming 1936; Elmer 10153 (det. *F. indica*), 16038; PNH 9482, 16897, 33342; Wenzel 1411, 1470. New Guinea:—Brass 21616, 21902; Carr 16359 (typus, herb. Br. Mus.); Doctors v. Leeuwen 9534; Hoogland 4167, 4269. New Britain:—NGF 7038.

sect. *Conosycea* (Miq.) Corner subsect. *Benjamina* Miq.
ser. *Callophyllae* Corner

F. callophylla Bl. var. **leytensis** Corner v. nov.—*F. pachyphylla* Merr. Philip. J. Sci. Bot. 8 (1913) 365, non King (1887).—Receptacula obovoidea, bracteis apicalibus in umbonem acutum instructis, bracteis basalibus 7–9 × 7–8 mm. acutis. Leyte (Wenzel 209, typus varietatis etiam *F. pachyphyllae* Merr.).

var. **malayana** Corner v. nov.—Lamina saepe major, valdius coriacea, venis quasi obscuratis. Receptacula majora, 14–17 × 15–20 mm., bracteis basalibus 8–10 × 7–12 mm. Tepala mascula (3–)4. Thailand, Malaya, Sumatra.

Thailand:—J. Schmidt 537; G. Seidenfaden 2079. Malaya:—Hullett 329; King's coll. 4697. Sing. F.n. 21190 (typus, herb. Singapore), 28634, 28657, 31662, 34144, 34460, 34464, 36955, 37987. Sumatra:—Forbes 1735, 2590.

var. **minor** Corner v. nov.—Receptacula minora 7–8 × 7–10 mm., bracteis basalibus 3–4 mm. longis. Celebes, Sumbawa.

Celebes:—Boschproefst. Cel/III–22, Cel/IV–114 (typus, leg. 27.VIII.32, herb. Leiden), Malili; Koorders 19199, 19329, 19337, Minahassa (det. *F. retusa*); Teysmann 12142, Pangkadjena. Sumbawa:—Elbert 3689.

F. curtipes Corner nom. nov.—*F. obtusifolia* Roxb. Fl. Ind. 3 (1832) 546, non HBK; King, Ann. R. Bot. Gard. Calc. 1 (1887) 42, pl. 49.

F. tristaniifolia Corner sp. nov.—Arbor mediocris, epiphytica, vix suffocans, foliis spiraliter dispositis, glabra. Ramuli 3–5 mm. crassi. Stipulae –22 mm. longae. Lamina 4.5–10.5 × 1.5–5 cm., anguste obovata v. spathulata, apice obtuso subtruncato v. subretuso, basi anguste cuneato, valdissime coriacea, crassiuscula, marginibus recurvis, sicco ferruginea, venis quasi obscuratis: costis lateralibus utrinsecus 7–9, obliquis, secundariis vix minus evolutis: costis basalibus utrinsecus 1, $1/3$ – $1/2$ laminae elongatis: petiolo 5–12 × 2 mm., brevi, applanato. Receptacula axillaria, binata, sessilia, 8–10 mm. lata, subglobosa, bracteis apicalibus 2 in discum planum 2 mm. latum instructis: bracteis basalibus 3–5 mm. longis, $1/3$ – $1/2$ receptaculi obscurantibus; setis internis nullis. Tepala 3, libera. Flores masculi et cecidiophori pedicellati, feminei sessiles. Malaya, Sumatra, Borneo, in silvis paludosis rara.

Malaya:—Ridley 1597, Malacca, S. Udang; Sing. F.n. 36606, 36698, Johore, Pontian, Penkalan Raja (36698 typus, herb. Singapore). Sumatra:—Bruinier 306, East Coast, S. Rawa. Borneo:—Buwalda 7852, Sampit; NIFS bb. 32411, Sampit; v. Romburgh 11, Paloh.

F. spathulifolia Corner (v. supra) facile confusa, sed foliis valdius coriaceis, venis ut in *F. callophylla*, receptaculis haud umbonatis.

F. microcarpa Linn. f. Suppl. Spl. Pl. (1781) 442.—*F. retusa* auct., *F. nitida* auct., *F. retusa* var. *nitida* auct., non verae.—This is the plant generally, but wrongly, called *F. retusa*, *F. nitida*, or *F. retusa* var. *nitida*. *F. retusa* Linn. is the species generally called *F. truncata* Miq. (v. supra), while *F. nitida* Thunb. is *F. benjamina* Linn., and *F. benjamina* sensu Thunb. is this *F. microcarpa*. I have disentangled the confusion by study of the types and original specimens. *F. microcarpa*, strangely enough, never reached Carolus Linneus. The name-change is

jarring, for this is one of the more widely cultivated species, but in the absence of *Nomina Specifica Conservanda* aut *Rejicienda* there is no way out. It ranges from Ceylon, India, South China, and Ryu Kyu islands to Australia and New Caledonia.

var. **microcarpa** f. **pubescens** Corner f. nov.—Stipulae et bracteae basales dense appresse puberulae. Ramuli et receptacula subvillosa. Thailand, in collibus calcareis.

Kerr 2168, Chawng Ke, N. Sawan (typus, herb. Br. Mus.); 10649, Chawn Bung, Rotburi; Kostermans 681, Kwae Noi Basin Exp., Brongkasi; 1441, Kin Sayok (120 km. n.w. Kwanburi).

var. **eubracteata** Corner v. nov.—Bracteae basales majores 4–5 mm. longae et latae, ovato-acutae. Lamina -11×5.5 cm., late elliptica v. ovato-elliptica. Thailand.

RFD 16711, Chiangmai, Chiangdao (typus, herb, Bangkok); 11990, Lampang, Ngao. Mae Huat.

Ut. var. *latifolia* sed bracteis basalibus quasi duplice majoribus.

var. **hillii** (Bailey) Corner comb. nov.—*F. hillii* F.M. Bailey. Contr. Queensl. Fl. 3 (1891) 16.—*F. schlechteri* Warb. Tropenfl. 7 (1903) 582.—Ut v. *microcarpa* sed costis basalibus vix elongatis, setis internis quasi nullis. Sunda Isl. (Alor Kechil), New Guinea, Queensland, New Caledonia, Loyalty Islands.

Forsan a v. *microcarpa* vix distincta.

var. **latifolia** (Miq.) Corner comb. nov.—*Urostigma accedens* Miq. v. *latifolia* Miq. Fl. Ind. Bat. 1, 2 (1859) 347.—*F. rigo* F.M. Bailey, *F. thynneana* F.M. Bailey, Queensl. Agr. J. 1 (1897) 231, 235.—*F. retusa* Linn. v. *rigo* (Bailey) Diels, Engl. Bot. Jahrb. 67 (1935) 183.—Ut v. *microcarpa* sed lamina -12×9 cm., late elliptica, apici obtuso v. subacuminato, basi rotundato v. late cuneato, venis subtus conspicuis, costis secundariis ut primariis quasi bene evolutis. Celebes. Moluccas, New Guinea, Queensland, Caroline Islands.

Celebes:—Nielsen 804. Moluccas:—Reinwardt s.n., Halawahoea (typus, herb. Leiden); de Vriese, Ternate; Alston 16649, Ternate. New Guinea:—Brass 3592, Rona, Laloki River; Carr 11441, Hisiu; Carr 11588, Veiya; NGF 8087, Port Moresby; Hellwig 187; Labillardiere, Waigeo Isl. Caroline Isl.:—Fosberg 25815, 25821, 25895, 31999, 32023; E.Y. Hosaka 3351.

var. **naumanni** (Engl.) Corner comb. nov.—*F. naumanni* Engl. Bot. Jahrb. 7 (1886) 451.—*F. dahlii* K. Schum. Notizbl. Bot. Gart. Mus. Berlin 2 (1898) 111.—*F. regnans* Diels, Engl. Bot. Jahrb. 67 (1935) 182.—Receptacula pedunculo 1–5 mm. longo praedita, bracteis basalibus caducis. New Guinea, New Britain, New Ireland.

New Guinea:—Brass 21926, Cape Vogel Pen., Menapi; 27781, Sudest Isl., Joe Landing; Carr 12342, 12484, Rouna; Ledermann 7476, 9491, 10844, Sepik; Nyman 233, Stephansort; coll. cet. cit. Engler, Segaar et MacCluer Bay. New Britain:—Dahl s.n., Ralum; v. Hugel 572, Blanche Bay; Lauterbach 215, Ralum. New Ireland:—Naumann s.n., Cartaret Bay (typus, herb. Berlin).

var. *saffordii* (Merr.) Corner comb. nov.—*F. saffordii* Merr. Philip. J. Sci. Bot. 9 (1914) 73.—*F. prolixa* Forst. f. v. *saffordii* (Merr.) Fosberg, Phytologia 5 (1955) 289.—Lamina 8.5×4.5 cm., ovato-cordata v. subcordata, apice acuminato, costis basalibus $\frac{4}{3}$ laminae elongatis. Ins. Caroline, Marianas.

Marianas:—Anderson 235; Fosberg 25159, 31873, 35359; McGregor 414 (typus); Nelson 150, det. *F. tenuistipula* Caroline Isl.:—Fosberg 32166; Kanehira 1907.

F. prolixa facile confusa sed cystolithis amphigenis, superne ut verrucellis in lamina sicca, in *F. prolixa* modo in pagina inferiori.

F. palaquifolia Corner sp. nov.—Arbor magna. epiphytica, suffocans, foliis spiraliter dispositis, glabra. Ramuli 4–5 mm. crassi. Stipulae 24 mm. longae. Lamina 7–12 \times 3–6.5 cm., elliptica v. subobovata, breviter et acute acuminata, basi cuneato, coriacea, sicco brunnea: costis lateralibus primariis utrinsecus 7–13, vix elevatis, subcrenulatis, secundariis vix minus evolutis, intercostis nullis: costis basalibus utrinsecus 1, vix elongatis: petiolo 18–38 \times 2–3 mm., sicco brunneo. Receptacula axillaria, binata, sessilia, 9–10 mm. lata (vivo, 12–15 \times 10–13 mm.), subpyriformia v. subglobosa, sicco subverrucosa (pariete pertenui ad semina contracto), bracteis apicalibus 2–3 in discum convexum v. subconicum 2–3 mm. latum instructis: bracteis basalibus 7–10 mm. longis, ovatis, obtusis, quasi $\frac{1}{2}$ receptaculi obscurantibus: setis internis nullis. Tepala 3–4, lineari-lanceolata, libera. Flores masculi pedicellati, feminei et cecidiophori sessiles. Semina crasse tunicata. Borneo.

Sing. F. n. 26703, 27413 (typus, herb. Singapore), Kinabalu, c. 1200 m. alt.; Hallier 3065, Liang Gagang.

F. polygramma, *F. archboldiana*, et *F. benjaminoides* affinis.

F. polygramma Corner sp. nov.—Arbor epiphytica, suffocans, foliis spiraliter dispositis, glabra v. ramuli, stipulae, petioli, et receptacula puberuli. Ramuli 3 mm. crassi. Stipulae 15–25 mm. longae. Lamina 6–9 \times 3–5.5 cm., elliptica, breviter acuminata, basi late cuneato, coriacea, sicco brunnea: costis lateralibus

primariis utrinsecus 9–13, ad paginas ambas leviter elevatis, secundariis vix minus evolutis, intercostis nullis: costis basalibus utrinsecus 1, haud elongatis: petiolo -25×2.5 mm., nigro. Receptacula axillaria, binata, sessilia, $15 \times 10-13$ mm., pyri-formia v. ellipsoidea, apice subtruncato v. obtuso, bracteis apicalibus 3 in cono brevi 1.5 mm. lato instructis: bracteis basalibus 3–4.5 mm. longis, ovatis, obtusis v. subacutis, crassiusculis, ad basim usque 1–2 mm. breviter et infundibuliforme connatis: setis internis nullis. Tepala 3, spathulata, libera. Flores masculi pedicellis subinduratis praediti, feminei et cecidiophori plus minus sessiles. Celebes.

Kjellberg 2702, Porema, c. 1200 m. alt. (typus, herb. Stockholm); Koorders 19429, 19275, Minahassa.

F. archboldianae Summerh. affinis sed bracteis basalibus connatis differt.

F. benjaminoides Corner sp. nov.—Arbor magna, epiphytica, suffocans, foliis spiraliter dispositis, glabra sed bracteis basalibus puberulis. Ramuli 3–4.5 mm. crassi, suberecti. Stipulae -20 mm. longae. Lamina $5-13 \times 2.3-5.7$ cm., anguste elliptica v. ovato-elliptica, acuta v. subacuminata, basi cuneato, tenue coriacea, sicco fusco-brunnea: costis lateralibus primariis utrinsecus 7–13, leviter elevatis, secundariis vix minus evolutis, intercostis nullis: costis basalibus utrinsecus 1–2, haud elongatis: petiolo 7–24 mm. longo, nigro. Receptacula axillaria, binata, sessilia, 5–6 mm. lata ($6-7 \times 7-8$ mm., vivo), subglobosa, plus minus depressa, subumbonata, bracteis apicalibus 2 in discum planum v. subconvexum 2–2.5 mm. latum instructis: bracteis basalibus $2.5-4 \times 3-6$ mm., ovatis, obtusis, puberulis: setis internis nullis. Flores masculi pedicellati, sparsi v. aggregati, tepalis 2–3 spathulatis. Flores cecidiophori breviter pedicellati v. sessiles, tepalis 2–3; feminei sessiles, tepalis 3–4. Nova Guinea.

Brass 5433, Terr. N. Guinea, Central div., Mafulu, c. 1250 m. alt.; BW 6592, Neth. N. Guinea, Asmat region; Carr 12093, Papua, Koitaki, c. 400 m. alt. (typus, herb. Br. Mus.).

F. benjaminiae similis sed foliis spiraliter dispositis sicco fusco-brunneis, ramulis suberectis, receptaculis minoribus, disco apicali latiori.

F. patellata Corner sp. nov.—Arbor magna, epiphytica, suffocans, foliis spiraliter dispositis, glabra. Ramuli 2.5–3 mm. crassi. Stipulae -11 mm. longae. Lamina $5-9 \times 2.5-5$ cm., elliptica,

breviter acuminata, basi late cuneato, coriacea, sicco brunnea: costis lateralibus primariis utrinsecus 13–16, gracilibus, vix elevatis, secundariis vix minus evolutis, intercostis nullis: costis basalibus utrinsecus 1, haud elongatis: petiolo 9–18 × 1.5–2 mm., nigro. Receptacula axillaria, binata, sessilia, 6–7 mm. lata, subglobosa, bracteis apicalibus 3 in discum planum 2 mm. latum instructis: bracteis basalibus in disco integro tumido patelliformi 6–7 mm. lato conjunctis: setis internis nullis. Flores masculi breviter pedicellati, tepalis 2. Flores cecidiophori sessiles v. subpedicellati, feminei sessiles, tepalis 3. Nova Guinea. (Exp. Lundquist, Aet 141, McCluer Bay, Jakati, pr. Bobo, typus herb. Leiden).

F. benjaminoides affinis sed receptaculo ad discum patelliformem instructo facile distinguitur.

sect. *Malvanthera* Corner ser. *Malvanthereae* Corner
subser. *Eubracteatae* Corner

F. triradiata Corner sp. nov.—Arbor magna, epiphytica, suffocans, glabra. Ramuli 3–6 mm. crassi. Stipulae –6 cm. longae, caducae. Lamina 7–14 × 3.5–5.8 cm., elliptica v. obovato-elliptica, subacuta, basi cuneato, rigide coriacea, margine plus minus recurvo: costis lateralibus primariis utrinsecus 6–10, haud elevatis, secundariis minus conspicuis: costis basalibus utrinsecus 1, haud v. vix elongatis: petiolo 15–30 mm. longo, subapplanato. Receptacula axillaria, binata: pedunculo 4–6 × 5–6 mm., apice –10 mm. lato incrassato: bracteis basalibus 3, 5–7 × 7–10 mm., ovatis, obtusis, persistentibus: receptaculi corpore 18–22 × 14–17 mm., truncato-subconico, ostiolo profunde triradiato breviter mammillato, pariete 2–3.5 mm. crasso subligneo: setis internis nullis. Flores masculi pedicellati, tepalis 4 spatulatis liberis, anthero reniformi crescentiforme dehiscenti. Flores feminei et cecidiophori sessiles v. breviter pedicellati, tepalis 4–5 lanceolatis: ovario libero rubro, stigmatate simplici. Queensland.

C. T. White 10536, Mt. Spurgeon (typus, herb. Brisbane); H. Flecher (N.Q. Naturalists Club n. 7260) Brooklyn-Mt. Lewis track.

var. **sessilicarpa** Corner v. nov.—Gracilis, laminis receptaculisque minoribus. Ramuli 3–4 mm. crassi. Lamina 6–12 × 2–4 cm., anguste elliptica v. lanceolata, costis primariis lateralibus utrinsecus 5–9. Receptacula 12–15 mm. (18–20 mm., vivo), subglobosa, plus minus sessilia: bracteis basalibus 5–7 × 8–10 mm. Queensland.

Brass 20052, Mt. Finnegan, 850 m. alt. (typus, herb. Brisbane).

sect. *Malvanthera* Corner ser. *Malvanthereae* Corner
subser. *Malvanthereae*

F. glandifera Summerh. var. **brachysyce** Corner v. nov.—Receptacula 10–13 mm. longa, subglobosa v. obovoidea, ad basim cupula adnata 2.5–5 mm. alta et 10–13 mm. lata inserta. Lamina 4–14 × 2–6 cm., elliptica, costis lateralibus primariis utrinsecus 11–15. Tepala feminea et cecidiophora 1–3. Celebes, Nova Guinea.

Celebes:—Elbert 2945, Muna Isl., Lombai, S.E. Celebes. New Guinea:—NGF 5218, (typus, herb. Lae), 5232, 7422, Bulolo, Morobe distr., 3500 ped. alt.

sect. *Malvanthera* Corner ser. *Malvanthereae* Corner
subser. *Platypodeae* Corner

F. leucotricha Miq. var. **megacarpa** F.v.M. ex Corner v. nov.—Ramuli crassior, 5–7 mm. Receptacula majora, 14 mm. lata. pedunculo 8–14 mm. longo: bracteis basalibus multo majoribus, –10 × 12 mm., apiculatis. Queensland (F. v. Mueller, Sea Range, typus herb. Kew).

Specimina in herb. Kew et Utrecht det. “*F. lanata* sp. nov. ♂ *megacarpa*” a F. v. Mueller, sed inedita. In v. *leucotricha* bractee basales 4–5 mm. longae.

var. **sessilis** Corner v. nov.—Receptacula sessilia: bracteis basalibus –10 × 7 mm., ovato-caudiculatis. New South Wales (specimen typicum in herb. Manchester “J. E. Smith N.S.W.” notatum).

F. obliqua Forst. f. var. **petiolaris** (Benth.) Corner comb. nov.—*F. platypoda* A. Cunn. ex Miq. var. *petiolaris* Benth. Fl. Austral. 6 (1873) 169.—This has the larger figs of *F. platypoda*, but the two basal bracts which distinguish *F. obliqua*. Some collections of *F. obliqua* have figs of intermediate size. As a detail, the leaves of var. *petiolaris* have the smooth lower epidermis of *F. obliqua*, not the finely striate epidermis round the stomata as in *F. platypoda*. The collection “Fraser, Brisbane and Hastings River”, cited by Benthham is to be excluded because it is *F. macrophylla* Desf.

F. obliqua Forst. f. var. **puberula** (Benth.) Corner comb. nov.—*F. eugenioides* F.v.M. var. *puberula* Benth. Fl. Austral. 6 (1873) 167.—*Urostigma brachypodum* Miq. Hook. Lond. J. Bot. 6 (1847) 562.—*F. brachypoda* Miq. Ann. Mus. Bot. Lugd. Bat 3 (1867) 287.—Ramuli et petioli puberuli. Lamina 2.5–6 × 1.1–2.3 cm., lanceolato-elliptica, subacuta, basi anguste et abrupte rotundato, costis lateralibus primariis utrinsecus

8-9: petiolo 3-5 mm. longo. Receptacula 5-6 mm. lata, breviter pedunculata. Queensland (A. Cunningham 304, York Sound, typus herb. Kew).

F. platypodae v. *minoris* similis sed puberula et receptaculum minus.

F. subpuberula Corner nom. nov.—*F. puberula* A. Cunn. ex Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 237, (non Kunth et Bouch., 1847).—This little known species may be a variety of *F. platypoda*.

F. platypoda A. Cunn. ex Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 287; Benth. Fl. Austral. 6 (1873) 169.—*Urostigma platypodum* Miq. Hook. Lond. J. Bot. 6 (1847) 561.—Miquel cited originally three collections:—

1. Cunningham, York Sound, (Herb. Hook), which is the type;
2. Fraser, Brisbane and Hastings River, called "forma major", which Bentham transferred to *F. platypoda* var. *petiolaris* Benth., but which is *F. macrophylla* Desf., and must be excluded;
3. Bynoe (Herb. Hook), called "forma minor" which is *F. platypoda* var. *minor* Benth.

sect. Malvanthera Corner ser. **Malvanthereae** Corner
subser. Hesperidiiformes Corner

F. augusta Corner sp. nov.—Arbor magna, epiphytica, suffocans. Ramuli, stipulae, et saepe receptacula albido-puberuli, glabrescentes. Ramuli 7-10 mm. crassi. Stipulae -22 cm. longae, vivo rubrae. Lamina -26 × 17 cm., ovato-subcordata v. late elliptica, subacuta v. breviter acuminata, basi rotundato-cordato v. late cuneato, coriacea: costis lateralibus primariis utrinsecus 12-17, vix elevatis, secundariis minus conspicuis: costis basalibus utrinsecus 1 (-2), $\frac{1}{4}$ - $\frac{1}{3}$ laminae elongatis: petiolo 30-100 × 3-5 mm. Receptacula axillaria, binata, maturitate rubescentia; pedunculo 4-6 × 5-7 mm. v. 20-25 × 8-10 mm., apice haud v. vix dilatato: bracteis basalibus 3, 1-2.5 × 2-3.5 mm., crescentiformibus, denique caducis: receptaculi corpore 50-80 × 27-50 mm., oblongo-ellipsoideo, apice umbonato (5-7 × 10-17 mm.), bracteis apicalibus inflexis 2-3 gibbosis: setis internis nullis: pariete crasso, lignoso, processibus floriferis praedito. Flores ut in *F. xylosycia* Diels, tepalis 3-4. Flores

masculi pedicellati, anthero reniformi crescentiforme dehiscenti sessili. Flores feminei sessiles, ovario in receptaculi pariete semi-immerso, stigmatе longe bifido. Nova Guinea.

Hoogland 5454, Terr. N. Guinea, Eastern Highlands, Goroka subdistr., Asaro Mairi divide, 2400 m. alt. (typus, herb. Lae); NGF 1020, Aiyura area.

F. hesperidiiformis King var. **myrmekiocarpa** (Summerh.) Corner comb. nov.—*F. myrmekiocarpa* Summerh. J. Arn. Arb. 22 (1941) 82.—This has somewhat smaller figs with more expanded apex to the peduncle than typical *F. hesperidiiformis*, but I can find no essential difference.

F. xylosycia Diels var. **cylindrocarpa** (Diels) Corner comb. nov.—*F. cylindrocarpa* Diels, Engl. Bot. Jahrb. 67 (1935) 181.—This has a smaller, narrowly cylindrical fig with slender peduncle, but it grades into typical *F. xylosycia*, as in Carr 14050 (Papua).

Taxonomic Notes on *Ficus* Linn., Asia and Australasia

II. SUBGEN. PHARMACOSYCEA MIQ.

By E. J. H. CORNER

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Summary

NEW SECTIONS, SERIES, and subseries:—sect. *Oreosyce* (Miq.) Corner comb. nov., ser. *Vasculosae* Corner, subser. *Vasculosae*, subser. *Albipilae* Corner, ser. *Nervosae* Corner, ser. *Austrocaledonicae* Corner.

Earlier specific epithets:—*F. albipila* (Miq.) King (*F. colossea* F. v. Muell. ex Benth, *F. microtricherinos* Backer); *F. habrophylla* G. Bennett (*F. edulis* Bur.).

New name for later homonym:—*F. pachystemon* Warb. (*F. mangiferifolia* K. Schum. et Laut., *haud* Griffith).

New species:—*F. gratiosa* Corner, *F. pachysycea* Diels ex Corner, *F. hombroniana* Corner, *F. subnervosa* Corner, *F. kjellbergii* Corner, *F. madhucifolia* Corner, *F. pseudojaca* Corner.

New varieties:—*F. albipila* (Miq.) King v. *glabra* Corner, *F. gratiosa* Corner v. *caudata* Corner, *F. pubinervis* Bl. v. *diandra* Corner et v. *sibulanensis* (Elm.) Corner, *F. subtrinervia* K. Schum. et Laut. v. *doormaniana* (Diels) Corner, *F. granatum* Forst. f. v. *minor* Corner, *F. smithii* v. *robusta* Corner, *F. austrocaledonica* Bur. v. *balansaeana* Corner.

Notes on *F. hadroneura* Diels.

subgen. *Pharmacosycea* Miq.

Ann. Mus. Bot. Lugd. Bat. 3 (1867) 299.—*Pharmacosycea* Miq. Hook. Lond. J. Bot. 6 (1847) 525; id. 7 (1848) 64.—Monoecious, all three kinds of flower in the same receptacle. Receptacles without lateral bracts on the body: interfloral bracts often present. Male flowers ostiolar or disperse: stamens 1–3, occasionally with pistillode. Gall- and female flowers similar, but the female generally sessile with longer style: ovary white or with a red spot at the base, sessile: style glabrous, stigma bifid.

Seed smooth, often keeled over the apex. Trees, rarely shrubs (not epiphytic, creeping, or climbing). Leaves generally entire and with a gland in the axil of each main basal nerve. Lectotype:—*F. maxima* P. Mill. (= *F. radula* Willd.).

sect. **Pharmacosycea**.—*Ficus* sect. *Pharmacosycea* (Miq.) Benth. et Hook. Gen. Pl. 3 (1880) 369.—Fig solitary, orifice in some species crateriform: interfloral bracts present: internal bristles absent. Male flowers disperse: stamens 2–3, the filaments sometimes shortly joined. Ovary often with a red mark at the base on the styler side. Cystoliths amphigenous. Stomata superficial or sunken. Microscopic gland-hairs with 4–6–12-celled head. Tropical America, c. 12 species: lectotype *F. maxima* P. Mill.

sect. **Oreosycea** (Miq.) Corner comb. nov.—*Urostigma* Gasp. sect. *Oreosycea* Miq. Hook. Lond. J. Bot. 6 (1847) 525, 585: Fl. Ind. Bat. I, 2 (1859) 353.—*Ficus* Linn. subgen. *Urostigma* (Gasp.) Miq. sect. *Oreosycea* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 286.—*Ficus* Linn. sect. *Leiosycea* Miq. Hook. Lond. J. Bot. 7 (1848) 454.—*Ficus* Linn. subgen. *Urostigma* (Gasp.) Miq. sect. *Stilpnophyllum* Endl. subsect. *Pedunculatae* Sata, Monogr. (1944) 179.—Figs typically paired, orifice not crateriform: interfloral bracts and internal bristles present or not. Male flowers disperse or ostiolar: stamens 1 or 2, rarely 3. Ovary without a red spot. Cystoliths mostly hypogenous, in a few species amphigenous. Stomata not sunken. Microscopic gland-hairs with 2–4-celled head. Madagascar, Asia, Australasia, 45 species: lectotype—*F. nervosa* Heyne ex Roth.

ser. **Vasculosae** Corner ser. nov.—Folia exsiccata griseo-viridia v. pallide brunnea, nervis reticulatis saepe ad paginam unam vel ambas elevatis, glandulis basalibus saepe nullis v. indistinctis. Receptaculum pedunculo distincto praeditum, cellulis scleroticis in pariete copiosis. Stamina plerumque 2 in floribus ostiolaribus (1 in *F. gratiosa*). Madagascar, Asia, New Guinea, Queensland, 7 species. Typus—*F. vasculosa* Wall ex Miq.

subser. **Vasculosae**.—sect. *Leiocarpa* Miq. l.c. (typus—*F. vasculosa* Wall.)—subsect. *Pedunculatae* Sata l.c. (lectotypus *F. callosa* Willd., = *F. malunuensis* Warb.).—Folia nitida coriacea, nervis intercostalibus numerosis (*F. callosa*) v. 0–1. Setae internae nullae (numerosae in *F. gratiosa*). Cystolitha hypogena. Sempervirens. Asia, 4 species. Typus—*F. vasculosa* Wall.

subser. **Albipilae** Corner subser. nov.—Folia haud nitida, membranacea v. chartaceo-coriacea, nervis intercostalibus 3-numerosis.

Setae internae copiosae v. nullae. Arbores deciduae, saepe albipilosae. Madagascar, Andaman Isl., Indochina, Thailand, Malaysia, Queensland, 3 species. Typus—*F. albipila* (Miq.) King.

ser. **Nervosae** Corner ser. nov.—Folia exsiccata saepissime fusco-brunnea, leniter v. rigide coriacea, glandulis basalibus 2 conspicuis, stipulis saepe elongatis. Receptaculum pedunculo saepe brevi praeditum. Stamen 1, vel 2 (–3). Arbores grandes, ? sempervirentes. Asia, New Guinea, Solomon Islands, 16 species. Typus.—*F. nervosa* Heyne ex Roth.

ser. **Austrocaledonicae** Corner ser. nov.—Folia exsiccata plerumque fusco-brunnea, membranacea v. coriacea, glandulis basalibus 2 plerumque conspicuis, stipulis haud elongatis. Stamina 1–2–3. Arbores mediocres v. suffrutices, raro grandes (*F. smithii*), ? sempervirentes. New Caledonia, Loyalty Isl., New Hebrides, Fiji, Solomon Isl., 23 species. Typus—*F. austrocaledonica* Bur.

It has been assumed on geographical grounds that this subgenus was confined to the American tropics but, as I have shown (Reinwardtia 4, 1958, 26), a block of Old World species, grouped about *F. vasculosa*, *F. nervosa*, and *F. austrocaledonica*, has the same essential characters and, indeed, is with difficulty distinguished. These Old World species have been referred to subgen. *Urostigma* where they are out of place, particularly in being independant trees and not banyans or stranglers. The species of New Caledonia have never been properly classified, and they are the closest in several respects to the American. The subgenus is absent from Africa, excepting Madagascar, where *F. assimilis* J. Baker occurs: it is almost the same as the wide-spread *F. albipila* (Thailand to Queensland).

I divide the subgenus into two sections, maintaining the geographical distinction for convenience, but redefinition will be necessary when the American species are better known. Indeed, nearly all distinctions, from varietal upwards, are unsatisfactory, and the whole group gives the impression of one played out into minor variation.

Typification. For the subgenus I take, on the concurrence of G. DeWolf, who has been studying the American species, *F. maxima* P. Mill.: he writes "It is the oldest species in point of description and probably the commonest in point of occurrence, also the most wide-spread". For sect. *Oreosyce*, Miquel gave originally the two

species *Urostigma nervosum* (Heyne) Miq. and *U. modestum*, which is a synonym of the first. Sect. *Leiosyceae* had only *F. vasculosa* Wall.

ser. Vasculosae Corner subser. Albipilae Corner

F. albipila (Miq.) King, Ann. R. Bot. Gard. Calc. 1 (1888) 179.—*Covellia* ? *albipila* Miq. Fl. Ind. Bat. Suppl. (1860) 175, 434. *Morus leucophylla* Miq. id. 415.—*F. mollis* Miq. var. *albipila* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 283, 296. *F. colosseae* F. Muell. ex Benth. Fl. Austral. 6 (1873) 163.—*F. malloides* Val. ex Backer, Blumea 6 (1948) 304 (non Mildbr. et Hutch., 1915).—*F. microtricheros* Backer, Bekn. Fl. Java 6 (1948) 40.—*F. cordifolia* Bl. sensu Koord. et Val. Bijdr. Booms. Java 11 (1906) 57, 60; Ic. Bog. XI, t.16: Atlas 4 (1916) f. 701.—This is the most widely distributed species of the subgenus. Collections are few, possibly because it is a large tree, but they indicate a range from North Thailand through Malaya, Sumatra, Java, Timor, and New Guinea to Queensland, where the species was common. *F. assimilis* Baker is a very close ally in Madagascar. I have examined all types; sterile specimens can easily be recognised from the amphigenous cystoliths.

var. **glabra** Corner v. nov.—Praeter setas internas glabra. Borneo (J. Motley 613, Banjarmasin, typus herb. Cambridge).

This is the only collection of the species from Borneo.

ser. Vasculosae Corner subser. Vasculosae

F. gratiosa Corner sp. nov.—Arbor 10 m. alta, foliis spiraliter dispositis. Ramuli, petioli, et costa (subtus) pilis cinnamomeis v. fusco-brunneis 0.5–1 mm. longis villosis-tomentosis, etiam saepe pilis minutis undulatis: nervi subtus villosi v. sparsim puberuli. Ramuli 2–4 mm. crassi. Stipulae 10–25 mm. longae, brunneo-sericeae. Lamina 12–20 × 3.5–5.7 cm., lanceolato-elliptica v. lanceolato-obovata, subacuta v. obtuse subacuminata, basi cuneata, subcoriacea, rigida, supra nitida, sicco griseo-viridis v. subfusca: costis lateralibus utrinsecus 10–13, obliquis, subtus valde elevatis, intercostis 0–1, nervis reticulatis supra leviter elevatis; nervis basalibus utrinsecus 1, brevibus, glandulis basalibus 2: petiolo 12–25 mm. longo. Receptacula axillaria, binata v. solitaria, brunneo-villosa glabrescentia: pedunculo 2–8 mm. longo: bracteis basalibus 1.5–3 mm. longis, sericeis: pedicello 0–2 mm. longo: corpore receptaculi 13–20 mm. lato, subglobo, ostiolo 3–4 mm. lato bracteis parvis numerosis ocluso:

setis internis nullis: cellulis scleroticis in pariete copiosis, tenuitunicatis. Tepala (3-) 4, lanceolata, longa glabra, in floribus masculis cecidiophorisque plus minus gamophylla. Flores masculi ostiolares, raro dispersi, sessiles: stamen 1 (-2). Semina 1.2-1.5 mm. longa, anguste carinata. Cystolitha hypogena. Celebes.

NIFS bb. 19584, Malili, 1,300 m. alt. (*typus*, herb. Leiden). Koorders 19349, Minahassa (Ficus sp. "R"). Sarasin 438, Minahassa, Tomaton (F. mollicosta Warb. ined.). Kjellberg 2688, Porema, 1,200 m. alt.

var. *caudata* Corner v. nov.—Lamina -27×9 cm., elliptica, apice caudato -30 mm. longo: intercostis 3-7: petiolo -40 mm. Receptacula pedunculo 2-3 mm., pedicello -10 mm. praedita: setis internis sparsis: pariete 2-3 mm. crasso. Celebes (Kjellberg 2886, Todjamboe, 800 m. alt., *typus*—herb. Stockholm).

Species distinctissima, *F. pubinervem* Bl. revocans sed lamina nitida, stipulis brevibus, *F. vasculosae* Wall. affinium.

ser. Nervosae Corner

F. pachysycia Diels ex Corner sp. nov.—Arbor, foliis laxe spiraliter dispositis. Ramuli, stipulae, petioli, et costa subtus breviter appresse brunneo-pilosi, glabrescentes. Ramuli 4-5 mm. crassi. Stipulae -20 mm. longae. Lamina 10-19 \times 6.5-12 cm., elliptica, obtusa, basi cuneata, crasse coriacea, rigida, sicco brunnea: costis lateralibus utrinsecus 7-10, intercostis 3-5 ad ambas paginas leviter elevatis: nervis basalibus utrinsecus 1 (-2), brevibus: petiolo 12-25 \times 4-5 mm., crasso. Receptacula (? axillaria, solitaria), 40-50 \times 30-35 mm., oblongo-pyriformia, attenuata in pedicellum brevem 2-4 mm. latum bracteis lateralibus 1-2, c. 2 mm. longis, praeditum, bracteis haud in collare ternatis, ostiolo plano 4-5 mm. lato bracteis apicalibus 4-5 vix projicientibus occluso: setis internis nullis: pariete crassissimo, sicco 5-10 mm. crasso, valde sclerotico, lumine multo compresso et in sectione elliptico. Tepala 4, libera, rubra. Flores masculi dispersi copiosi: pedicellis 1.5-2.5 mm. longis: tepalis spathulatis: staminibus 2 (-3), haud mucronatis, pistillodio nullo. Flores cecidiophori pedicellis 0.5-2 mm. longis: tepalis ovato-lanceolatis: stigmatate breviter bifido. Flores feminei similes, sessiles. Semina ? Cystolitha hypogena. New Guinea (Clemens 3676, Morobe District; *typus*-herb. Berlin, det Diels ms.).

Lamina ut in *F. subnervosa* Corner, receptaculum *F. habrophyllam* Benn. (ser. *Austrocaledonicae*) revocans.

F. hombroniana Corner sp. nov.—Arbor 27 m. alta, latice seriffuo albedo, foliis spiraliter dispositis. Ramuli, stipulae petioli, et nervi subtus dense v. sparsim pilis subfulvis 0.5–1 mm. longis appresse vestiti, v. puberuli glabrescentes. Ramuli 2–4 mm. crassi. Stipulae 20–75 mm. longae, subulatae, curvatae, sericeae v. glabrae. Lamina 7–19 × 3.5–8.5 cm, elliptica, plerumque obovata, obtusa v. subacuta (? in juventute subacuminata), basi cuneata, subnitida, coriacea, sicco brunnea: costis lateralibus utrinsecus 9–13, confertis, inferioribus ad costam quasi rectangularis, subparallelis, intercostis 0–4 indistinctis, vix elevatis: costis basalibus utrinsecus 1 (–2), glandulis basalibus 2: petiolo 5–22 × 2–3 mm. Receptacula axillaria, binata, glabra, maturitate rufa: pedunculo 0–2 mm. longo: bracteis basalibus 2–3, 1–1.5 × 1.5–2 mm., ovato-acutis, appresse puberulis: pedicello 2–12 × 1 mm.: corpore receptaculi 10–12 mm. lato, subgloboso v. ovoideo, ostiolo 1–1.5 mm. lato bracteis apicalibus 2–3 ocluso: setis internis nullis: cellulis scleroticis copiosis per parietem 1.2–2 mm. crassum. Perianthium gamophyllum, breviter 2–3-lobatum, rubrum, glabrum. Flores masculi ostiolaris sessiles, et dispersi pedicellati: stamine 1. Flores feminei et cecidiophori sessiles v. pedicellati: stigmatibus bifido. Semina in loculis in pariete ligneo receptaculi plus minus inserta. Cystolitha hypogena. Moluccas, New Guinea, Solomon Isl.

Amboina:—de Fretes 5762; Hombron s.n. (herb. Paris); H.B. 1885 (herb. Utrecht 47537); de Vriese s.n. (herb. Leiden). Batjan:—n. 5610 (Herb. Utrecht 47536). Boeroe:—Stresemann 367. Saparoea:—Reinwardt s.n., 1821 (herb. Leiden). Netherlands New Guinea:—BW 6506, Asmat region, Erma, 'terkeen' (Asmat). Papua:—Brass 28598 (typus, Grey herb., Harvard), 28653, Woodlark Isl, Kalumadau. Solomon Isl.:—J.H.L. Waterhouse B286a. Bougainville, Siwai, 'tuparemu', 'tarimu'. Java:—cult. Hort. Bog. VIII C 9.

A Hombron (Voyage de l'Astrolabe et de la Zélée, 1838–1840) primo collecta sed in statu sterili. Hic *F. pubinervem* Bl. pilis appressis stipulis elongatis similis, illic receptaculis floribusque *F. smithii* Horne revocans; lamina etiam ut in *F. pachystemon*.

F. pubinervis Bl. var. **diandra** Corner v. nov.—Flores masculi ostiolaris sessiles, et dispersi pedicellati: staminibus 2, raro 1. Receptacula 6–8 mm. lata, sessilia. Stipulae 10–28 mm. longae. Celebes.

Kjellberg 2060, Waroe-waroe; Kjellberg 2100, Malili; NIFS Cel/II–366, Malili, Oesoe; NIFS bb. 1831, Malili, La Roua; Teysmann 12423, Pangkadjena (typus, herb. Bogor); Teysmann 12773 (Maros), 13964 (Bonthain, Lokka).

Receptaculis parvis diandris distinguenda; ad *F. subtrinerviam* v. *doormanianam* approximans.

F. pubinervis Bl. v. **sibulanensis** (Elm.) Corner comb. nov.—*F. sibulanensis* Elm. Leaflet. Philip. Bot. 4 (1911) 1266.—*F. pubinervis* Bl. f. *sibulanensis* (Elm.) Sata, Monogr. (1944) 187.—Lamina subtus pilis erectis molliter villosa. Philippines (Elmer 11154, Mindanao, Mt. Apo, *typus*; Bur Sci. 17530, Samar, det. *F. samarensis* Merr. ined.).

F. subnervosa Corner sp. nov.—Arbor –25 m. alta, cortice griseo, latice copioso, foliis laxè spiraliter dispositis, glabra. Ramuli 1–2.5 mm. crassi. Stipulae 7–26 mm. longae, in novellis prominentes. Lamina 9–22 × 3.6–10 cm., elliptica v. obovata, obtusa, subacuta v. obtuse subacuminata, basi cuneata, tenue coriacea, sicco brunnea: costis lateralibus utrinsecus 5–9 (–10), subtus vix elevatis, intercostis 1–3 indistinctis: costis basalibus utrinsecus 1 (–2), brevibus, glandulis basalibus 2: petiolo 7–22 mm. Receptacula axillaria, binata v. solitaria: pedunculo 0–6 mm. longo: bracteis basalibus 3, 1 mm. longo: pedicello 2–4 mm. longo: corpore receptaculi 10–18 mm. lato (17–30 mm., vivo), subglobo, ostiolo parvo plano bracteis apicalibus paucis ocluso: setis internis nullis: pariete 1–1.5 mm. crasso, carnosio, cellulis scleroticis nullis v. sparsis. Perianthium breviter 3–4-lobatum carnosum, rubrum. Flores masculi dispersi pauci pedicellati, ostiulares sessiles: stamine 1. Flores cecidiophori pedicellati, feminei sessiles: stigmatibus bifido. Semina 1 mm. longa, vix carinata. Cystolitha hypogena. New Guinea.

Netherlands New Guinea:—Aet 582, Tarera, pr. Oeta; Aet et Idjan 721, Jappen-Biak, pr. Seroei; Beccari s.n., Andai (R. Ist. Fir. 9244); BW 1828, Hollandia, Skyline; Kostermans 374, 450 (*typus*, herb. Leiden), 2940, 2961, Manokwari, Warnapi, Warsui, Momi; v. Royen 3060, Sorong.

Papua:—Brass 27288 (Fergusson Isl.), 28092 (Sudest Isl.), 28576 (Rossel Isl.). Terr. New Guinea:—Hoogland 4811, Northern district, Tufi subdistr., Korea village; Ledermann 6819, Sepik (det. *F. subulata* Bl.): J. C. Saunders 223, 449, Madang district, Bismark Range, Ramu valley.

Species glabra paucinervosa, receptaculi pariete carnosio, perianthio gamophyllo distincta. Cave *F. casearioidem* King et *F. pedunculosam* Miq., species dioicas.

F. kjellbergii Corner sp. nov.—Arbor mediocris, –5 m. alta, glabra, foliis dense spiraliter dispositis. Ramuli 1–2 mm. crassi. Stipulae 5–11 mm. longae. Lamina 4–7.5 × 2–3.8 cm., obovata, obtusa

v. subacuta, basi attenuato-cuneata, tenue coriacea, sicco fusco-brunnea: costis lateralibus utrinsecus 7-9, haud v. vix elevatis, intercostis nullis: costis basalibus utrinsecus 1, brevibus, glandulis basalibus 2 in axillis costarum lateralium primarum: petiolo 6-18 mm. longo. Receptacula axillaria, binata, maturitate e flavo rubescentia; pedunculo nullo: bracteis basalibus 2-3, 0.5 mm. longis, ad basim pedicelli 6-9 mm. longi: corpore receptaculi 6-8 mm. lato, subgloboso, ostiolo plano 1 mm. lato bracteis apicalibus parvis ocluso: setis internis nullis: cellulis scleroticis in pariete copiosis. Perianthium breviter 3 (-4)-lobatum, rubrum. Flores masculi ostiolaris sessiles (? paucissimi dispersi): stamine 1. Flores cecidiophori pedicellati, feminei sessiles: stigmatibus bifido. Cystolitha hypogena. Celebes (Kjellberg 2437, Tolala, *typus* herb. Stockholm).

Ut *F. hombroniana* Corner, sed in omnibus partibus minor et paucinervosa, stipula haud prominente.

F. subtrinervia Laut. et K. Schum. var. **doormaniana** (Diels) Corner comb. nov.—*F. doormaniana* Diels, Engl. Bot. Jahrb. 67 (1935) 192.—*F. behrmanniana* Diels, id.—Lamina 24×8.5 cm., ovato-lanceolata v. elliptico-lanceolata, attenuata v. subacuminata: costis lateralibus utrinsecus 8-16. Bractee basales acutae. Plus minus glabra. New Guinea.

H. J. Lam 1380, Mamberamo R., Doorman R. (*typus*); Docters v. Leeuwen 10259, Rouffaer R.; Kanehira et Hatusima 12813, pr. Nabire; NIFS bb. 30583, Jappen Isl., Seroei; Ledermann 8249, Sepik (*typus*, *F. behrmanniana* Diels); Brass 13222, 13433, 13679, Idenburg R.; Brass 28076, Papua, Sudest Isl.; Hinds s.n., (det *F. pubinervis*).

Ad *F. pubinervis* v. *diandram* Corner approximans, sed costis lateralibus pluribus.

F. pachystemon Warb. in Laut. et K. Schum. Nachtr. Fl. Schutzgeb. (1905) 242.—*F. mangiferifolia* Laut. et K. Schum. Fl. Schutzgeb. (1901) 275, haud Griffith 1854.—The type of *F. pachystemon* (Dahl s.n., Ralum, Gazelle Peninsula, Neu Pommern) at Berlin has shorter leaves and smaller figs ($10-11 \times 8-9$ mm.) than in the later homonym *F. mangiferifolia* but I can see no other difference. The species seems not uncommon as a river-side shrub or tree in New Guinea and New Britain, and such variability is likely.

F. madhucifolia Corner sp. nov.—Arbor, foliis fasciculato-confertis, glabra. Ramuli 3 mm. crassi. Stipulae ~ 30 mm. longae. Lamina $8-20 \times 3-9$ cm., anguste obovata, subacuta, basi

cuneata, tenue subcoriacea, sicco brunnea: costis lateralibus utrinsecus 7-9, subtus leviter elevatis, 0-2 (-3) intercostis: costis basalibus utrinsecus 1, brevibus, glandulis basalibus 2: petiolo 7-20 mm. longo. Receptacula axillaria, binata, sessilia, 10-11 mm. lata, subglobosa, ostiolo plano bracteis apicalibus applantatis 3 ocluso: bracteis basalibus 3, 2-3.5 × 2-2.5 mm., ovatis, acutis: setis internis nullis: cellulis scleroticis in pariete copiosis. Tepala 3-4, libera, rubra, oblonga. Flores masculi dispersi, copiosi, plus minus sessiles: stamine 1. Flores cecidiophori sessiles v. breviter pedicellati, feminei sessiles: stigmatibus bifido. Cystolitha hypogena. Celebes (Buwalda 3719, Bantimoe-rong, *typus* herb. Leiden; Teysmann 12621, 12637, Tjambu).

F. gratiosam Corner lamina floribusque sessilibus revocans, sed glabra, receptacula sessilia, flores masculi dispersi copiosi.

F. hadroneura Diels, Engl. Bot. Jahrb. 67 (1935) 186.—This extremely interesting, large-leaved species, allied perhaps with *F. pseudojaca* Corner, is represented by three sterile collections and the type (Lane Poole and Brass 290), of which there is a leaf only in the Berlin-herbarium, but a leafy twig with figs in the Brisbane-herbarium. This Brisbane specimen is labelled by Diels and must be taken as the type. Identical with it are:—

BW 390, 365, Manokwari, Prafi, 'ateska'; J. C. Saunders 532, Terr. New Guinea, Madang subdistr., Ramu valley, 5 miles S.E. of the Faita airstrip, rainforest, c. 800 ft. alt., 'uli' (Bilia), 'bambam' (Amele), 'sungung' (Dumpu).

F. pseudojaca Corner sp. nov.—Arbor -35 m. alta, cortice brunneolo, latice cremeo, foliis distichis. Ramuli, petioli, et stipulae pilis flexuosis cervicolaribus 0.5-1 mm. longis villosi, costae et costulae subtus appresso-puberulae. Ramuli 2.5-4 mm. crassi. Stipulae 12-18 mm. longae. Lamina 10-21.5 × 4.5-14 cm., elliptica v. ovato-elliptica. subacuta v. breviter acuminata, basi rotundata v. late cuneata et minute auriculata, subasymmetrica, chartacea v. tenue coriacea, sicco fusco-brunnea v. griseo-viridis: costis lateralibus utrinsecus 10-15, supra impressis, subtus prominentibus, intercostis 3-9, nervulis reticulatis supra tenue, subtus valdius, elevatis: costis basalibus utrinsecus 3, brevibus, glandulis basalibus 2: petiolo 6-20 × 2.5-3.5 mm. Receptacula ? Cystolitha hypogena. New Guinea.

Netherlands New Guinea:—BW 1399, Salawati Isl. Terr. New Guinea:—NGF 1944, Lae; J. C. Saunders 289, 294, 301, 430 (*typus*, herb. Lae), 595, Madang district, Ramu Valley. Papua:—L. E. Cheesman 40, Kokoda.

Specimina sterilia, nihilominus species facile distinguenda, *Artocarpum* simulans, forsan *F. hadroneurae* Diels affinis.

ser. *Austrocaledonicae* Corner

F. habrophylla G. Bennett ex Seem. Fl. Vit. (1868) 248.—*F. bennettii* Seem. id., 250.—*F. tanensis* G. Bennett ex Seem. id., 248.—*F. edulis* Bur. Ann. Sci. Nat. ser. 5, Bot. 14 (1872) 271.—The types of *F. habrophylla* and *F. tanensis* at Kew, both from Tanna, show that they are identical with *F. edulis*, as Bureau suspected. The type of *F. bennettii*, at the British Museum, is from a plant cultivated in the Sydney Botanic Garden. This is an extremely variable species requiring field-examination.

F. granatum Forst. f. var. **minor** Corner v. nov.—Arbor —25 m. alta. Stipulae, pedunculi, bractaeque basales tenue appresse brunneo-puberuli. Ramuli 2–4 mm. crassi. Lamina 11–23 × 6–10 cm., elliptica v. elliptico-obovata, obtusa v. subacuta, basi cuneata: costis lateralibus utrinsecus 9–11, intercostis 1–3: petiolo 20–80 × 1.5–2.5 mm. Receptacula maturitate rubra: pedunculo 0–5 mm. longo: bracteis basalibus 3, 1–1.5 mm. longis, caducis: pedicello 2–6 mm. longo: corpore receptaculi 10–11 × 8 mm., ellipsoideo, ostiolo plano 1.5 mm. lato bracteis apicalibus disciformibus ocluso: setis internis copiosis: cellulis scleroticis in pariete copiosis. New Hebrides (Aneityum, Eromango: Kajewski 324, 732-typus herb. Kew, 956).

Ut v. *granatum* sed gracilior et receptacula multo minora, v. *granatum* ipsa quamvis raro collecta nec satis cognita.

F. smithii Horne ex Baker var. **robusta** Corner v. nov.—Arbor —30 m. alta, stipulis ramulisque appresse brunneo-pilosis glabrescentibus. Lamina 7–22 × 3.6–9.5 cm., elliptica v. elliptico-obovata, obtusa v. subacuta: costis lateralibus utrinsecus 8–13: petiolo 15–35 × 1.5–3 mm. Receptacula 10–13 mm. lata, pedunculo 7–15 × 1–1.5 mm, pedicello 0–5 mm.: cellulis scleroticis sparsis in strato parietis interno. Flores masculi et cecidiophori pedicellis induratis scleroticis. New Hebrides (Aneityum), Fiji (Viti Levu, Vanua Levu, Taveuni), in silvis ad 700 m. alt.

New Hebrides:—Kajewski 862, 955, Aneityum, Anelgauhat Bay. Vanua Levu:—A. C. Smith 605, 1728. Viti Levu:—A. C. Smith 5357, 5879, 5952, 5995, 8497, 8709, 9162, 9273. Taveuni:—J. W. Gillespie 4753, A. C. Smith 8339 (typus, herb. Cambridge).

Var. *smithii* gracilis, —15 m. alta: lamina —13 × 4.2 cm., anguste elliptica v. lanceolata, obtuse acuminata, costis lateralibus

utrinsecus 7-9, petiolo 4-14 mm.: receptacula 5-6 mm. lata, pedunculo 6-12 \times 0.5 mm., gracillimi, cellulis scleroticis in pariete copiosis: Fiji, Solomon Isl. (Guadalcanal).

F. austrocaledonica Bur. var. **balansaeana** (Bur.) Corner comb. nov.—*F. balansaeana* Bur. Ann. Sci. Nat. ser. 5, Bot. 14 (1872) 262.—So far as I can see this differs from v. *austrocaledonica* merely in the closely and appressedly hairy twigs, petioles, pedicels, and fig-body. It is known only from the type, Balansa 138 (New Caledonia, Prony Bay).

Taxonomic Notes on *Ficus* Linn., Asia and Australasia

III. SUBGEN. *FICUS* AND SECT. *FICUS*

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Summary

NEW SUBSECTIONS, series and subseries of sect. *Ficus*:—subsect. *Ficus* ser. *Rivulares*, *Pseudopalmeae*, *Sinosyceae*, *Cariceae*, *Erythroyneae*, *Podosyceae*, subser. *Basitopalae*; subsect. *Eriosyceae* (Miq.) Corner, ser. *Eriosyceae*, subser. *Eriosyceae*, *Trichosyceae*, *Dehiscentes*, *Cuneifoliae*; ser. *Auratae*, subser. *Auratae*, *Monandreae*.

Earlier specific epithets:—*F. subincisa* B. Ham. ex J.E. Sm. (*F. cunia* B. Ham. ex Roxb.), *F. neriifolia* J.E. Sm. (*F. nemoralis* Wall. ex Miq.), *F. gasparriniana* Miq. (*F. silhetensis* Miq.).

New species:—*F. trivialis*, *F. halmaherae*, *F. subfulva* et var. *villosula*, *F. litseifolia*, *F. endospermifolia*, *F. bruneiensis*, *F. brunneoaurata*, *F. androchaete*, *F. eumorpha* et v. *subglabra*, *F. paramorpha*.

New varieties and forms:—*F. deltoidea* Jack v. *angustifolia* (Miq.) Corner et f. *angustissima*, v. *arenaria*, v. *bilobata*, v. *borneensis* et f. *subhirsuta*, v. *intermedia*, v. *kunstleri* (King) Corner, v. *lutescens* (Desf.) Corner et f. *longipedunculata* et f. *subsessilis* (Miq.) Corner, v. *motleyana* (Miq.) Corner, v. *oligoneura* (Miq.) Corner, v. *peltata*, v. *trengganuensis*.—*F. oleaefolia* King v. *dodonaefiformis* (Gagnep.) Corner, v. *memecylifolia*, v. *myrsinoides*, v. *riparia*. *F. neriifolia* J.E. Sm. v. *fieldingii* (Miq.) Corner, v. *nemoralis* (Wall. ex Miq.) Corner, v. *trilepis* (King) Corner. *F. pedunculosa* Miq. v. *confertifolia* (Merr.) Corner, v. *imberbis* (Elmer) Corner, v. *macropoda* (Miq.) Corner, v. *mearnsii* (Merr.) Corner, v. *segaarensis* (Engl.) Corner, v. *velutina*—*F. erecta* Thunb. v. *erecta* f. *sieboldii* (Miq.) Corner, var. *beeheyana* (Hook. et Arn) King f. *koshunensis* (Hayata) Corner.—*F. gasparriniana* Miq. v. *esquirolii* (Lévl. et Vant.) Corner, v. *laceratifolia* (Lévl. et Vant.) Corner, v. *viridescens* (Lévl. et Vant.) Corner.—*F. stenophylla*

Hemsl. v. *macropodocarpa* (Lévl. et Vant.) Corner, v. *nhatrangensis* (Gagnep.) Corner.—*F. ischnopoda* Miq. v. *subcylindrica*.—*F. pustulata* Elmer v. *lanceifolia* (Sata) Corner.—*F. grossularioides* Burm. f. v. *robusta*, v. *stenoloba*.—*F. hirta* Vahl v. *appressa*, v. *brevipila*, v. *dumosa* (King) Corner, v. *malayana*, v. *squamosa*.—*F. simplicissima* Lour. v. *annamica* (Gagnep.) Corner.—*F. fulva* Reinw. v. *timorensis*.—*F. glandulifera* Wall. v. *camiguinensis* (Merr.) Corner, v. *villosa*.—*F. chartacea* Wall. v. *lanceolata*.—*F. tuphapensis* Drake v. *annamensis* (Gagnep.) Corner.—*F. aurata* Miq. v. *brevipilosa*, v. *longipilosa*, v. *palawanensis*, v. *pedunculata*.—*F. macilenta* King v. *gibbsiae* (Ridley) Corner, v. *ilicifolia*.—*F. setiflora* Stapf v. *adelpha*, v. *puberula*.

subgen. *Ficus*

subgen. *Eusyce* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 289.—subgen. *Carica* Mildbr. et Bur., Engl. Bot. Jahrb. 46 (1912) 174.—subgen. *Metamorphe* Sata J. Sci. Tr. Agr. Taiwan 6 (1934) 19.—subgen. *Eumetamorphe* Sata, Monogr. (1944) 244.—subgen. *Caricae* Sata, Monogr. (1944) pt. 4, 179.—Dioecious. Interfloral bracts absent. Style of gall-flowers much shorter than that of the female; female stigma simple or bifid, gall-stigma simple and, often, more or less infundibuliform. East Africa, Asia, Australasia, 312 spp.

I distinguish eight sections:—

sect. *Ficus*, sect. *Rhizocladus* Endl., sect. *Kalosyce* Miq. (sect. *Synoecia* Miq.), sect. *Sinosycidium* sect. nov., sect. *Neomorphe* King, sect. *Sycocarpus* Miq. (sect. *Covellia* auct.), sect. *Sycidium* Miq., sect. *Adenosperma* Corner.

sect. *Ficus*

This is the group with bistaminate male flowers which has *F. carica* Linn. as its type. I divide it into two subsections, each with several series. These subsections are so different in detail that they appear worthy of sectional rank. There are, however, a few species in South China and Indochina which come between them and in some way bridge the differences. Hence I adopt the more conservative classification.

subsect. **Ficus**.—Semina laevia, non v. vix carinata. Tepala plerumque glabra. Flores masculi ostiolares v. dispersi, antheris non mucronatis. Lamina cystolithis praedita. Glandulae microscopicae capitatae, cellulis 2–4, v. flabelliformes. East Africa usque ad Japan et New Guinea, 31 spp. Typus, *F. carica* Linn.

ser. **Rivulares** Corner ser. nov.—Semina compressa, auriculiformia. Perianthium cupulare 2–4-lobatum, ovario albido plus minus obtegens. Flores masculi ostiolares, staminibus (1–) 2. Stigma simplex. Receptacula axillaria, solitaria. Cystolitha hypogena. Ins. Philippines, 1 sp. *F. rivularis* Merr.

ser. **Pseudopalmeae** Corner ser. nov.—*Ficus* sect. *Pseudopalma* Elmer, Leaf. Philip. Bot. 1 (1908) 283.—Semina lentiformia. Flores sessiles, masculi ostiolares. Tepala libera. Ovarium cecidiophorum rufo-brunneum longistipitatum. Arbuscula pachycaulis sparsim ramosa, foliis magnis brevipetiolatis grosse dentatis. Cystolitha amphigena. Ins. Philippines, 1 sp. *F. pseudopalma* Blanco.

ser. **Sinosyceae** Corner ser. nov.—Semina lentiformia. Tepala libera, rubra v. albida. Flores masculi ostiolares v. dispersi, staminibus 1–5. Receptacula plerumque solitaria, axillaria. Stipulae binatae. Cystolitha amphigena. India, Burma, China, Indochina, Thailand, 2 spp. *F. henryi* Diels, typus, et *F. subincisa* B. Ham. ex J. E. Sm. (*F. clavata* Wall. ex Miq.).

ser. **Cariceae** Corner ser. nov.—Semina lentiformia. Tepala libera, albida v. carnea, membranacea. Flores masculi ordinibus numerosis ostiolares, raro etiam dispersi: staminibus 2–4. Receptacula plerumque solitaria, axillaria. Folia palmato-lobata v. ovato-cordata, plerumque dentata. Cystolitha hypogena. East Africa, Asia Minor, Pakistan, India, Bonin Isl., 3 spp. *F. carica* Linn. (typus), *F. palmata* Forsk., *F. iidaiana* Wilson.

ser. **Erythrogynae** Corner ser. nov.—*Erythrogyne* Vis. ex Gasp. Parl. Giorn. Bot. 2 (1844) 219; Ann. Sci. Nat. ser. 3, 3 (1845) 348.—*Ficus* sect. *Erythrogynae* (Vis.) Endl. Gen. Pl. Suppl. 4, 2 (1847) 34.—subgen. *Erythrogyne* (Vis.) Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 289.—Semina magna reniformia, 2.5–6 mm. longa, vix carinata, per receptaculum pauca: cotyledones duplicatae. Tepala libera rubra, ovario femineo semper multo breviora. Flores masculi ostiolares. Ovarium cecidiophorum saepe crustaceum et rugoso-angulatum. Frutices v. arbusculae, saepe epiphyticae, haud sarmentosae. Folia acutilanceolata et penninervia, vel obtusa costa dichotoma, integra. Cystolitha hypogena. Western Malaysia, 2 spp. *F. deltoidea* Jack (typus), *F. oleaefolia* King.

ser. **Podosyceae** Corner ser. nov.—*Ficus* sect. *Podosycea* Miq. Hook. Lond. J. Bot. 7 (1848) 442.—sect. *Didymophora* Miq. et sect. *Thamnosycea* Miq., id. 453, 454.—sect. *Eusyce* (Miq.) King subsect. *Frutescentiae* Sata, Monogr. (1944), 332, 385 (lectotypus, *F. pedunculosa* Miq.).—Semina 1–3 mm. longa, lentiformia v. reniformia, per receptaculum numerosa. Tepala libera, raro

conjuncta, *rubra*, ovario femineo equalia v. breviora. Flores masculi dispersi, raro solum ostiolares. Frutices v. arbores, raro epiphyticae sed nonnullae repentes. Asia, Malaysia, 22 spp. Typus, *F. pedunculosa* Miq.

subser. **Podosyceae**.—Flores cecidiophori et sessiles et pedicellati, tepalis ovario sessili v. substipitato plus minus equalibus. Flores feminei tepalis ovario longioribus v. brevioribus. 10 spp. Typus, *F. pedunculosa* Miq.

subser. **Basitopalae** Corner.—Flores cecidiophori plus minus sessiles, tepalis ovario longistipitato multo brevioribus, ut in floribus femineis. Sinohimalaya, Philippines, 4 spp. Typus, *F. abelii* Miq.

subsect. **Eripsycea** (Miq.) Corner subsect. nov.—*Ficus* sect. *Eripsycea* Miq. Hook. Lond. J. Bot. 7 (1848) 455; emend. Miq. Fl. Ind. Bat. I, 2 (1859) 293; Ann. Mus. Bot. Lugd. Bat. 3 (1867) 290.—sect. *Trichosyceae* Miq. Fl. Ind. Bat. I, 2 (1859) 296; Ann. Mus. Bot. Lugd. Bat. 3 (1867) 290.—Semina plerumque tuberculata v. echinata, carinata et basi duplice carinata, haud compressa. Tepala rubra v. albido-ochracea et setosa. Flores masculi ostiolares: staminibus 2, 1–2, vel 1, antheris breviter mucronatis v. modo acutis. Cystolitha nulla. Glandulae microscopicae capitatae, cellulis plerumque numerosis. Frutices v. arbores, haud epiphyticae, foliis saepe palmato-lobatis praecipue juvenilibus. Asia, New Guinea, 28 spp. Typus, *F. grossularioides* Burm. f.

ser. **Eripsyceae** Corner ser. nov.—Tepala rubra 3–7, plerumque 4–5, glabra v. apice marginibusque ciliolatis. Stamina et ovaria saepe basi setulis circumdata. 19 spp. Typus, *F. grossularioides* Burm. f.

subser. **Eripsyceae**.—Folia subtus areolis obscuratis pilis undulatis albidis griseis v. fulvis lanata, juvenilia plerumque palmato-lobata. China, Indochina, Thailand, West Malaysia, 3 spp. Typus, *F. grossularioides* Burm. f.

subser. **Trichosyceae** Corner subser. nov.—sect. *Trichosyceae* Miq. l.c.—Folia subtus haud lanata, areolis haud obscuratis, dentata v. denticulata, juvenilia saepe palmato-lobata. India, China, usque ad ins. Moluccanas, 7 spp. Typus, *F. hirta* Vahl.

subser. **Dehiscentes** Corner subser. nov.—Folia subtus haud lanata, integra, intercostis numerosis strictis, juvenilia raro palmato-lobata. Receptacula cecidiophora irregulariter dehiscentia, maturitate viridia v. flavescencia, feminea rubra indehiscentia. India usque ad New Guinea, 3 spp. Typus, *F. glandulifera* Wall. ex Miq.

subser. **Cuneifoliae** Corner subser. nov.—Folia subtus haud lanata, parviuscula integra, intercostis paucis et saepe laxis, basi cuneata, brevipetiolata, juvenilia haud v. raro palmato-lobata. Receptacula cecidiophora ut feminea rubescentia indehiscentia. Stamina 1–2, vel 1, antheris haud mucronatis. India, China, Indochina, Thailand, Malaya, Sumatra, Borneo, 3 spp. Typus, *F. chartacea* Wall. ex King.

ser. **Auratae** Corner ser. nov.—Flores feminei et cecidiophori tepalis 3–4 (–5) albidis v. ochraceis dense setosis. Setulae c. stamina et ovaria plerumque deficientes. Setae internae copiosissimae rigidae. Indochina, Thailand, Malaya, Sumatra, Borneo, Palawan, 9 spp. Typus, *F. aurata* Miq.

subser. **Auratae**.—Flores masculi ordinibus numerosis ostiolaris, sessiles et pedicellati, tepalis haud setosis, staminibus 2. Receptacula 10–26 mm. lata, plerumque sessilia. Lamina majuscula. 4 spp. Typus, *F. aurata* Miq.

subser. **Monandreae** Corner subser. nov.—Flores masculi ordine uno ostiolaris sessiles, v. etiam ordine secundo pedicellati, tepalis albido-setosis ut in floribus cecidiophoris, stamine uno. Receptacula 10–16 mm. lata, sessilia v. pedunculata. Lamina saepe minuscula. Borneo, 5 spp. Typus, *F. setiflora* Stapf.

subject. **Ficus ser. Sinosycae** Corner

F. subincisa B. Ham. ex J.E. Sm. Rees Cyclop. 14 (1810) n. 91.—*F. chincha* Roxb. Fl. Ind. 3 (1832) 534.—*F. clavata* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 431.—*F. caudata* Griff. Ic. Pl. As. (1854) t. 557 (i).—The type of *F. subincisa* is in the herbarium of the Linnean Society of London (n. 1610.42), and there is a specimen of *F. chincha* named by Roxburgh in the Martius herbarium at Brussels. They leave no doubt that they are earlier names for the same species as *F. clavata* Wall.

subject. **Ficus ser. Erythrogyneae** Corner

F. deltoidea Jack, Mal. Misc. 2 (1822) 71; Merrill, J. Arn. Arb. 33 (1952) 225.—This common shrub of Western Malaysia is now represented in herbaria by more than 600 collections, and I have myself studied many more living plants. Superficially there is bewildering diversity, but attention to detail has led me to distinguish twelve varieties. Most of these appear to have geographical delimitation which it should not be difficult to check because the plants are easy to recognise and to gather. It is,

however, necessary to collect gall-plants as well as the seed-plants, because diagnostic characters lie in the gall-ovary and tepals: in a few varieties it is impossible to classify seed-plants. *F. diversifolia* Bl. is the common Javanese mountain shrub known, through cultivation in Europe, as var. *lutescens* Desf., specimens of which are preserved in the herbaria at Paris, Kew, and Florence; Blume's type is at Leiden. Of Jack's two species, *F. ovoidea* and *F. deltoidea*, the first is authenticated by Wallich 4526 from Penang, labelled *F. ovoidea* Jack: King made this var. *ovoidea* which is antedated by var. *angustifolia* Miq. There remains the identity of *F. deltoidea*. Jack did not mention penninerved leaves, which he would surely have done if he had been describing var. *lutescens*. Hence I identify his plant with that of Sumatran and Malayan lowlands which lack the penninerved leaves in the adult state: his description agrees, but lacks other details diagnostic of particular varieties.

var. **angustifolia** (Miq.) Corner comb. nov.—*Synoecia diversifolia* (Bl.) Miq. v. *angustifolia* Miq. Pl. Jungh. (1851) 67.—*F. ovoidea* Jack. Mal. Misc. 2 (1822) 71.—*F. diversifolia* v. *ovoidea* (Jack) King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 140, pl. 174D.—Miquel's type, at Leiden, shows that it is the narrow spatulate-leaved variety of *F. deltoidea*.

f. **angustissima** Corner f. nov.—Ramuli 1–1.5 mm. crassi. Lamina 2–3.3 × 0.5–1 cm., anguste spatulata, costa sub mediam laminae dichotoma. Receptacula 5 × 3–4 mm., pedunculo 2–5 mm. longo. Semina 1–2 per receptaculum. Mentawai Isl.

H.H. B.B. 639 (Batoe), Iboet 259 (Siberut), Sing. F.n. 14753 (Sipora, *typus* herb. Singapore).

var. **arenaria** Corner v. nov.—Frutex –2 m. altus. Lamina 2.5–11 × 1.8–4 cm., plerumque elliptica v. anguste obovata, acuta v. subacuminata, penninervia, costis lateralibus utrinsecus 3–5: folia superiora pauca obovata, obtusa, costa ad v. super mediam laminae dichotoma. Receptacula 10–12 × 7–9 mm., ellipsoidea, v. 7–9 mm. lata subglobosa: pedunculo 1–9 mm. longo. Flores cecidiophori tepalis ovario angulato tenuiter crustaceo multo brevioribus. Borneo, ad terram arenosam.

Alston 13092 (Sampit); Brunei 5352 (Kuala Belait, *typus* herb. Cambridge), 5367 (Badas); Bur. Sci. 290 (Sandakan); Dunselman 103 (Singkawang); Hose 211 (Sarawak, Marudi, Baram); Purseglove 5024 (Bako National Park); Richards 2644, 2645 (Marudi, Sarawak).

This is like *v. intermedia* and *v. motleyana*, but differs from both in the short gall-tepals. Thus it suggests *v. deltoidea* but its leaves are mostly acute as in *v. motleyana*. I have seen many plants in the *kerangas*-vegetation in Sarawak and Brunei and consider that it is usefully distinguished.

var. **bilobata** Corner v. nov.—Frutex v. arbuscula –5 m. altus. Lamina 2–7 × 1–3.5 cm., spatulato-obovata v. obdeltoidea, apice saepe breviter bilobata, costa ad v. infra mediam dichotoma: glandula ad furcam costae, basalibus 2 v. nullis, aliquando glandulis parvis ad furcas nervorum: petiolo 3–25 mm. Receptacula 5–8 mm. lata, pedunculo 2–10 mm. longo. Tepala cecidiophora ovario rugoso-angulato equalia. Malaya (Selangor, Pahang, Perak, Kedah) in silvis montanis 1000–2000 m. alt. et ad cacumina collium calcareorum.

Sing. F.n. 2368 (Taiping Hill, *typus*, herb. Singapore), 8443, 11077, 19701, 29689, 32551, 38028, 38708; Ridley 7628; Haniff 3908; King's Coll. 2430; Scortechini 308; Wray 1099; Yapp 488.

This approaches *v. intermedia*, *v. kunstleri*, *v. lutescens*, and *v. trengganuensis*, but cannot be placed satisfactorily with any. It requires field-study. Possibly all these varieties converge to this effect in their high mountain forms.

var. **borneensis** Corner v. nov.—Ramuli 2–5 mm. crassi. Lamina 4.5–13 × 3–9 cm., obovata, obtusa v. subrotundata, costa plus minus ad mediam dichotoma, foliis ad basim caulis solo acutis penninerviis: glandulis 2 basalibus, raro ad furcam costae: petiolo 4–25 mm. longo, 3–4 mm. crasso. Receptacula 8–12 mm. lata (11–16 mm., viva), pedunculo 0.5–6 mm. longo: bracteis basalibus 2–2.5 × 3–4 mm. Flores cecidiophori sessiles v. breviter pedicellati: tepalis ovario valde rugoso-angulato sessili v. longis-tipitato multo brevioribus. Borneo.

Amdjak 492; Anderson 9754; Brunei 649; Dunselman 90; Enderd 3920 (West Koetei, Mt. Kemoel, *typus* herb. Leiden); Hallier 1372, 2240; Sahib 16321; Sales 774; Sing. F.n. 27370; S. 4807, 5856, 9953.

This appears to be widely distributed in all parts of Borneo from the lowlands to an altitude of 1,500 m. In the large leaf and fig it approaches *v. kunstleri* (not known from Borneo), but differs in the short peduncle, short gall-tepals, and the fewer leaf-glands. Thus it is, in fact, an enlarged state of *v. deltoidea*.

f. **subhirsuta** Corner f. nov.—Receptacula tenuiter appresse pilosa, aliquando etiam ramuli. Sarawak, S. Borneo.

Beccari 274, 815, 1246; Clemens 21907 (Gat, Upper Rejang River, *typus* herb. Br. Mus.); Sarawak Mus. 4807; Teysmann 7118.

Varietates *F. deltoideae* praecipue glabrae.

var. **intermedia** Corner v. nov.—*F. kinabaluensis* Stapf, Tr. Linn. Soc. Bot. ser. 2, 4 (1894) 226.—*F. burkillii* Ridl. Fl. Mal. Pen. 3 (1924) 330.—Frutex –4 m. alta. Folia plerumque dimorpha, penninervia ut in v. *motleyana*, vel lamina obtusa spathulata 3–10 × 1.5–5.5 cm., semper longiori quam lata, costa super mediam, saepe prope apicem, dichotoma: glandulis 2 basalibus: petiolo 2–15 mm. Receptacula rubra dein nigro-purpurea, 6–10 mm. lata, subglobosa: pedunculo 1–11 (–15) mm.: bracteis basalibus 1–2 mm. longis. Flores cecidiophori tepalis ligulatis v. lanceolatis ovario laevi v. leviter subangulato longioribus. Malaya, Borneo, (? Celebes), in silvis montanis 800–2,600 m. alt. saepe epiphytica. *Typus*, Purseglove 4281 (Pahang, Fraser's Hill, herb. Singapore).

I distinguished this variety because it comes between v. *motleyana* and v. *lutescens* and predominates in Malayan mountains where neither of these varieties occurs. The differences from v. *motleyana* are the more coriaceous leaf, the subglobose fig, the smooth gall-ovary, and the greater production of obtuse leaves with dichotomous midrib. On Mt. Kinabalu it seems that these obtuse leaves are few, and specimens exactly like those of *F. kinabaluensis* have been collected from G. Tahan in Malaya. Generally, in Malaya abundant obovate obtuse leaves are formed and this is *F. burkillii*.

All the numerous collections from Malaya identified as *F. deltoidea* (or *F. diversifolia*) v. *lutescens* belong here and, also, the following from Borneo:—

Clemens 10700, 10996, 20161, 28787, 28932, 29257, 29916, 30292, 30294, 30296, 30766, 30988, 31503, 31665, 32936, 32937, 32940, 33193, 33625, 33830, 40696, 50635, 51082. Endert 3912, 3917. Haviland 1215, 1216. Purseglove 5024. San. 17580. Sing. F.n. 12209, 26400, 27524, 27695, 27714, 28007. SK 29, 136.

var. **kunstleri** (King) Corner comb. nov.—*F. diversifolia* Bl. v. *kunstleri* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 140, pl. 175 A, B.

var. **lutescens** (Desf.) Corner comb. nov.—*F. diversifolia* Bl. Bijdr. (1825) 456.—*F. lutescens* Desf. Cat. ed. 3 (1829) 413.—*F. diversifolia* Bl. v. *lutescens* (Desf.) King, Ann. R. Bot. Calc. 1,

2 (1888) 140.—This is the Javanese and Sumatran plant with the obtuse leaves broad and with the midrib dichotomous at or below the middle.

f. **longipedunculata** Corner f. nov.—(*F. diversifolia* Bl. v. *longipedunculata* Miq. ined.).—Pedunculi 14–30 mm. longi. Java, Sumatra.

Sumatra:—Beccari 190 (Mt. Singalan); Bunnemeyer 5629 (G. Gombah), 9187 (G. Koerintji, *typus* herb. Leiden); Meijer 5008 (Mt. Sago); v. Steenis 3669 (G. Pesagi).

Java:—Backer 8677, 25722, 25941; Blume s.n. (G. Salak); Coert 689; Harrevelde 1961; Herb. Junghuhn s.n. (G. Gedeh), n. 177, et s.n. (Hoch Ankola); Koorders 9404, 9406, 26491, 26812; Schiffner s.n. (1872); de Vriese s.n. (det. v. *longipedunculata* Miq. ms., ? Java, ? Sumatra).

f. **subsessilis** (Miq.) Corner comb. nov.—*F. diversifolia* Bl. v. *subsessilis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 268, 289.—Pedunculi 0–4 mm. longi. Java, Sumatra.

This is represented by many collections. The type (de Vriese, Batjan, herb. Leiden, herb. Utrecht) was said to come from the Moluccas, but these lie outside the range of the species and, I think, this was an error for Java.

var. **motleyana** (Miq.) Corner comb. nov.—*F. motleyana* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 228, 294.—The typical form of *F. motleyana* with oblong, shortly pedunculate fig and only lanceolate, acute, penninerved leaves seems specifically distinct, but *F. deltoidea* v. *intermedia* provides so many intermediates that it is almost impossible to draw a line between them in the herbarium.

var. **obligoneura** (Miq.) Corner comb. nov.—*F. oligoneura* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 289.—*Urostigma oligoneuron* Miq. Fl. Ind. Bat. Suppl. (1860) 438.—This is close to v. *lutescens* but has larger figs and long-pedicellate gall-flowers. Its leaf is extremely variable.

v. **peltata** Corner v. nov.—Frutex repens gracilis, internodiis elongatis. Lamina 1.5–2.7 cm. lata, suborbicularis, anguste peltata, costa infra mediam dichotoma: glandulis 3 (2 basalibus, 1 ad furcam costae): petiolo 10–18 × 1 mm. Receptacula 8 × 5 mm., ellipsoidea: pedunculo 1–1.5 mm. longo: pedicello 2–3 mm. longo: Flores cecidiophori sessiles v. pedicellati: tepalis 4–5 ligulatis, ovario laevi equalibus v. longioribus. Sumatra (Mt. Sago, Harau Canyon, ad scopulos).

Meijer 3980 (*typus*, herb. Cambridge); Jacobsen 2194.

Habitu repenti foliis suborbicularibus anguste peltatis distinctissima sed v. *lutescentis* affinis.

var. **trengganuensis** Corner v. nov.—Ramuli 2 mm. crassi. Lamina 2.3–8 × 1.8–5.5 cm., elliptica v. rotundato-obovata, etiam subbilobata, costa ad v. super mediam dichotoma: glandulis 3–4 (–5), 2 basalibus, ceteris ad furcas nervorum: petiolo 10–50 mm. longo. Receptacula 9–12 mm. lata (14–18 × 11–14 mm., viva), roseo-rubra dein nigro-purpurea: pedunculo 6–20 × 1.5 mm.: bracteis basalibus 1–1.5 mm. longis. Flores cecidiophori sessiles v. pedicellis –1.5 mm. longis praediti: tepalis 3–4, lanceolatis v. ligulatis ovario rugoso-angulato equalibus, saepe pilo apicali praeditis. Malaya (Trengganu, Pahang costa orientali) in locis arenosis et montanis, terrestres v. epiphytica.

Cons. For. 3112: Kep. F.n. 37354; Ridley 1401, 1444; Sing. F.n. 15346, 17458, 17515, 25841, 30079 (*typus*, herb. Singapore), 31039, 31075, 39914, 40405; Vesterdal 284.

Inter v. *kunstleri* et v. *intermediam* sed lamina elliptica obtusa.

F. oleaefolia King var. **dodonaeformis** (Gagnep.) Corner comb. nov.—*F. dodonaeformis* Gagnep. Lec. Notul Syst. 4 (1927) 90.

var. **epiphytica** (Elmer) Corner comb. nov.—*F. williamsii* C. B. Robinson Philip. J. Sci. Bot. 3 (1908) 177.—var. *epiphytica* Elmer, Leafl. Philip. Bot. 7 (1914) 2396.

var. **memecylifolia** Corner v. nov.—Frutex v. arbuscula –5 m. alta. Lamina 2–7 × 0.7–2.7 cm., lanceolato-elliptica, acuminata, saepe obtusiuscule; petiolo 1–7 mm. longo. Receptacula cecidiophora 4–5 mm. lata, subglobosa, feminea 4–7 × 3–6 mm. ellipsoidea: pedunculo 3–14 × 0.5 mm. Flores cecidiophori tepalis ovario valde angulato plerumque brevioribus. Semina 4 mm. longa, 1–4 per receptaculum. Borneo, Celebes, in silvis montanis muscosis 900–2000 m. alt., saepe epiphytica.

A v. *oleaefolia* pedunculo longiori gracillimi et a v. *myrsinoide* lamina acuminata differt.

Borneo:—Bur. Sci. 2027; Clemens 20696, 27939 (*typus*, herb. Br. Mus.) 26708, 28758, 30570, 31276, 34010, 40741; Ender 3837, 4268, 4398; For. Dept. B.N.B. A4461; Hallier 2673, 3421; Haviland 87; Pickles 3701, 3772; San. A4173; Sing. F.n. 26338. 27817. Celebes:—Kjellberg 1668 (Makale), 2310 (B. Wawoe Meesa), 2728 (Porema); NIFS 227 (O. Masamba Lemboeng).

var. **myrsinoides** Corner v. nov.—Frutex v. arbor –13 m. alta, trunco –20 mm. crasso. Lamina 2.5–9 × 0.8–3 cm., spatulata v. anguste obovata, apice obtusa v. rotundata: petiolo 1–10

mm. Receptacula cecidiophora 5–6 mm. lata subglobosa, feminea $7 \times 4\text{--}5$ mm. ellipsoidea: pedunculo $1.5\text{--}8 \times 0.7$ mm. Flores cecidiophori tepalis ovario laevi v. subangulato equalibus v. longioribus. Semina 3–4 mm. longa, 1–3 per receptaculum. Borneo, in silvis montanis muscosis 500–2100 m. alt., saepe epiphytica.

Kinabalu:—Clemens 11005, 29529, 29915, 29930, 31410, 31863, 32490, 32671, 32936, 40087, 40968; Sing. F.n. 26977, 27546, 27550 (*typus*, herb. Singapore); San. A4228; Sinclair 9058. Sarawak:—SK 87 (Merurong Plateau). Indonesian Borneo:—Amdjah 490 (Batoe Lesseng).

Receptaculo parvo gracile pedunculato, foliis obtusis distincta. var. **riparia** Corner v. nov.—Frutex riparius. Lamina $6\text{--}9 \times 1.5\text{--}2$ cm., lanceolata, acuta v. breviter acuminata: costis lateralibus utrinsecus 13–16: petiolo 2–5 mm. Receptacula cecidiophora 5–6 mm. lata subglobosa: pedunculo $15\text{--}20 \times 0.7$ mm. Flores cecidiophori tepalis ovario angulato brevioribus v. longioribus. Sarawak (Upper Baram River, 200 m. alt., Sing. F.n. 6871, *typus* herb. Singapore).

sect. *Ficus* ser. *Podosyceae* Corner subser. *Podosyceae*

F. neriifolia J.E. Sm. Rees Cyclop. 14 (1810) n. 21.—*F. gemella* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 454.—*F. nemoralis* Wall. ex Miq. var. *gemella* (Wall. ex Miq.) King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 162, pl. 206.—Smith's type (n. 1610. 39) in the herbarium of the Linnean Society of London is this characteristic plant with thick-walled fig.

var. **fieldingii** (Miq.) Corner comb. nov.—*F. nemoralis* Wall. ex Miq. var. *fieldingii* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 163.—*F. fieldingii* Miq. Hook. Lond. J. Bot. 7 (1848) 439.

var. **nemoralis** (Wall. ex Miq.) Corner comb. nov.—*F. nemoralis* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 453.

var. **trilepis** (King) Corner comb. nov.—*F. nemoralis* Wall. var. *trilepis* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 162.—*F. trilepis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 228, 294.

F. pedunculosa Miq. var. **confertifolia** (Merr.) Corner comb. nov.—*F. confertifolia* Merr. Philip. J. Sci. 18 (1921) 59.

var. **imberbis** (Elmer) Corner comb. nov.—*F. luzonensis* Merr. var. *imberbis* Elmer, Leaflet. Philip. Bot. 4 (1911) 1323.

var. **macropoda** (Miq.) Corner comb. nov.—*F. macropoda* Miq. Hook. Lond. J. Bot. 7 (1848) 442.

var. **mearnsii** (Merr.) Corner comb. nov.—*F. mearnsii* Merr. Philip. J. Sci. Bot. 3 (1908) 402.

var. **segaarensis** (Engl.) Corner comb. nov.—*F. segaarensis* Engl. Bot. Jahrb. 7 (1886) 453.

var. **velutina** Corner var. nov.—Hispidovillosa pilis brunneis 0.5 mm. longis mollibus, lamina supra tenuiter villosa. Lamina 13×6 cm., elliptico-obovata, breviter acuminata, acuta, basi anguste subcordata v. cuneata: costis lateralibus utrinsecus 6–8, basalibus ad $\frac{1}{4}$ laminae elongatis: petiolo 20 mm. longo. Receptacula ellipsoidea 12–15 mm. lata: pedunculo 30–40 mm.: pedicello 4–5 mm.: setis internis copiosis. Flores masculi dispersi. Burma (Toong Dong, Wallich 4528, *typus* herb. Kew).

In view of the numerous collections of *F. pedunculosa*, these species can now be treated only as varieties. The species extends from Formosa to New Guinea but in Malaysia it is not to the west of Celebes. The sole collection of v. *velutina* from Burma is therefore exceptional and needs further collecting.

F. erecta Thunb. var. **erecta** f. **sieboldii** (Miq.) Corner comb. nov.—*F. sieboldii* Miq. Ann. Mus. Bot. Lugd. Bat. 2 (1866) 199.—*F. erecta* Thunb. var. **sieboldii** (Miq.) King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 142, pl. 178B.

var. **beeheyana** (Hook. et Arn.) King f. **koshunensis** (Hayata) Corner comb. nov.—*F. koshunensis* Hayata, J. Coll. Sci. Imp. Univ. Tokyo 30 (1911) 276.—*F. beeheyana* Hook. et Arn. var. **koshunensis** (Hayata) Sata, J. Soc. Tr. Agr. 6 (1934) 22.

F. trivialis Corner sp. nov.—*F. cuneata* Lévl. et Vant. Fedde's Rep. 4 (1907) 84, pr. p. Bodinier 2363 (alt. p. = *F. heteromorpha* Hemsl.).—Frutex v. arbor 7 m. alta, foliis longipetiolatis spiralter dispositis. Ramuli glabri v. puberuli: petioli et costae (subtus) pilis fulvidulis patentibus 0.5–1.5 mm. longis sparsim puberuli, v. subglabri. Ramuli 2.5–4 mm. crassi, brunnei. Stipulae 6–15 mm. longae, appresse pilosae v. pilis patentibus. Lamina $5\text{--}18 \times 2.3\text{--}10$ cm., elliptica v. obovata, angustior ad ramulos superiores, apice acuta v. breviter acuminata 10 mm. longo, basi cuneata, integra, laevis, membranacea v. subcoriacea, sicco obscure viridis v. brunneola: costis lateralibus utrinsecus 4–7, v. 3–4 in foliis minoribus, obliquis, intercostis laxis 2–5, subtus leviter elevatis: costis basalibus utrinsecus 1–2, ad $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 9–70 mm. longo. Receptacula axillaria binata, maturitate rubra v. purpurea: pedunculo 3–8 mm. longo, glabro. v. puberulo: bracteis basalibus 3, 1–1.5 mm. longis, acutis, puberulis: corpore receptaculi

8–10 mm. lato, subglobozo v. subellipsoideo, ostiolo bracteis 3 planis ut disco 1.5–2 mm. lato ocluso: setis internis nullis v. paucis minutis: cellulis scleroticis nullis. Flores masculi pedicellati, ostiulares et dispersi, cecidiophoris equales v. longiores: staminibus 2. Flores cecidiophori sessiles v. pedicellati: tepalis ovario albido sessili v. substipitato longioribus. Flores feminei sessiles, tepalis ovario brevioribus: stylo glabro, stigmatate obliqua, haud bifido. Semina $2 \times 1.5 \times 1.3$ mm., subreniformia, vix carinata, laevia. Cystolitha hypogena. China, Tonkin, in silvis montanis.

F. chapaensis Gagnep. affinis sed stipula hirta, lamina laevi, pedunculo longiori differt.

China:—Bodinier 2363 (Kweichou); Cavalerie 7809, 7810 (Kweichou); Esquirol 2053 (Kweichou); Ford 175, 177 (Kwangtung); A. N. Steward et H. C. Cheo 446 (Kwangsi, Ling Yuen Hsien); Y. W. Taam 59 (Kwangsi, pr. Pai Shou); Y. Tsiang 6827 (Kweichou); T. M. Tsui 523, 716 (Kwangtung, Yang Shan, pr. Linchow). Indochina:—Bon 2709 (Tonkin, Dong Ham valley, *typus* herb. Paris).

F. gasparriniana Miq. Hook. Lond. J. Bot. 7 (1848) 436.—*F. silhetensis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 223, 291.—The type at Kew, though poor, leaves no doubt that it is the earlier name for *F. silhetensis*, a variable species.

var. **esquirolii** (Lévl. et Vant.) Corner comb. nov.—*F. esquirolii* Lévl. et Vant. Fedde's Rep. 4 (1907) 84.—This is a variety with lanceolate multicostate lamina.

Cavalerie 125, 129; Decker 144; Esquirol 2588 (*typus*); Faber 446; Y. Tsiang 1471, 6053; T. M. Tsui 643; E. H. Wilson 2789.

var. **laceratifolia** (Lévl. et Vant.) Corner comb. nov.—*F. laceratifolia* Lévl. et Vant. Fedde's Rep. 4 (1907) 85.—*F. rhomboidalis* Lévl. Fl. Kouy-Tcheou (1915) 433.—This is a form with lobed dentate leaves and, to judge from herbarium material of v. *gasparriniana*, it is not its sapling state.

Bodinier 1663 (*typus*); Cavalerie 420, 7813, 7814; Ducloux 2202; Esquirol 3267 (*typus*, *F. rhomboidalis*), 6365; Faber 444; W. P. Fang 2415, 5645; Henry 12090; W. R. Price 1268; A. N. Steward et H. C. Cheo 598.

var. **viridescens** (Lévl. et Vant.) Corner comb. nov.—*F. cyanus* Lévl. et Vant., et v. *viridescens* Lévl. et Vant. Fedde's Rep. 4 (1907) 84.—This is the more villous state of *F. gasparriniana*, which seems commoner at higher altitudes. There are many collections.

F. stenophylla Hemsl. emend. Rehder, J. Arn. Arb. 17 (1936) 79, 80.—var. **macropodocarpa** (Lévl. et Vant.) Corner comb. nov.—*F. macropodocarpa* Lévl. et Vant. Fedde's Rep. 4 (1907) 66.—This is a state with long peduncles (13–55 mm.).

China:—Cavalerie 3589, 7812; Esquirol 838, 2216; A. N. Steward et H. C. Cheo 833. Laos:—Poilane 1880. Annam:—Poilane 6584, 29168.

var. **nhatrangensis** (Gagnep.) Corner comb. nov.—*F. nhatrangensis* Gagnep. Lec. Notul. Syst. 4 (1927) 92.—This differs in the broader lamina (4–16 × 1.5–5 cm.) with fewer pairs of lateral nerves (5–10).

Poilane 3431 (*typus*, Nhatrang); Chevalier 38658 (Nhatrang) (? Kostermans 390, Thailand).

F. ischnopoda Miq. var. **subcylindrica** Corner v. nov.—Receptacula corpore 20–30 × 7–10 mm., subcylindrico: pedunculo 10–25 mm. longo. Annam (Tourane, Clemens 3442, *typus* herb. Kew, et 4009). Receptacula matura, floribus masculis apertis, non juvenilia.

subject. Ficus ser. Podosyceae Corner **subser. Basitopalae** Corner

F. pustulata Elmer var. **lanceifolia** (Sata) Corner comb. nov.—*F. cardinalicarpa* Elmer, Leafl. Philip. Bot. 4 (1912) 1391.—var. **lanceifolia** Sata et v. **linearifolia** Sata, Monogr. (1944) 356. This differs from v. *pustulata* only in the lanceolate multicostate leaf.

subject. Erioseyca (Miq.) Corner ser. Erioseycae
Corner subser. Erioseycae

F. grossularioides Burm. f. Fl. Ind. (1768) 227.—*F. alba* Reinw. ex Bl. Bijdr. (1825) 467. var. **robusta** Corner v. nov.—Ramuli, petioli, costae (subtus) pilis fulvis patentibus 1–2.5 mm. longis hirsuti, glabrescentes. Ramuli 4–7 mm. crassi. Lamina major, ad ramulos fertiles saepe trilobata v. ovato-cordata. Receptacula 15–20 mm. lata (20–30 mm., viva): pedunculo 4–6 × 3–4 mm.: bracteis basalibus 3–4 mm. longis: setis internis copiosis. Flores feminei pedicellis – 6mm. longis praediti, stylo hirsuto. Malaya.

Pahang (Fraser's Hill, 1,200 m. alt.):—Sing. F.n. 33187 (*typus*, herb. Singapore), Purselove 4317, Corner s.n. 10.viii. 37. Selangor:—Sing. F. N. 32970 (? Kuala Selangor).

Omnibus partibus robustior bene distincta.

var. **stenoloba** Corner v. nov.—Ut v. *grossularioides* sed lamina lanceolata- elliptica (-14×4 cm.), juvenilis anguste lanceolato-lobata (lobo medio 1–2.5 cm. lato). Sumatra, in silvis montanis 1,200 m. altis, praecipue ad clivis volcanicis.

Bartlett 8310 (Simeloengoen); Lorzing 4356, 6585, 8511 (*typus*, herb. Leiden), 9471, 9890 (Sibolangit); Ouwehaud 249; Teysmann 714 (pr. Siboga); v. d. Vecht s.n. 25. xii. 54 (Berastagi).

**subject. Eriosyce (Miq.) Corner ser. Eriosyceae Corner
suber. Trichosyceae Corner**

F. hirta Vahl. var. **appressa** Corner v. nov.—Ramuli pilis appressis 1–2 mm. longis, costa subtus 2–3 mm. longis, praediti. Receptacula pilis appressis vel patentibus praedita. Laos, North Thailand, in silvis montanis 500–1,300 m. alt.

Laos:—Poilane 20052, 20378, 26141 (*typus*, herb. Paris), 26347.—Thailand:—RFD 9552 (Chiengrai).

var. **brevipila** Corner v. nov.—Ramuli, petioli, costae (subtus), et receptacula pilis brunneolis patentibus -1 mm. longis villosi. Lamina 8–16 \times 4.7–8.5 cm., obovata, basi cuneata, integra, supra subscabrida, subtus aspero-villosa: costis lateralibus utrinsecus 5–7, basalibus 1, ad $1/3-\frac{1}{2}$ laminae elongatis: petiolo 11–23 mm. longo. Receptacula 12–15 mm. lata sessilia, dense villosa: bracteis basalibus 1.5–2 mm. longis: setis internis copiosis flavidulis. Pedicelli florum glabri. Yunnan, Annam, in silvis montanis 1,200–1,500 m. alt.

Kingdom Ward 12755 (Yunnan, Mong Hai); Poilane 4046 (Annam, Nhatrang, *typus* herb. Paris).

var. **dumosa** (King) Corner comb. nov.—*F. dumosa* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 151, pl. 190.—This differs merely in being thinly hispid-villous and in having for the most part palmately lobed leaves, few being simple. All collections come from the neighbourhood of G. Dempo and G. Raja in Sumatra. The Indochinese records are *F. hirta* v. *imberbis* Gagnep.

var. **malayana** Corner v. nov.—*F. cordata* Ridley, J. R. As. Soc. Str. Br. 57 (1911) 93.—Receptacula 12–25 \times 10–16 mm. (18–33 \times 15–22 mm., viva), conica, sessilia: bracteis basalibus 6–9 \times 3–5 mm., caducis. Perianthium masculum et cecidiophorum plus minus cupulare, 3–4-dentatum. Pili 2–4 mm. longi. Nepal, Assam, Indochina, Thailand, Hainan, Malaya (Perak, Pahang), in silvis montanis 500–1,700 m. alt.

Inter v. *hirtam* et v. *roxburghii* (Miq.) King intermedia.

Nepal:—Stainton, Sykes, et Williams 5241 (Rupukot Tal.). Assam:—King's coll. s.n. (Lushai Hills, 1890), Hook. f. et Thomson s.n. (Khasia). Hainan:—C. I. Lei 118 (det. *F. fulva*). Laos:—Poilane 26246 (Huat Laos, inter M. Luong Nam Eh et M. Sing). Annam:—Poilane s.n. (prov. Quang Tri, Dong Iam Pe, 22. ix. 39). Thailand:—Kerr 701 (Chiengmai, Doi Sootep), 7614 (Pattani, Betong), 20134 (Kao Krading, Toi), Sing. F.n. 4704 (Kantang). Perak:—Ridley 14624 (type, *F. cordata*), Wray 3413. Pahang:—Purseglove 4264, For. Dept. 7776, Sing. F. n. 32571, Corner s.n. 10.viii. 37 (*typus*, herb. Singapore), Fraser's Hill: For. Dept. 28165, Kep. F.n. 30986, Ridley 13720, Sing. F.n. 10948, 33550, Cameron Highlands: Sing. F. n. 31911, Sungei Tahan.

var. *squamosa* Corner v. nov.—Ut. v. *roxburghii* (Miq.) King sed receptacula minora 20–25 mm. lata, v. $-28 \times 18-20$ mm., bracteis lateralibus nonnullis crassiusculis 3–5 mm. longis praedita: bracteis basalibus 6–8 mm. longis, subcaducis. Ramuli et petioli pilis brunneis 2–6 mm. longis praediti: receptacula pilis brunneis 1–2 mm. longis sparsim hispida et pilis brevioribus pallidis villosa. Stylus glaber. Folia plerumque palmatolobata. Sumatra, in silvis montanis 1,000–1,600 m. alt.

Alston 15134 (Sidikalang, inter Lae Pondor et Silalahi; *typus*, herb. Br. Mus.); NIFS bb. 6851 (Karoland, Tongkok); O. Hagerup s.n. (Toba, 25.xi. 16); Ridley s.n. (Berastagi, 8.ii. 21).

Bracteis lateralibus in sect. *Fico singularis*.

F. simplicissima Lour. var. *annamica* (Gagnep.) Corner comb. nov.—*F. silhetensis* Miq. var. *annamica* Gagnep. Lec. Fl. Gen. I.-C. 5 (1928) 788.—*F. touranensis* Gagnep. Lec. Notul. Syst. 4 (1927) 97.

F. halmaherae Corner sp. nov.—Arbor –30 m. alta, foliis longipetiolatis spiraliter dispositis. Ramuli, petioli, costae (subtus) pilis rigidis fulvidulis (? irritantibus) 1–2 mm. longis hispidi, nervuli subtus pilis mollibus –0.5 mm. longis villosi, areolae glabrae. Ramuli 10–12 mm. crassi. Stipulae – 25 mm. longae, appresse pilosae. Lamina –20 cm. longa et lata (? multo major), ovata-cordata, acuminata, denticulata, membranacea: costis lateralibus utrinsecus 4–6, intercostis –12 subtus elevatis; costis basalibus utrinsecus 3–4, ad $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 100–160 mm. longo. Receptacula axillaria, binata, pedunculata, primo ut ramuli hispida dein pilis rigidis caducis molliter et breviter villosa: pedunculo $2.5-4 \times 2.5-3$

mm.: bracteis basalibus 1.5–2 mm. longis, appresse puberulis: corpore receptaculi -22×17 mm., ellipsoideo, ostiolo subdepresso bracteis apicalibus numerosis parvis appresse pilosis ocluso; setis internis -1.5 mm. longis, flavidulis rigidis copiosis: cellulis in pariete receptaculi omnibus fibriformibus elongatis crasse tunicatis. Flores masculi ordinibus duobus ostiolaribus sessilibus: staminibus 2, filamentis rubris. Flores cecidiophori sessiles v. pedicellis glabris albidis -2 mm. longis praediti. Flores feminei et semina ? Cystolitha nulla. Halmaheira (Gunong Sembilan, c. 600 m. alt., "common along path in forest"; Pleyte 369, *typus herb.* Leiden).

Ut arbor *Hibiscus*, forsan *F. mollissimae* Ridley (Malaya) affinis, sed cellulis fibriformibus in pariete receptaculi singularis.

F. fulva Reinw. ex Bl. var. **timorensis** Corner v. nov.—Semina laevia, vix carinata. Stylus glaber v. subpuberula. Setae receptaculi internae paucissimae, breves. Pedicelli florum femineorum glabri. Timor (Forbes 3444 et 3579, *typus herb.* Br. Mus.).

F. subfulva Corner sp. nov.—Arbor -7 m. alta, foliis spiraliter dispositis. Ramuli, petioli, et costae (subtus) pilis fulvidulis -0.5 mm. longis sparsim puberuli. Ramuli $4-6$ mm. crassi. Stipulae -15 mm. longae, appresse pilosae. Lamina $10-25 \times 5-11.5$ cm., elliptica, apice acuminata -10 mm. longo, basi rotundato-subcordata v. cuneata, integra, margine saepe recurvata, plus minus rigide coriacea, utrimque scabrida, sicco brunnea: costis lateralibus utrinsecus $4-6$, intercostis -10 subtus elevatis: costis basalibus utrinsecus $2-3$, ad $\frac{1}{2}-\frac{2}{3}$ laminae elongatis, glandulis basalibus 2: petiolo $12-50$ mm. longo. Receptacula axillaria binata pedunculata, sparsim appresse puberula, glabrescentia, maturitate rubra (cecidiphora et feminea): pedunculo $4-10$ mm.: bracteis basalibus $2-4$ mm. longis, ovato-acutis, appresse pilosis: pedicello nullo: corpore receptaculi $10-12$ mm. lato ($14-16 \times 16-20$ mm., *viya*), globoso v. ellipsoideo, ostiolo bracteis apicalibus $3-5$ planis ocluso sed maturitate hiascenti: setis internis $2-4$ mm. longis, flavidis rigidis copiosis: cellulis scleroticis copiosis. Pedicelli florum albido-setosi: tepala glabra rubra spathulata. Stamina 2. Stylus glaber. Semina 1.5 mm. longa, tuberculata, valde carinata. Cystolitha nulla. Borneo.

var. **subfulva**.—Kinabalu, Sing. F. n. 26612, 26642; G. Klam, Hallier 2349, *typus herb.* Leiden.

var. **villosula** Corner v. nov.—Costae, intercostae et nervuli reticulati subtus pilis fulvidulis -0.5 mm. longis dense villosuli. Setae internae $1-1.5$ mm. longae: cellulis scleroticis nullis.

Hallier 2869 (*typus*, herb. Leiden) et 2977, Lianggagang; Havi-land 85 (Braang); Beccari 962 (Kuching, det. *F. leucoptera* Miq.); Clemens 20698 (Sarawak, Bidi Cave).

F. auratae Miq. persimilis sed vero inter *F. fulvam* et *F. glandulosam* Wall., fere ut hybrida, referenda.

subsect. Eriosycea (Miq.) Corner ser. Eriosyceae Corner
subser. Dehiscentes Corner

F. glandulifera (Wall. ex Miq.) King var. **camiguinensis** (Merr.) Corner comb. nov.—*F. banahaensis* Elmer, Leaflet. Philip. Bot. 1 (1907) 252.—var. *typica* et var. *camiguinensis* (Merr.) Sata Monogr. (1944) 267, 370.—*F. camiguinensis* Merr. Philip. J. Sci. Bot. 9 (1914) 276.—This differs merely in details of hairiness.

var. **villosa** Corner v. nov.—Ut v. *glandulifera* sed costis et nervulis reticulatis subtus villosulis, pilis saepe undulosis, haud glabrescentibus. Borneo, Celebes, Morotai, New Guinea.

Borneo:—Bur. Sci. 193 (B.N.B.); For. Dept. B.N.B. 2930; Kostermans 6187 (pr. Sangkalang), 9546 (Mahakam River), East Borneo. Celebes:—NIFS bb 24166 (O. Masamba, Biridondok). Morotai:—Kostermans 1003, 1083. New Guinea:—BW 755 (Cyclops Mt.); Carr 12763 (Papua, Koitaki); Doctors v. Leeuwen 10537 (Nassau Mt.); Kanihera et Hatusima 13219 (Waren); NGF 3753 Sepik district, *typus* herb. Lae); NIFS bb 30745 (Biak), 31116 (Membramo, Hollandia).

subsect. Eriosycea (Miq.) Corner ser. Eriosyceae Corner
subsect. Cuneifoliae Corner

F. chartacea Wall. ex King var. **lanceolata** Corner var. nov.—Lamina 7–23 × 1–3 cm., lanceolata: costis lateralibus utrinsecus 9–16, angulo lato exeuntibus, intercostis 0–1: petiolo 5–20 mm. Receptacula breviter stipitata. Frutex riparius, in silvis. Annam, Thailand.

Annam:—Poilane 10574, 12233, 18313, 19770, 32287 (det. *F. macilenta* King). Thailand:—Kerr 773 (Kaw Pa-ngan) 11724 (Nam Chut, Ranawng, *typus* herb. Br. Mus.); RFD 14834 (Nakhawn Srithamarat, Chawang).

F. litseifolia Corner sp. nov.—Frutex v. arbor –8 m. alta, trunco –20 cm. crasso, cortice rufobrunneo, latice albo: foliis brevipe-
tiolatis spiraliter dispositis. Ramuli, petioli, stipulae, costae (subtus) et receptacula pilis albidis v. brunneis –0.5 mm. longis

appressis tenuiter vestiti, v. costae subtus pilis brevibus patentibus subscabrae. Ramuli 1.5–3 mm. crassi. Stipulae –7 mm. longae. Lamina 4–14 × 1.5–5 cm., lanceolata, anguste elliptica v. obovata, apice acuminata 7–18 mm. longo, basi cuneata v. basi cuneata v. subrotundata, integra v. distanter denticulata, raro sublobata, coriacea, laevis v. subtus subscabridula, sicco viridis v. subtus brunneola: costis lateralibus utrinsecus 4–8, angulo lato exeuntibus, intercostis 0–2 laxis, subtus leviter elevatis: costis basalibus utrinsecus 1, brevibus v. ad $\frac{1}{2}$ laminae elongatis, glandulis basalibus nullis: petiolo 4–12 × 1 mm. Receptacula axillaria binata glabrescentia, maturitate rubra: pedunculo 2–7 mm. longo: bracteis basalibus 1 mm. longis: corpore receptaculi 5–8 mm. lato, ostiolo plano bracteis apicalibus parvis numerosis ocluso: setis internis copiosis: cellulis scleroticis nullis. Tepala 4–5, rubra libera glabra v. apice ciliata. Flores masculi ordine uno sessiles ostiolares; staminibus 2. Flores feminei et cecidiophori sessiles v. pedicellis pilosis –2 mm. longis praediti: stylo femineo sparsim piloso. Semina 0.8–1 mm. longa, tuberculata, carinata. Cystolitha nulla, lamina pilis microscopicis cystolithiformibus praedita. Malaya, Sumatra, in silvis montanis 1,000–1,600 m. alt.

F. oreophila Ridley affinis sed brevopilosa, receptaculis et seminibus minoribus, florum pedicellis pilosis, petiolis brevioribus differt.

Malaya:—Sing. F.n. 31094 (Trengganu, G. Padang). Sumatra:—Altson 14740 (Atjeh, Blangkedjeren); Bartlett 11128 (Tapianoeli, Toba); Forbes 2241 (Mt. Dempo); Jacobs 4672 et Meijer 3670, 5290 (Pajakumbuh, Mt. Sago); v. Steenis 3548 (Palembang, G. Raja, *typus* herb. Leiden).

F. tuphapensis Drake var. **annamensis** (Gagnep.) Corner comb. nov. *F. annamensis* Gagnep. Lec. Notul. Syst. 4 (1927) 85.—*F. cambodica* Gagnep. id. 87.—This differs from v. *tuphapensis* in the larger fig, the two stamens rather than one in the male flower, and the puberulous female style. It relates *F. tuphapensis* closely with *F. chartacea*.

subject. **Eriosycea** (Miq.) Corner ser. **Auratae** Corner
subser. **Auratae**

F. endospermifolia Corner sp. nov.—Arbor –25 m. alta, foliis longipetiolatis spiraliter dispositis, omnibus partibus pilis brunneis rigidis patentibus 0.5–1.5 mm. longis hispido-villosis, nervulis subtus villosulis v. minute puberulis. Ramuli 4–7 mm. crassi, lente glabrescentes. Stipulae 10–30 mm. longae, appresse

pilosae. Lamina 13–25 cm. lata, tam longa quam lata v. paulum latior, ovata, apice acuminata –12 mm. longo, basi cordata v. subtruncata, denticulata, membranacea, supra hispidula, subtus villosa, sicco brunnea: costis lateralibus utrinsecus 4–5, glandulis axillaribus praeditis, intercostis strictis –16, subtus elevatis, areolis glabris: costis basalibus utrinsecus 3–4, ad $\frac{1}{2}$ – $\frac{2}{3}$ laminae elongatis, glandulis basalibus 2: petiolo 35–100 mm. longo, glandula subnodali praedito. Receptacula axillaria binata sessilia, hispido-villosa v. tomentosa, 18–25 × 15–20 mm. (23–30 mm. longa et lata, viva), ovoidea v. subglobosa, ostiolo parvo subdepresso: bracteis basalibus 3–5 mm. longis, ovatis, obtusis v. breviter acuminatis, appresse pilosis, caducis: setis internis –2.5 mm. longis, flavidis, copiosis: cellulis scleroticis in pariete receptaculi cecidiophori copiosis, feminei sparsis v. nullis. Florum pedicelli pilosi. Flores masculi 2.5–7 mm. alti, ordinibus numerosis ostiolaris, sessiles v. pedicellis –4 mm. longis praediti: tepalis 4, rubris, margine ciliolatis, haud setosis: staminibus 2, antheris breviter mucronatis. Flores neutri (in rec. fem.) ordinibus 2–3 ostiolaris. Flores feminei et cecidiophori sessiles v. pedicellis –4 mm. longis praediti: tepalis 3–4, lanceolatis v. anguste spathulatis, flavidis, apicem versus dense setosis: stylo femineo piloso. Semina 1–1.3 mm. longa, breviter oblonga, carinata, tuberculata. Cysotolitha nulla. Borneo (Mt. Kinabalu), in silvis montanis 1,000–1,800 m. alt.

Clemens 28223 (Tenompok), 34381 (Colombon River): For. Dept. B.N.B. 3621, A4492 (Tenompok, *typus* herb. Kew); San. 15444 et Sinclair 8974 (Kota Belud, Kandangan); Sing. F.n. 26902, 27842 (Tenompok).

F. bruneiensis, *F. eumorpha*, et haec species arbores spectabiles latifoliae hispidissimae ad regionem North Borneo restrictae. *F. auratae* affinis sed *F. bruneiensis* et *F. endospermifolia* inter alia praecipue florum masculorum tepalis rubris, non setosis, ut in ser. *Eriosyceae* distinctae.

F. bruneiensis Corner sp. nov.—Arbor –13 m. alta, cortice brunneo, latice albo copioso, foliis longipetiolatis spiraliter dispositis: stipulis, petiolis costisque primo rubris (vivis). Petioli et costae (subtus) pilis aureis v. brunneis rigidis patentibus 2–4 mm. longis strigosi, nervuli pilis brevioribus: nervuli reticulati et areolae subtus toto minute velutinati. Ramuli 6–9 (–12) mm. crassi, minute puberuli mox glabri, brunnei, cavi. Stipulae 20–60 mm. longae, lanceolato-ellipticae caducae, appresse sericeo-puberuli, pilis brunneis longis paucis ad carinam praediti. Lamina 28–45 × 16–28 cm., elliptica v. ovata, apice acuminata –15 mm.

longo, basi cordata v. rotundato-cuneata, denticulata, membranacea, scabrida, sicco viride-brunnea: costis lateralibus utrinsecus 5–6, glandulis axillaribus praeditis, intercostis strictis –12, subtus elevatis, areolis ut nervulis reticulatis minute velutinosi: costis basalibus utrinsecus 3–4, ad $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 80–180 m. longo, glandula subnodali praedito. Receptacula axillaria binata sessilia, pilis pallidis 1–2 mm. longis dense hispido-villosa, maturitate rubra, $24\text{--}30 \times 20\text{--}26$ mm. (pilis exclusis: –30 mm. lata, viva), subglobosa v. ovoideoconica, ostiolo bracteis apicalibus 3–5 ocluso: bracteis basalibus $6\text{--}10 \times 5\text{--}7$ mm., ovatis v. oblongo-ellipticis, acutis, minute appresse puberulis, caducis: setis internis –2.5 mm. longis, copiosis, flavidis: cellulis scleroticis sparsis in pariete receptaculi cecidiophori. Flores masculi et cecidiophori ut in *F. endospermifolia*, sed majusculi: aliquando staminibus 3. Cystolitha nulla. Brunei (Ulu Belalong, prope flumen; Brunei 5338, typus herb. Cambridge).

Inter *F. endospermifoliam* et *F. brunneo-auratam*, sed ramulis subglabris, receptaculis majoribus. Forsan arbor montana secundo flumine descendens.

F. brunneo-aurata Corner sp. nov.—Arbor –15 m. alta, foliis longipetiolatis spiraliter dispositis, juvenilibus 3–5 palmato-lobatis. Indumentum duplex: ramuli et petioli pilis aureis v. fusco-brunneis 1–4 mm. longis patentibus strigosi, costae subtus brevioribus, et omnes partes (praeter paginam laminae superiorem) pilis brevibus pallidis minute velutinosi. Ramuli 3–6 (–10) mm. crassi. Stipulae 10–35 mm. longae (ad folia juvenilia 70×18 mm.) sericeae, pilis longis brunneis paucis ad carinam praeditae. Lamina 15–30 \times 6–14 cm., (–50 \times 45 cm., juvenilia lobata), ovato-elliptica v. elliptica, apice acuminata –10 mm. longo, basi anguste subcordata v. cuneata, serrulata v. subintegra, chartaceo-coriacae, sicco brunnea: costis lateralibus utrinsecus (3–) 4–5 (–8), glandulis axillaribus praeditis, intercostis numerosis strictis, subtus elevatis, areolis ut nervis et nervulis minute velutinosi: costis basalibus utrinsecus 2–3, ad $\frac{1}{3}\text{--}2/3$ laminae elongatis, glandulis basalibus 2: petiolo 15–60 mm. longo, glandula subnodali praedito. Receptacula axillaria binata sessilia velutinata glabrescentia, maturitate rubra, 11–16 mm. lata (12–22 mm., viva) subglobosa, subsulcata, ostiolo bracteis apicalibus 3 planis ocluso: bracteis basalibus 1–1.5 mm. longis, pusillis ovatis acutis: setis internis 1.5–3 mm. longis brunneolis copiosis: cellulis scleroticis numerosis. Flore masculi ordinibus

numerosis ostiolares, sessiles v. pedicellis subrubris sparsim pilosis praediti: tepalis 4 rubris spathulatis, marginibus ciliolatis: staminibus 2. Flores neutri (in rec. fem.) ostiolares, tepalis rubris. Flores feminei et cecidiophori sessiles v. pedicellis glabris v. sparsim pilosis, aliquando cecidiophoris induratis, praediti: tepalis 3-4, dense setosis ut in *F. aurata*, albidis: stylo femineo rubro, puberulo v. glabro. Semina ut in *F. aurata*. Cystolitha nulla. Borneo, in silvis secundariis ad 1,100 m. alt., forsan communis.

F. hirta et *F. fulva* confusa et praecipue *F. subfulva*. Plantas numerosas vivas in Sarawak et Brunei studui, semper distinctas.

Sarawak:—Beccari 1360 (det. *F. hirta* v. *roxburghii*); Corner s.n. Jan. 1959; Haviland 153; Brunei:—Brunei 5307, 5308. Brit. North Borneo, Kinabalu:—Sing. F.n. 25125 (Dallas), 26608 (Mene-tendok Gorge, *typus* herb. Singapore). Indonesian Borneo:—Hallier 1519 et 2525 (G. Klam), 2909 (Lianggagang), det. *F. fulva*.

F. aurata Miq. var. **brevipilosa** Corner v. nov.—*F. inaequipetiolata* Merr. Philip. J. Sci. 21 (1922) 517.—Ramuli, petioli, et receptacula pilis brevioribus 0.5-1 mm. longis sparsim hirsuti, nervuli subglabri. Lamina 12-26 × 2.5-8.5 cm., oblonga, lanceolata, v. subovata, utrimque scabriuscula: costis lateralibus utrinsecus 4-9, v. 16-20 in laminis oblongis v. lanceolatis. British North Borneo.

Bur. Sci. 178, 485, 602 (*typus*), 1141, 1885; Creagh s.n. (1895). For. Dept. B.N.B. 2459, 9368, 9371; Ridley s.n. (1887).

var. **longipilosa** Corner v. nov.—Ramuli, petioli, et costae (subtus) pilis 2-4 mm. longis villosi (1-2 mm. in v. *aurata*). Lamina elliptico-obovata v. oblonga. Malaya, Sumatra, Riouw Archipelago, Borneo.

Malaya (Singapore to Perak):—For. Dept. 12110, 15076; Hullett 381; Hume 9203; King's coll. 8553; Sing. F.n. 29387, 32313 (*typus*, herb. Singapore). Sumatra:—Bartlett 7885 (Asahan); Curtis 3548 (Indragiri); Postumus 563, 674, 685 (Djambi). Riouw:—Bunne-meyer 6952 (Lingga); Buwalda 6229 (Riouw). Borneo:—Brunei 575; Hallier 2238 (G. Klam); Motley 600 (Banjermasim); Teysmann 7899 (det. *F. hirta*).

var. **palawanensis** Corner v. nov.—Quisumbing, Philip. J. Sci. 41 (1930) 317 (ut *F. chrysocarpa*).—Folia sicca fusco-brunnea (aureo-brunnea in v. *aurata*): juvenilia breviter trilobata, basi cordato-subtruncata, petiolo -16 cm. longo: lamina superiora 15-28 × 8-17 cm., elliptica v. obovata, basi cordata v. late cuneata; costis lateralibus utrinsecus 4-6. Pili ut in v. *aurata*: nervuli subtus

villosuli, areolae glabrae. Receptacula 14–18 × 12–14 mm. Palawan, Balabac. Bur. Sci. 49913, 77382 (*typus*, herb. Singapore), 77425.

Forsan species nova, *F. brunneo-auratae* affinis. Folia juvenilia palmato-lobata in *F. aurata* incognita.

var. **pedunculata** Corner v. nov.—Ut v. *aurata* sed receptacula pedunculis 2–5 mm. longis, cellulis scleroticis in pariete praedita. Malaya.

Perak:—King's coll. 3738, 4328, 5834, 7776, 10106, 10225 (det. *F. hirta* et *F. chrysocarpa*); Scortechini 365 (*typus*, herb. Singapore), 529; Wray 493. Trengganu:—Kep. F.n. 26990 (S. Kemaman); Selangor:—H. M. Burkill 1021 (S. Buloh), For. Dept. 12900 (Ginting Simpang). Java:—HHBB 135866, 135867, 135868 (cult.).

**subject. Eriosyce (Miq.) Corner ser. Auratae Corner
subser. Monandreae Corner**

F. androchaete Corner sp. nov.—Arbor –10 m. alta, foliis spirali-ter dispositis. Ramuli, stipulae, petioli, et receptacula pilis rigidis appressis flavidulis 0.5–1 mm. longis tenuiter vestiti, glabrescentes: costae subtus pilis patentibus sparsis, nervuli subglabri. Ramuli 3–4 mm. crassi. Stipulae –7 mm. longae. Lamina 11–20 × 4–9 cm., elliptica v. subobovata, saepe angusta, apice acuminata –10 mm. longo, basi cuneata, integra, subcoriacea, utrimque subscabrida, sicco brunnea: costis lateralibus utrinsecus 4–6, obliquis, intercostis –4, subtus leviter elevatis: costis basalibus utrinsecus 1, ad $1/3$ – $1/2$ laminae elongatis, glandulis basalibus 2: petiolo 12–50 mm. longo: lamina juvenilia –33 × 13 cm., oblongo-elliptica, apice –35 mm. longo acuminata, haud lobata, costis lateralibus utrinsecus 5–8, petiolo –110 mm. longo. Receptacula axillaria binata: pedunculo 3–5 × 2 mm.: bracteis basalibus 1–1.5 × 2–3 mm., ovatis, subacutis: corpore receptaculi 12–15 mm. lato, subgloboso, ostiolo parvo plano: setis internis –1.5 mm. longis, copiosis: cellulis scleroticis nullis. Florum pedicelli setosi. Flores masculi ordinibus duobus ostiolares, secundo pedicellati: tepalis 3, setosis, albidis: stamine uno. Flores feminei et cecidiophori sessiles v. pedicellis –5 mm. longis praediti: tepalis 3–4, setosis, albidis: stylo glabro. Semina 1.3 mm. longa, carinata, tuberculata. Cystolitha nulla. North Borneo, in silvis prope flumina.

F. macilentae affinis, sed omnibus partibus major.

Brunei 389, 5309, 5310, 5320 (Ulu Belalong, *typus* herb. Cambridge); For. Dept. B.N.B. San. 16285, 17397; Nieuwenhuis (Taheri) 952 (Tepoese, Lilit boelan).

F. macilenta King var. **gibbsiae** (Ridley) Corner comb. nov.—*F. gibbsiae* Ridley, J. Linn. Soc. Bot. 42 (1915) 137.—This differs from v. *macilenta* in the pedunculate fig, and the less hairy leaves and fig.

var. **ilicifolia** Corner v. nov.—Ramuli, petioli, stipulae, costae (subtus), et receptacula sparsim et minute puberuli, glabrescentes. Lamina 2.5–11 × 1–4 cm., lanceolato-elliptica, apice acuminata –10 mm. longo, basi cuneata, grosse et distanter dentata dein integra, coriacea, utrimque scabriuscula, sicco flavo-viridis et subtus aureo-brunnea: costis lateralibus utrinsecus 4–8, intercostis 0–1, nervulis reticulatis subtus leviter elevatis: costis basalibus brevibus: petiolo 8–40 mm. Receptacula solitaria, 7–11 mm. lata: pedunculo 3–10 mm. longo: cellulis scleroticis copiosis. Kinabalu, 1500–2000 m. alt. Clemens 50712, Gurulau spur; Sing. F. n. 26952, path to Ranau, *typus* herb. Singapore.

A var. *gibbsiae* pedunculo longiori, lamina subscabrida, saepe dentata differt.

F. eumorpha Corner sp. nov.—Arbor –18 m. alta, Ramuli, folia, et receptacula pilis fusco-brunneis patentibus 0.5–1.5 mm. longis dense hispidi, nervuli subtus et areolae pilis albidis v. fulvidulis –0.5 mm. longis minute velutinosi. Ramuli 4–5 mm. crassi. Stipulae –15 mm. longae, strigoso-hispidae. Lamina 8–20 × 6.5–14 cm., ovato-cordata v. subtriangularis, longior quam lata, breviter acuminata, dentata, membranacea, supra hispidopustulata, sicco griseo et subtus aureo-brunnea: costis lateralibus utrinsecus 5–7 (–8), intercostis –6, subtus elevatis, areolis impressis velutinosi: costis basalibus utrinsecus 3, ad 1/3–½ laminae elongatis, glandulis basalibus 2: petiolo 40–85 mm. longo. Receptacula axillaria binata sessilia, aureo-hispida, 16–17 × 14–15 mm. (pilis exclusis; 18–20 mm., viva), subglobosa v. ellipsoidea, ostiolo bracteis apicalibus 3–4 subumbonatis ocluso: bracteis basalibus 3–3.5 mm. longis, ovato-acutis, appresse pilosis: setis internis 1–2 mm. longis, copiosis. cellulis scleroticis sparsis. Flores masculi et cecidiophori? Flores neutri ordine uno ostiolaris sessiles. Flores feminei sessiles v. pedicellis albido-setosis –2.5 mm. longis praediti: tepalis 3, albidis, dense setosis: stylo puberulo v. glabro. stigmatate bifido. Semina 1–1.2 mm. longa, subcarinata, subtuberculata (? immatura). Cystolitha nulla. Borneo.

var. **eumorpha**.—Sing. F. n. 27566, Tibobah River (*typus* herb. Singapore); Clemens 32524, Marai Parai “perhaps the tallest *Ficus* in this vicinity”.

var. **subglabra** Corner v. nov.—Areolae subtus puberula v. subglabra. Florum femineorum tepala glabra v. ad apicem pilis 1–3 praedita. Receptacula, minora, 8–9 × 10–11 mm., bracteis basalibus obtusis, cellulis scleroticis copiosis. Central East Borneo (W. Koetai, Mt. Kemoel, 1,800 m. alt.; Endert 4416, *typus* herb. Leiden.).

Inter *F. endospermifoliam* et *F. paramorpham* sed. floribus masculis incognitis, incertae sedis.

F. paramorpha Corner sp. nov.—Frutex v. arbor parva. Ramuli, petioli, et costae (subtus) pilis fusco-brunneis patentibus 0.5 mm. longis villosi, nervuli subtus pilis brevioribus, aliquando ramuli et petioli appresse pilosi. Ramuli 2–3 mm. crassi. Stipulae 7 mm. longae, appresse brunneo-pilosae. Lamina 6–14 × 3–5.5 cm, elliptica, breviter acuminata, basi cuneata, serrato-denticulata, plus minus chartacea, supra hispido-scabra, sicco grisea et subtus aureo-brunnea: costis lateralibus utrinsecus 5–6, intercostis 5, subtus valde elevatis, areolis quasi glabris: costis basalibus utrinsecus 1 (–2), ad $\frac{1}{4}$ – $\frac{1}{3}$ laminae elongatis, glandulis basalibus 2: petiolo 12–25 mm. Receptacula axillaria binata sessilia, pilis fusco-brunneis brevibus appressis tenuiter vestita, maturitate rubra, 9–10 mm. lata, subglobosa: bracteis basalibus 1.5 mm. longis, ovato-subacutis: setis internis 2.5 mm. longis, copiosis, aureis: cellulis scleroticis copiosis. Florum pedicelli setosi: tepala 3–4 albido-setosa. Flores masculi ordine uno ostiolares: stamine uno. Flores feminei et cecidiophori sessiles v. pedicellati: stylo glabro. Semina 1–1.2 mm. longa, subcarinata, subtuberculata (? immatura). Cystolitha nulla. Borneo Kinabalu, 1,600–2,200 m. alt.).

Clemens 31777, Upper Kinataki River, *typus* herb. Leiden; 32523, Marai Parai.

F. eumorphae affinis sed lamina elliptica, receptaculis minoribus inter alia differt.

F. setiflora Stapf var. **adelpa** Corner v. nov.—Ramuli, petioli, costae (subtus), et receptacula pilis albidis v. aureo-brunneis obliquis 0.5–1 mm. longis villosi. Ramuli 2–2.5 mm. crassi. Lamina 4.5–12 × 2–4.5 cm., anguste elliptica v. lanceolata, breviter acuminata, basi anguste cuneata, supra hispidulo-scabra, subtus villosa: petiolo 3–18 mm. Receptacula 6–7 mm. lata, pedunculo 1–2.5 mm. longo. Stylus femineus pilosus. Semina obtuse carinata, valde tuberculata. North Borneo Kinabalu, 1,100–2,500 m. alt.).

Ut speciminibus exsiccatis videtur, decidua. A var. *setiflora* indumento villosa, lamina anguste elliptica, pedunculo distincto differt.

Sing. F.n. 26930, 27876 (Tenompok, *typus* herb. Singapore); Sinclair 8975 (Bt. Kinasaruban); Clemens (Tenompok, Colombon River, et Mt. Nunok) 28402, 28433, 29353, 29482, 30295, 32684, 32719, 33905, 34453, 40123.

var. **puberula** Corner v. nov.—Ramuli et petioli pilis 0.5 mm. longis subvillosuli, costae subtus sparsim puberulae. Receptacula sparsim appresse puberula, pedunculo 0.5–1 mm. longo. Stylus femineus glaber. Semina obtuse carinata, valde tuberculata. Central East Borneo (W. Koetai, Mt. Kemoel, 1,700 m. alt.; Endert 4275, *typus* herb. Leiden).

Forsan v. *adelphae* forma.

Taxonomic Notes on *Ficus* Linn., Asia and Australasia

IV. SUBGEN. *FICUS* SECT. *SYCIDIUM* MIQ.

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Summary

New sections, subsections, and series:—subsect. *Sycidium* ser. *Prostratae*, *Pungentes*, *Phaeopilosae*, and *Copiosae* ser. nov.; subsect. *Varinga* (Miq.) Corner comb. nov., ser. *Heterophylleae*, *Cyrtophylleae*, and *Exasperatae* ser. nov.; subsect. *Palaeomorphe* (King) Corner comb. nov., ser. *Subulatae* and *Fibrosifoliae* ser. nov.

Earlier specific epithets:—*F. semicordata* B. Ham. ex J.E. Sm. (*F. cunia* B. Ham. ex Roxb.), *F. pungens* Reinw. ex Bl. (*F. myriocarpa* Miq.), *F. wassa* Roxb. (*F. duriuscula* King), *F. fraseri* Miq. (*F. proteus* Bur.), *F. coronata* Spin. (*F. stephanocarpa* Warb.), *F. asperiuscula* Kunth et Bouché (*F. leptorhyncha* Koord. et Val.), *F. virgata* Reinw. ex Bl. (*F. decaisneana* Miq.), *F. heteropleura* Bl. (*F. urophylla* Wall. ex Miq.), *F. sinuata* Thunb. (*F. rostrata* Lam.).

New names for later homonyms:—*F. gul* Laut. et K. Schum. (*F. rudis* Miq., non Pers.), *F. andamanica* Corner (*F. macropoda* Kurz, non Miq.), *F. elmeri* Merr. (*F. semicordata* Miq., non J.E. Sm.), *F. celebensis* Corner (*F. irregularis* Miq., non Steud.).

New species:—*F. koutumensis*, *F. complexa*, *F. porphyrochaete*, *F. subsidens*, *F. griseifolia*, *F. primaria*, *F. cauta*, *F. goniophylla*, *F. tenuicuspudata* et v. *major*, *F. oleracea* et v. *pugnans*, *F. chrysochaete*, *F. imbricata*, *F. gryllus*, *F. erinobotrya* et v. *solomonensis* et f. *glabrior*, *F. leptogramma*, *F. praetermissa*, *F. midotis*, *F. leptocalama*, *F. rubroscupidata*, *F. rubromidotis*.

New subspecies and varieties:—*F. gul* Laut. et K. Schum. v. *lasiocarpa* Corner, v. *solomonensis* Corner; *F. montana* Burm. f. v. *purpurascens* (Bl.) Corner; *F. madurensis* Miq. v. *angustifolia* Corner; *F. copiosa* Steud. v. *pubescens* Corner; *F. wassa* Roxb. v. *nubigena* (Diels) Corner, v. *obversifolia* (Miq.) Corner; *F. balica* Miq. v. *colffsii* Corner; *F. cumingii* Miq. v. *androbrotia* (Summerh.) Corner v. *angustissima* (Merr.) Corner, v. *worcesteri* (Merr.) Corner; *F. fiskei* Elmer v. *multinervia* Corner; *F. riedelii*

Miq. v. *minor* Corner; *F. ampelas* Burm. f. v. *linearis* Corner, v. *soronensis* (King) Corner; *F. guyeri* Elmer v. *sibuyanensis* (Elmer) Corner; *F. melinocarpa* Bl. v. *hololampra* (Diels) Corner; *F. trachypison* Laut. et K. Schum. v. *pallida* Corner; *F. tonsa* Miq. v. *aspera* Corner, v. *leptodictya* (Diels) Corner, v. *subcordata* Corner; *F. irisana* Elmer v. *validicaudata* (Merr.) Corner; *F. opposita* Miq. v. *micracantha* (Miq.) Corner, v. *indecora* (A. Cunn. ex Miq.) Corner; *F. storckii* Seem. v. *kajewskii* (Summerh.) Corner; *F. tinctoria* Forst. f. ssp. *gibbosa* (Bl.) Corner et v. *rigida* Miq., ssp. *parasitica* (Willd.) Corner et v. *anastomosans* (Wall. ex Kurz) Corner, ssp. *swinhoei* (King) Corner; *F. virgata* Reinw. ex Bl. v. *philippinensis* (Miq.) Corner, v. *sessilis* (Bur.) Corner; *F. subulata* Bl. v. *gracillima* (Diels) Corner; *F. sinuata* Thunb. v. *oblonga* Corner, ssp. *cuspidata* (Reinw. ex Bl.) Corner; *F. heteropleura* Bl. v. *hirta* Corner, v. *mindanaensis* (Warb.) Corner; *F. aurita* Reinw. ex Bl. v. *auriculifera* (Merr.) Corner, v. *celebica* (Reinw. ex Bl.) Corner; *F. obscura* Bl. v. *angustata* (Miq.) Corner, v. *borneensis* (Miq.) Corner, v. *kunstleri* (King) Corner.

Notes on *F. madurensis* Miq., *F. ampelas* Burm. f., *F. scobina* Benth., *F. aspera* Forst. f., *F. cyrtophylla* Wall. ex Miq., *F. obscura* Bl.

sect. *Sycidium* Miq.

Hook. Lond. J. Bot. 7 (1848) 228; Ann. Mus. Bot. Lugd. Bat. 3 (1867) 291; King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 73; OK in T. Post Lex. Gen. Phan. (1904) 236; Sata, Monogr. (1944) 252.—subgen. *Sycidium* (Miq.) Mildbr. et Burr. Engl. Bot. Jahrb. 46 (1912) 175.—Dioecious. Figs pedunculate or pedicellate without a collar of basal bracts, rarely sessile: body often with scattered lateral bracts. Tepals free or shortly joined, red, pink, or white. Male flowers ostiolar: stamen 1, or 1–2: anther not mucronate. Style subterminal: stigma simple, subclavate. Seed small, lenticular or shortly oblong, generally with a single keel, smooth or, in a few species, reticulate: hilum rarely prominent. Cystoliths variously present. Africa, Asia, Australasia, c.100 spp. Lectotypus:—*F. aspera* Forst. f.

In 1848 Miquel made three series of this section. King (1887) extrated ten species along with numerous synonyms, and made of them sect. *Palaeomorphe* King. These comprise most of the two series Cuspidate and Pallidae, which I refer accordingly to subsect. *Palaeomorphe*. The species of the third series *Scabrae* Miq. were mostly retain by King in sect. *Sycidium*, the typification of which should, therefore, come from this series. Choice of type might favour *F. montana* Burm f., which appears with six other species

now known to be synonyms, in ser. *Scabrae*, but *F. montana* has generally a gall-ovary in the male flower and should have been placed by King in sect. *Palaeomorpha*. Second choice might be *F. scabra* Forst. f., but Miquel does not appear to have seen a specimen of it in 1848. Hence I choose the related *F. aspera* Forst. f. which makes the largest group of species representative of the section and subsect. *Sycidium*.

subsect. **Sycidium**.—sect. *Covellia* (Gasp.) Miq. subsect. *Pandaniflorae* Sata, Monogr. (1944) 293 (ut *Pandanusiflorae*; lectotypus, *F. minahassae* Teysm. et de Vr.).—subsect. *Pseudosycidium* Sata, id. 253, 258, 381 (lectotypus, *F. fiskei* Elmer).—Seed lenticular, as long as wide, slightly keeled all round or in the upper half, rarely not at all. Male flowers without a normal gall-ovary, sometimes with a rudiment. Fig often pedunculate with a collar of three basal bracts. Cystoliths often papillate. Trees or shrubs, not epiphytic or climbing. Trop. Asia, Australasia, 65 spp. Lectotype, *F. aspera* Forst. f.

ser. **Prostratae** Corner ser. nov.—Albido- v. brunneo-pilosae. Folia brevipetiolata disticha. Receptacula geocarpica ad ramos efoliatis internodis elongatis e trunco basim versus orientes, bracteis basalibus ternatis pedunculata, corpore saepe bracteis laterali- bus paucis, setis internis praedito, cellulis scleroticis nullis. Tepala rubra glabra. Stamine 1–2. Ovarium rubrum v. albidum, stylo glabro. Semina 1–1.5 mm. longa, hilo non prominenti. Cystolitha plerumque hypogena. Continens Asiatica, 3 spp. Typus, *F. semicordata* B. Ham. ex J. E. Sm. (*F. cunia* B. Ham.).

This series relates with sect. *Ficus*, but habit and convenience place it here. *F. semicordata* has two stamens in the male flower, *F. prostrata* has one, while in *F. koutumensis* the male flowers are not known. The first two species have usually been placed in sect. *Sycocarpus* (*Covellia*) because of their cauliflorous habit, but the free tepals at once exclude them, and relate them with the following two series.

ser. **Pungentes** Corner ser. nov.—*Bosscheria* Teysm. et de Vr. Nat Tijd. N.I. 23 (1861) 212.—sect. *Covellia* (Gasp.) Miq. subsect. *Pandaniflorae* Sata, Monogr. (1944) 293 (ut *Pandanusiflorae*; lectotypus, *F. minahassae* Teysm. et de Vr.).—Brunneo-setosa. Folia longipetiolata spiraliter disposita, aut brevipetiolata et disticha. Receptacula parva pedunculata, bracteis basalibus ternatis, lateralibus deficientibus, rami- et cauliflora ad ramos longos efoliatis pendentes sed haud geocarpicos: setis internis copiosis longis albidis: cellulis scleroticis nullis. Tepala 3–4 rubra glabra.

Ovarium brunneo-rufum, femineum stylo hirsutissimo. Semina 0.5–0.7 mm. longa, hilo parvo prominenti. Cystolitha hypogena. Borneo, Philippines, Malaysia Orientalis, 3 spp. Typus, *F. pungens* Reinw. ex Bl.

As the preceding series, this has also been wrongly assigned to sect. *Sycocarpus*. *F. minahassae* and *F. pungens* are closely allied, but the third, *F. petrotica* Diels, has distichous, short-petiolate, leaves.

ser. **Phaeopilosae** Corner ser. nov.—Purpureo- v. brunneo-setosae v. hirtae. Folia longipetiolata symmetrica spiraliter disposita. Receptacula axillaria v. cauliflora, raro geocarpica, sessilia v. pedicellata, bracteis lateralibus dispersis, ad corpus receptaculi saepe bene evolutis; cellulis scleroticis nullis. Tepala rubra glabra. Ovarium albidum, stylo glabro. Borneo, Philippines, Malaysia Orientalis, 7 spp. Typus, *F. complexa* Corner.

This is the most generalised series and it relates to the more generalised species of sect. *Adenosperma* and sect. *Sycocarpus*. Except for *F. gul* Laut. et K. Schum., the species occur in New Guinea.

ser. **Copiosae** Corner ser. nov.—Albido-pilosae v. glabrae, saepe scabridae. Folia plerumque longipetiolata et symmetrica, spiraliter disposita v. decussata. Receptacula axillaria v. rami- et cauliflora, pedicellata bracteis lateralibus paucis parvis dispersis; cellulis scleroticis nullis v. paucis. Tepala purpureo-rubra pallescentia v. albida, saepe puberula v. hispidula. Ovarium albidum. India usque ad insulas Solomon, 11 spp. Typus, *F. copiosa* Steud.

ser. **Scabrae** Miq. Hook. Lond. J. Bot. 7 (1848) 228.—subgen *Palaeomorphe* (King) Sata sect. *Palaeomorphe* ser. *Nonminutuliflorae* Sata (lectotype, *F. ulmifolia* Lam.), subser. *Fulvobrunneifoliae* Sata (lectotypus, *F. ulmifolia* Lam.) et subser. *Metallicifoliae* Sata (lectotypus, *F. blepharistoma* Warb.), Monogr. (1944) 223, 224, 378.—subgen. *Eumetamorphe* Sata sect *Sycidium* Miq. subsect. *Sycidium* ser. *Viridifoliae* Sata (lectotypus, *F. worcesteri* Merr.) et ser. *Lineariangustifoliae* Sata (lectotypus, *F. angustissima* Merr.), Monogr. (1944) 253, 254, 380.—subsect. *Pseudosycidium* Sata (lectotype, *F. fiskei* Elmer) et ser. *Scabricordatogibbosifoliae* Sata (lectotype, *F. fiskei* Elmer), ser. *Lanceifoliae* Sata (lectotype, *F. celtoides* Elmer), ser. *Subscabririgidifoliae* Sata (lectotype, *F. ampelas* Burm. f.), Monogr. (1944) 253, 258, 260, 262, 381, 382.—Albido-, luteo- v. brunneo-pilosae. Folia brevipetiolata decussata, spiraliter disposita, v. disticha, saepe asymmetrica et scabra. Receptacula axillaria v. cauliflora, pedunculata

v. *pedicellata*: cellulis scleroticis nullis v. copiosis. Ovarium albidum: stylo puberulo v. glabro. Seminis hilum non prominens. Madagascar, Ryu Kyu, Formosa, Malay Archipelago, Australasia, c. 50 spp. Lectotypus, *F. aspera* Forst. f.

This is the short petiolate remainder, comprising the majority of the species. Let us hope that some of these synonyms may never have to be used.

subject. **Varinga** (Miq.) Corner comb. nov.—*Ficus* sect. *Carica* Miq. subject. *Varinga* Miq. Ann. Sci. Nat. ser. 3, 1 (1844) 33 (haud sect. *Varinga* Miq. sensu OK in T. Post Lex. Gen. Phan. 1904, 236).—Ut subject. *Sycidium* sed semina breviter oblonga: tepala et ovarium albida. Arborea v. frutices, raro sarmentosae (Africa), haud epiphytica. Africa, Ceylon, Asia continentalis. Sumatra, Java, Borneo, c. 13 spp. Lectotypus, *F. scabrella* Roxb. (*F. heterophylla* Linn. f.).

As the character of subject. *Varinga*, Miquel gave the unistaminate flower. This excludes all the species which he cited except *F. scabrella* Roxb., which is a synonym of *F. heterophylla* Linn. f., and *F. radicans* Roxb. which, as a synonym of *F. heteropleura* Bl., is provided for in subject. *Palaeomorpha* (King) Corner. Hence my choice of *F. scabrella* as lectotype. The species much resemble those of ser. *Scabrae* (subject. *Sycidium*) but cannot be fitted in with them, and the group permeates a different geographical region.

ser. **Heterophylleae** Corner ser. nov.—Receptacula axillaria solitaria, 10–20 mm. lata v. latiora, plerumque pedunculata bracteis basalibus ternatis, lateralibus et setis internis deficientibus. Tepala plus minus glabra. Semina laevia. Lamina plus minus symmetrica. Africa, Asia, 6 spp. Typus, *F. heterophylla* Linn. f.

ser. **Cyrtophylleae** Corner ser. nov.—Receptacula binata, axillaria v. ad truncum ramosque fasciculata, pedicellata, bracteis lateralibus dispersis. Tepala plus minus glabra. Semina laevia. Folia disticha brevipetiolata, saepe asymmetrica. Africa, Asia, 6 spp. Typus, *F. cyrtophylla* Wall. ex Miq.

ser. **Exasperatae** Corner ser. nov.—Receptacula axillaria, plerumque solitaria, pedicellata, bracteis lateralibus dispersis. Tepala hispida. Semina reticulata. Africa usque ad Indiam, Ceylon, 1 sp. *F. exasperata* Vahl.

subject. **Palaeomorpha** (King) Corner comb. nov.—*Ficus* sect. *Paleomorpha* King, Ann. R. Bot. Gard. Calc. 1 (1887) 1, 3.—subgen. *Palaeomorpha* (King) Sata, J. Soc. Tr. Agr. 6 (1934)

26; Monogr. (1944) 217.—*Ficus* sect. *Grossularia* OK in T. Post Lex. Gen. Phan. (1904) 236.—Semina oblonga, apice carinata v. gibbosa, laevia. Flores masculi plerumque ovario cecidiophori praediti. Folia disticha brevipetiolata. Receptacula pedicellata v. sessilia, bracteis haud in collare ternatis. Cystolitha haud papillata. Arbores, frutices, saepe epiphytica etiam suffocantes, v. sarmentosae: ramulorum radicumque cortice saepe flavescenti. Asia, Australasia, 19 spp. Lectotypus, *F. gibbosa* Bl. = *F. tinctoria* Forst. f. ssp. *gibbosa* (Bl.) Corner.

The tendency is to discard this group because of the variable development of the gall-ovary in the male flower in the whole section. When, however, the shape of the seed, the leaf-arrangement, and the habit of the plants are taken into account, the well-developed, insect-inhabited, gall-ovary in these species is, as King perceived, a good character. Thus the group is certainly distinguishable as a natural entity from subsect. *Sycidium*, and should, perhaps, be given its original sectional rank. However, I prefer to await the elucidation of the African and Madagascan species and their relation with ser. *Copiosae* (subsect. *Sycidium*), for they impinge on the species of subsect. *Palaeomorpha*.

ser. **Pallidae** Miq. Hook. Lond. J. Bot. 7 (1848) 433.—ser. *Euglabrifoliae* Sata (lectotypus, *F. tinctoria* Forst. f.) Monogr. (1944) 217, 218, 377.—ser. *Glabrifoliae* Sata (lectotypus, *F. philippinensis* Miq.), id. 262, 382.—Arbores mediocres v. grandes, saepe epiphyticae et suffocantes. Stipula terminalis plerumque conspicua, recta, rigida. Lamina coriacea, haud caudata, plerumque integra, sicco pallida v. subtus brunneo-areolata. Receptacula sicca laevia, bracteis lateralibus nullis: setis internis minutis: cellulis scleroticis in pariete copiosis. Tepala puberula v. hispidula. Cystolitha amphigena. Asia, Australasia, 3 spp. Lectotypus, *F. tinctoria* Forst. f.

Of the species assigned first to this series by Miquel, *F. hederacea* Roxb. belongs to sect. *Rhizocladus* Endl., *F. septica* Burm f. to sect. *Sycocarpus* Miq., and *F. undulata* B. Ham. (*F. nervosa* Heyne) to subgen. *Pharmacosycea* Miq. These excluded, the remaining eleven are *F. tinctoria* and *F. virgata* Reinw. ex Bl. or their synonyms. I choose *F. tinctoria* as type because it is the better known.

ser. **Subulatae** Corner ser. nov.—Arbores parvae v. frutices, saepe epiphyticae v. sarmentosae, haud suffocantes. Stipula terminalis conspicua curvata gracilis. Lamina subcoriacea v. membranacea, acuminata v. caudata, integra. Receptaculis sicca contracta et rugosa, plerumque bracteis lateralibus paucis parvis

praedita: setis internis et cellulis scleroticis nullis. Tepala albida. Flores feminei et cecidiophori pedicellis induratis, tepalis linearibus v. subulatis. Cystolitha hypogena, raro amphigena. India usque ad insulas Solomon, 2 spp. *F. subulata* Bl. (typus), *F. armiti* King.

ser. **Cuspidatae** Miq. Hook. Lond. J. Bot. 7 (1848) 428.—ser. *Glabriusculifoliae* Sata (lectotype, *F. caudatifolia* Warb.), Monogr. (1944) 217, 220, 378.—Arbores parvae, frutices, v. sarmentosae. Stipula inconspicua. Lamina caudata, dentata v. integra, siccis nervis reticulatis supra leviter elevatis, saepe fusco-brunnea. Receptacula raro bracteis lateralibus praedita: cellulis scleroticis nullis. Tepala albida membranacea. Semina valde carinato-gibbosa. Cystolitha hypogena. India usque ad Malaysiam Occidentalem, 4 spp. Lectotypus, *F. cuspidata* Reinw. ex Bl. = *F. sinuata* Thunb. ssp. *cuspidata* (Reinw. ex Bl.) Corner.

I have taken *F. cuspidata* as lectotype because it agrees with Miquel's diagnosis of the series and obviously provided the name.

ser. **Minutuliflorae** Sata, Monogr. (1944) 217, 222, 378.—Arbores parvae v. frutices, saepe epiphyticae, plerumque luteo-v. brunneo-pilosae. Stipula inconspicua. Lamina caudata, basi saepe auriculata, dentata v. integra, membranacea. Receptacula saepe bracteis lateralibus parvis 1–2 praedita: cellulis scleroticis nullis. Tepala albida membranacea. Cystolitha hypogena, raro amphigena. Sumatra, Borneo, Philippines, Celebes, Moluccas, New Guinea, 3 spp. Lectotypus, *F. hispidulosa* Elmer (*F. aurita* Bl.).

ser **Fibrosifoliae** Corner ser. nov.—Ut ser. Minutuliflorae sed lamina fibris microscopicis sclereidiformibus in mesophylla copiosis praedita. Stipulae saepe conspicuae. Flores feminei et cecidiophori sessiles. Tepala rubra v. albida. Cystolitha amphigena v. hypogena. Burma, Thailand, Malaysia Occidentalis usque ad insulas Philippinenses et Moluccanas, 7 spp. Typus, *F. obscura* Bl.

This group is abundantly distinct in the microscopic feature of sclereid-like fibres excurrent from the vascular bundle-sheaths and permeating the whole mesophyll between upper and lower epidermis. It is a feature which can be observed very easily and quickly in a minute fragment of dried leaf-tissue cleared by placing in a drop of dilute potash on a slide and warming for a minute: the fibres appear like white worms under a low power of the microscope. The species are closely related and show, as any other natural group of *Ficus*, the common evolutionary trends in leaf and receptacle.

subject. *Sygidium* ser. *Prostratae* Corner

F. semicordata B. Ham. ex J. E. Smith, Rees Cyclop. 14 (1810) n. 71.—*F. cunia* B. Ham. ex Roxb. Fl. Ind. 3 (1832) 561; Wight Ic. t. 648: (*F. cunea* B. Ham. ms.).—This is represented by two sheets in the Smith herbarium of the Linnean Society of London, namely n. 1610.26 (narrow leaf) and 1610.27 (broad leaf, the *lectotype*). The name antedates *F. semicordata* Miq. for which *F. elmeri* Merr. must be used. The common name for the species has been *F. cunia*, of uncertain etymology, but it is spelled *F. cunea* on the labels of B. Hamilton's specimens.

var. **conglomerata** (Roxb.) Corner comb. nov.—*F. conglomerata* Roxb. Fl. Ind. 3 (1832) 559; Wight Ic. t. 669.—*F. cunia* B. Ham ex Roxb. var. *conglomerata* (Roxb.) Kurz, For. Fl. Br. Burma 2 (1877) 461.

F. koutumensis Corner sp. nov.—Arbor -9 m. alta, foliis symmetricis distichis. Ramuli, petioli, et costae (subtus) pilis albidis v. brunneis -1.5 mm. longis hispidi, nervuli pilis brevioribus; lamina supra pilis albidis appressis scabrida, glabrescens. Ramuli 4-6 mm. crassi, posteriores 2-3 mm. Stipulae -17 mm. longae, puberulo-glabrescentes v. glabrae, subcaducae. Lamina 10-21 × 3-9.5 cm., oblongo-elliptica, apice acuminata -15 mm. longo, basi late cuneata v. rotundata symmetrica, denticulata v. serrulata, subcoriacea, supra scabrida, subtus hispidoscabrida, sicco brunnea: costis lateralibus utrinsecus 6-8, obliquis, intercostis -10, subtus leviter elevatis: costis basalibus utrinsecus 2-3 (-4), ad $\frac{1}{4}$ - $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 12-55 mm. longo. Receptacula ad ramulos efoliatis geocarpicos ut in *F. semicordata* J. E. Sm., stipulis plus minus persistentibus; pedunculo 3-10 mm. longo, albido-villoso dein glabro: bracteis basalibus in collare ternatis, 2-3 mm. longis, glabris v. appresse puberulis: corpore receptaculi 15-20 mm. lato, albido-villoso dein glabro, bracteis lateralibus nullis v. unico, ostiolo plano bracteis apicalibus planis 4-5 ocluso: setis internis paucis albidis: cellulis scleroticis nullis. Flores feminei ut in *F. semicordata*, plus minus sessiles: tepala 3-4 libera rubra lanceolata, ovario equalia: ovario sessili v. breviter stipitato, rubro: stylo valde laterali, glabro, stigmati simplici. Semina laevia, vix carinata et vix gibbosa. Cystolitha hypogena v. supra vix evoluta. Annam, pr. Koutum, in silvis montium 1,000-1,800 m. alt.

Poilane 18220, mont. Mam Ray: 32027, pr. Moi de Tu-inh (typus, herb. Paris).

Lamina symmetrica ut in *F. prostrata* Wall. sed denticulata, scabrida, et hispida ut in *F. semicordata* J. E. Sm.: stipulis et seminibus intermedia.

subject. Sycidium ser. Pungentes Corner

F. pungens Reinw. ex Bl. Bijdr. (1825) 478.—*F. myriocarpa* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 230, 296.—The type of *F. pungens* (Reinwardt 1486, Ternate) is sterile. I know of no way to distinguish sterile material surely of *F. minahassae* Teysm. et Binn. and *F. myriocarpa* Miq., but there are later collections of *F. myriocarpa* from Ternate and Morotai, whereas *F. minanassae* occurs to the westward (Talaud, Philippines, Celebes, North Borneo) and does not stretch into the Moluccas proper or to New Guinea, which is the domain of *F. myriocarpa*. Hence I identify *F. pungens* with *F. myriocarpa*. King mistook a Moluccan species of sect. Sycocarpus (*F. calcarata* Corner sp. nov.) for *F. pungens* Reinw. in which he was followed by Diels.

subject. Sycidium ser. Phaeopilosæ Corner

F. complexa Corner sp. nov.—Arbor -7 m. alta, latice albedo, foliis longipetiolatis spiraliter dispositis. Ramuli et petioli pilis brunneis v. purpureis 1-3 mm. longis erectis v. curvatis rigidis strigosi, glabrescentes: costae subtus pilis brunneolis 0.5-1 mm. longis appressis v. patentibus, nervuli puberulo-scabridi: lamina supra pilis appressis rigidis sparsis, glabrescens. Ramuli 4-6 mm. crassi, glandulis subnodalibus deficientibus. Stipulae 15-25 × 9-15 mm., ovato-lanceolatae, persistentes, appresso-puberulae v. subglabrae v. ad carinam pilis erectis brunneis strigosae. Lamina 18-32 × 12-19 cm., late elliptica v. ovata, apice gracili acuminata -25 mm. longo, basi cordata, symmetrica, denticulata, utrimque scabrida, membranacea, sicco fusca et subtus griseo-viridis: costis lateralibus utrinsecus 5-7, plerumque glandula axillari praeditis, intercostis 5-10, subtus elevatis: costis basalibus utrinsecus 3-4, ad 1/3-1/2 laminae elongatis, glandulo axillari praeditis: petiolo 4-15 cm. longo. Receptacula axillaria, solitaria v. binata, etiam rami- et cauliflora ad ramulos congestos, internodis vix evolutis, -50 × 5 mm., efoliatis, maturitate brunneo-rubra: pedicello 4-15 × 3-4 mm., bracteis lateralibus dispersis 2-5 × 2-4 mm., appressis v. patentibus, haud ternatis, praedito: corpore receptaculi 10-13 mm. lato (16-20 mm., vivo), subgloboso, interne ob flores breves cavo, pilis albidis -1 mm. longis laxe hispido, glabrescenti scabrido, bracteis lateralibus appressis numerosis ovato-lanceolatis acutis

5-16 × 4-9 mm, receptaculis juvenilibus toto obscurantibus, ostiolo bracteis similibus erectis numerosis 4-8 mm. longis ocluso: setis internis minutis sparsis: pariete crasso (4-5 mm., vivo), cellulis scleroticis nullis. Tepala 4-5 fusco-rubra, spathulata v. in floribus sessilibus ovato-lanceolata, libera, glabra. Flores masculi ostiolares sessiles, ordinibus 1-2 instructi: stamine 1, anthero minute mucronato, pistillodio nullo. Flores cecidiophori sessiles v. pedicellis glabris -1 mm. longis praediti, feminei sessiles: ovario sessili albido: stylo glabro, stigmatibus subinfundibuliforme puberulo. Semina 1 mm. longa, lentiformia, laevia, vix compressa, subcarinata. Cystolitha hypogena: pili papillati. Papua, in silvis montium 1,000-1,600 m. alt.

Brass 23213, Milne Bay district, Maneau Range, Mt. Dayman; Carr 14023 (Lalu River), 14660 (Boridi), 15753 (Isuarava, *typus herb. Br. Mus.*).

F. conocephalifoliae Ridley affinis sed lamina latiori, plus ovato-cordata, receptaculi bracteis lateralibus longioribus floribus sessilibus v. breviter pedicellatis. An *F. eustephana* Diels, e specimine miserabili descripta ?

F. porphyrochaete Corner sp. nov.—Arbor -12 m. alta, latice albido subseriflua, foliis longipetiolatis spiraliter dispositis. Ramuli, petioli, et receptacula setis purpureo-brunneis 1-4 mm. longis (ad costas et receptacula 1-2 mm.) irritantibus erectis hispidi, costae subtus pilis brunneolis plus minus appressis: lamina supra sparsim et appresse albido-hirsuta, glabrescens scabra. Ramuli 5-7 mm. crassi. Stipulae 15-35 × 6-11 mm., ovato-lanceolatae, persistentes, appresso-hirsutae. Lamina 23-40 × 11-20 cm., elliptico-obovata, apice acuminata -25 mm. longo, basi rotundato-cuneata v. subcordata, denticulata, membranacea, utrimque scabrida, sicco griseo-viridis, cyanea, v. brunneola: costis lateralibus utrinsecus 6-8, curvato-ascendentibus, glandula axillari praeditis, intercostis 6-12, subtus elevatis: costis basalibus utrinsecus 3, ad $\frac{1}{4}$ - $\frac{1}{3}$ laminae elongatis, glandulis basalibus 2: petiolo 25-75 mm. longo. Receptacula axillaria et cauliflora in cumulis magnis (-60 receptaculis aggregatis) ad ramulos efoliatos congestos -50 × 5-10 mm., internodiis vix evolutis, maturitate e brunneo rubescentia; pedicello 3-20 mm. longo, in receptaculis axillaribus brevi, bracteis lateralibus 1-2 (-3) dispersis, haud ternatis, ovato-lanceolatis puberulis, 1-2 mm. longis, praedito: corpore receptaculi 8-11 mm. lato (setis exclusis: 17-19 mm., vivo), subgloboso hispido glabrescenti, bracteis lateralibus paucis 1-2.5 × 3-5 mm., ostiolo bracteis numerosis erectis, externis ad apicem recurvatis, 1-1.5 mm. longis ocluso: setis internis brevibus, brunneolis,

sparsis v. copiosis: cellulis scleroticis nullis. Tepala 4–6 fusco-rubra albomarginata oblonga libera glabra. Flores masculi ostiolaris sessiles, ordine uno instructi: stamine 1, non mucronato, pistillodio nullo. Flores feminei et cecidiophori sessiles v. pedicellis albidis glabris –2.5 mm. longis praediti: ovario sessili albido-luteo: stylo glabro. Semina 0.8–1 mm. longa, lentiformia, subcarinata, laevia, hilo vix prominenti. Cystolitha amphigena: pili papillati. Papua, Solomon Islands, in silvis –500 m. alt.

Brass 24162, Papua, Milne Bay district, Kwagira River, Peria Creek (*typus*, Gray herb. Harvard): Carr 16381, Papua, Kokoda; J. H. L. Waterhouse B146, B146a (Bougainville Isl, Siwai), 236 (New Georgia).

F. complexae Corner affinis sed receptaculis minoribus setosis parvibracteatis, cystolithis amphigenis.

F. gul Laut. et K. Schum. Fl. Deutsch. Schutzgeb. Suds. (1901) 278.—*F. rudis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 222, 291 (non Pers.).—*F. keyensis* Laut. et K. Schum. id. 270.—*F. manilensis* Warb., Perkins Fragm. Fl. Philip. 3 (1905) 199.—This is a widespread, common, and variable species extending from North Borneo and the Philippines to New Guinea and New Britain.

var. **lasiocarpa** Corner v. nov.—Receptacula pilis albidis, luteolis, v. brunneolis 1–2 mm. longis dense villosa, bracteis lateralibus obscuratis. Morotai, Halmaheira, Netherlands New Guinea.

Aet 218 (Exp. Lundquist) et BW 6889, SW New Guinea, Kaimana; A. W. Herre 636, Manokwari; Idjan 183, Halmaheira, Goal; Kanehira et Hatusima 13353, Momi, 60 miles south of Manokwari (*typus*, herb. Bogor); Kostermans 1348 (Morotai). 2619 (Manokwari, Warnapi).

var. **solomonensis** Corner v. nov.—Ramuli, petioli, et costae pilis 1–2 mm. intensius brunneis villosi. Receptacula pilis brunneis –0.5 mm. longis hispida, 9–12 mm. lata, bracteis lateralibus 1.5–3 mm. longis, bracteis apicalibus 1–1.5 mm. longis projicientibus: pedicello –12 mm. longo. Tepala ad apicem pilosa. Solomon Islands.

Brass 2578, San Cristoval, Waimamuru; Kajewski 1651, 1712 (Bougainville, Kupei Gold Field; *typus* 1651, herb. Kew) 2118 (Bougainville, Buin, Koniguru), 2796 (San Cristoval, Puepue River).

A v. *gul* receptaculis majoribus et bracteis apicalibus projicientibus differt: ad *F. porphyrochaete* Corner tendit.

subject. *Sycidium* ser. *Copiosae* Corner

F. montana Burm. f., Fl. Ind. (1768) 226.—*F. quercifolia* Roxb. Fl. Ind. 3 (1832) 534; Wight Ic. t. 646; King, Ann. R. Bot. Gard. Calc. 1 (1888) 77, pl. 95.—This is undoubtedly the correct name for *F. quercifolia* Roxb., though Burmann's type (herb. Delessert, Geneva) had been misnamed *F. ampelas*.

var. **purpurascens** (Bl.) Corner comb. nov.—*F. purpurascens* Bl. Bijdr. (1825) 471; King, Ann. R. Bot. Gard. Calc. 1 (1888) 75, pl. 93.—Leaves purple or violet beneath. Java.

A recent collection (Meijer 3981, Tjibodas) proves that this is merely a variety of *F. montana*. Blume's type is at Leiden.

F. madurensis Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 222, 291.—*F. smaragdina* S. Moore, J. Bot. (1925) 171.—*F. copiosa* Steud. *sensu* Ridley, Fl. Mal. Pen. 3 (1924) 340.—This has a more tree-like habit than *F. montana*, and is truly cauliflorous, with more persistent stipules, larger leaves, and broader tepals; and it is a plant of high forest, unlike *F. montana*. However, it requires field-study and it would be desirable to grow it along with *F. montana*, *F. andamanica*, *F. wassa*, and *F. copiosa*, which may be almost impossible to distinguish from sterile material. Because it has been misunderstood, I cite the collections which I refer to *F. madurensis*:—

Tenasserim:—Beddome 7489 (*F. smaragdina*, type). Thailand:—Kostermans 176, Kwae Noi Exped., pr. Wangka. Perak:—Wray 1732, Sing. F.n. 12728, Curtis s.n. May 1890, (Maxwell's Hill). Pahang:—Ridley 13719 (Telom), Sing. F.n. 31335, 32941 (Cameron Highlands). Selangor:—Ridley 8496, Robinson and Kloss s.n. 7 Sept., 1917, (Ginting Simpah). Negri Sembilan:—Ridley s.n. 23 Dec., 1920 (Bt. Tangga), Sing. F.n. 9856 and Furtado s.n. 16 June, 1937 (Ulu Bendol). Sumatra:—Beccari 772 (Padang; referred to *F. copiosa* Steud. by King); Borssum-Waalkes 1060 (Krakatau); Lorzing 4632 (Sibolangit), v. Steenis 9850 (Atjeh, Gajolanden). Java:—Zollinger 3803.4 (It. sec., Br. Mus.); Horsfield s.n. (Br. Mus.); Reinwardt s.n. (Utrecht, det. *F. subcrenata* Miq. ined.) Madura:—de Vriese s.n. (*type*, Leiden),; Zollinger 2449.

It looks as if the species has become extinct in Java.

var. **angustifolia** Corner v. nov.—Lamina 20–25 × 5–6.5 cm. lanceolata. Sumatra.

Krukoff 4178, Asahan, Masihi For. Res. (*typus*, herb. Leiden); Lorzing 5662 (Sibolangit).

F. andamanica Corner nom. nov.—*F. macropoda* Kurz, Prelim. Rep. For. Veg. Pegu App. A (1875) p. cxxiii; For. Fl. Br. Burma 2 (1877) 459, (non Miquel).—This is close to *F. madurensis* but has a longer fig-pedicel, internal bristles, puberulous tepals, and no ovary in the male flower. These are small points but they show that the two are not identical, and both require further field-study. In having the reticulate seed, it may connect *F. exasperata* Vahl (Peninsular India, Ceylon, East Africa) with *F. madurensis* and *F. montana* of Western Malaysia. I have seen the following collections:—

South Andaman Isl.:—Kurz s.n. and n.2 (syntypes, but with n.2, at Kew, are mixed figs of *F. variegata* Bl.); King's collector s.n. and n. 326; Parkinson 411. Barren Isl.; Prain s.n. 1891, Narcondam, common. Gt. Cocos Isl.:—Prain s.n. (det. *F. brevicuspis* Miq.).

F. subsidens Corner sp. nov.—Frutex laxa ramosa, ramulis decumbentibus v. repentibus, internodis elongatis, foliis longipetiolatis laxe spiraliter dispositis, scabridula. Ramuli 3–4 mm. crassi. Stipulae caducae. Lamina 17–22 × 9–11.5 cm., elliptica, apice breviter acuminata –10 mm. longo, basi late cuneata, denticulata, utrimque scabrida, membranacea, siccò brunneo-viridis: costis lateralibus utrinsecus 8–10, intercostis strictis –11, subtus leviter elevatis: costis basalibus utrinsecus 1 (–2), brevibus, glandulis basalibus 2: petiolo 30–70 × 3–4 mm. Receptacula binata, axillaria ad ramulos frondosos et ad caules repentis defoliatos, scabridula, maturitate externe et interne roseo-rubra: pedicello 5–8 mm. longo, bracteis lateralibus 2–3 parvis dispersis, haud ternatis: corpore receptaculi 6–8 mm. lato (10–11 mm., vivo), subgloboso, bracteis lateralibus parvis paucis, ostiolo subdepresso bracteis apicalibus umbonatis 4–5 occluso: setis internis et cellulis scleroticis nullis. Flores masculi et cecidiophori? Flores feminei sessiles v. pedicellis glabris –1mm. longis praediti: tepala 3–5 lineari-lanceolata, leniter gamophylla, glabra, albida: ovario sessili v. substipitato, parte inferiori carnosio: stylo glabro. Semina 1–1.2 mm. longa, lentiformia, vix compressa, subcarinata, laevia. Cystolitha ut pili microscopici amphigena. North Borneo (Kinabalu), inter lapides riparia, c. 1,500 m. alt.

Sing. F.n. 26443, Kinataki River, leg. C. E. Carr (*typus*, herb. Singapore); Clemens 32402, pr. mont. Nunkok.

Species notabilis, in distributione singularis, *F. montanam* Burm. f. revocans sed semina haud reticulata et lamina majoribus, intercostis pluribus.

F. copiosa Steud. var. **pubescens** Corner v. nov.—*F. krausseana* Rechinger, Fedde's Rep. 11 (1912) 180.—*F. acanthophylla* Summerh. J. Arn. Arb. 10 (1929) 142.—Ramuli, petioli, lamina (subtus), et receptacula juvenilia pilis albidis -1 mm. longis villosi v. hispiduli, plus minus muriculati. Moluccas, New Guinea, New Britain, New Ireland, Solomon Islands, Queensland.

Moluccas:—Beguin 1827, Boger 9 (Halmaheira); Kostermans 1339 (Morotai); Labillardiere s.n. (Boeroe et Amboina). New Guinea:—Brass 1388, 8749, 24127; Carr 11728, 11732, 16445; Hoogland 4209; Kostermans 310 (*typus*, herb. Leiden), 493, 2853; NGF 861. New Britain:—Waterhouse 247. New Ireland:—Labillardière s.n. Solomon Isl.:—Brass 2580 (San Cristoval), 3193 et 3196 (Ysabel); Kajewski 1836, Rechinger 4713, Waterhouse 156, 226, B324, 801 (Bougainville). Queensland:—S. T. Blake 14976; Kajewski 1178 et C. T. White 8021 (det. *F. magnifolia* F.v.M.).

Ut species nullo modo distinguenda.

F. wassa Roxb. Fl. Ind. 3 (1832) 539; Wight Ic. t. 666.—*F. duriuscula* King, Ann. R. Bot. Gard. Calc. 1 (1888) 155, pl. 195.—*F. eulampra* K. Sch. Fl. Deutsch. Schutzgeb. Suds. (1901) 279.—*F. lamprophylla* Laut. et K. Schum. id. 271.—*F. portus-finschii* Warb. in Laut. et K. Schum. Nachtr. Fl. Schutzgeb. (1905) 250.—*F. rhodocarpa* Summerh. J. Arn. Arb. 10 (1929) 150.—*F. anggica* Diels, Engl. Bot. Jahrb. 67 (1935) 198.—*F. wassa* is identifiable from Roxburgh's specimen (herb. Martii, Brussels), his description, and Wight's figure. *F. copiosa* Steud. is identifiable from Roxburgh's description of *F. polycarpa* Roxb. (non Jacqu.) and Wight's figure (t. 632), but I have found no specimen of Roxburgh's. I treat *F. copiosa* in the customary sense, as the species with large leaves and figs, but Buch. Hamilton 2426 (at Edinburgh), labelled "F. polycarpa Roxb. Hort. Beng. 66: colitur in horto prope Calcuttam botanico e Moluccis", resembles *F. wassa* rather than *F. copiosa*. *Wassa* is a common name in Eastern Malaysia for any rough-leaved fig, comparable with *ampelas* in Western Malaysia, and may signify *F. ampelas*, *F. melinocarpa*, *F. heteropoda*, *F. copiosa*, *F. wassa* or any other.

var. **nubigena** (Diels) Corner comb. nov.—*F. nubigena* Diels, Engl. Bot. Jahrb. 67 (1935) 209.—*F. caroli* Diels id. 200.—Diels indicated that *F. caroli* might have to be reduced to *F. nubigena*. Many specimens are now at hand for the common *F. wassa*

and several of these are intermediate to *F. nubigena* which, in fact, differs merely in the following, rather vague, and, in some respects, probably phenotypic characters:—

Leaves mostly decussate; lamina elliptic, often dentate; petioles 2–22 mm., rather short. Tepals dark red, fading pinkish white. New Guinea, mountain and mossy forest, 1,300–2,400 m. alt.

Brass 5098; BW 3087, 3101; Carr 13304, 13630, 13656, 14211, 14342, 14866, 15979, 16095, 16402; Eyma 4913, 5319, 5424; Kanehira et Hatusima 13637; Ledermann 11826 (*F. caroli*, type), 11970, 12535 (*F. nubigena*, type), 12901; Nielsen 808; NGF 7847.

var. **obversifolia** (Miq.) Corner comb. nov.—*F. ampelas* Burm. f. var. *obversifolia* Miq. Ann. Mus. Bot. Lugd., Bat. 3 (1867) 272.—*F. reticulatissima* S. Moore, J. Bot. (1925) Suppl. 108.—Scabridissima. Ramuli, petioli, et costae (subtus) pilis pustulatis –0.5 mm. longis muriculati. Flores, Timor, Halmaheira, Morotai.

Timor: Forbes 3551, 3704, 3294. Flores:—Elbert 4321. Halmaheira:—Nedi 221. Teysmann 5649 (*typus*, herb. Leiden). Morotai:—Kostermans 1487.

Muriculata ut *F. copiosa* Steud. sed in omnibus partibus minor ut in *F. wassa*.

F. balica Miq. var. **colfsii** Corner v. nov.—Ramuli, petioli, et receptacula albido-villosi, haud glabrescentes; lamina subtus molliter villosa. Ramuli 2–4 mm. crassi. Lamina basi cordata: costis lateralibus 6–8 v. 8–11. Receptacula pedicellis 8–30 mm.; corpore 12–15 mm. lato. Flores sessiles v. pedicellis rubris –1 mm. longis praediti; tepala 4–5 rubra libera oblonga, glabra v. puberula. Flores masculi ordinibus duobus instructi: stamine 1 (–2), pistillodio nullo. Lombok, Sumbawa, Flores, in silvis ad 1200 m., alt.

Colfs 295, Sumbawa (*typus*, herb. Leiden); Elbert 4220, Flores; Rensch 645, Sumbawa; Elbert 895, 896, 1651, Lombok.

F. griseifolia Corner sp. nov.—Arbor –8 m. alta, latice seriflua, foliis laxe spiraliter dispositis. Petioli, laminae pagina superior, et costae (subtus) pilis rigidis conicis erectis –0.5 mm. longi sparism muriculati, nervuli subtus scabriduli; ramuli stipulaeque glabri. Ramuli 2–3 mm. crassi, fusco-brunnei. Stipulae 5–9 mm. longae, graciles, liberae, caducae. Lamina 8.5–17.5 × 5–12 cm., ovato-elliptica, apice acuminata 12–22 mm. longo, basi cordata v. rotundata, saepe subasymmetrica, serrulato-denticulata, rigide membranacea, utrimque scabrida, sicco griseo-olivacea v. plumbea: costis lateralibus utrinsecus 5–8, intercostis strictis –8, subtus elevatis: costis basalibus utrinsecus

2-3, ad $1/3$ laminae elongatis, glandulis nullis v. indistinctis: petiolo 20-55 \times 2 mm., glandula subnodali praedito. Receptacula rami- et cauliflora ad ramulos efoliatis congestos -30 \times 3-4 mm., basi -10 mm. latos, internodis vix evolutis: pedicello 15-20 \times 1 mm., gracili, sparsim muriculato v. glabro, bracteis lateralibus glabris subacutis 1-3, 0.5-1 mm. longis, dispersis, haud ternatis: corpore receptaculi 7 \times 6 mm. (immature), ellipsoideo, subscabrido, bracteis lateralibus 1-2 parvis appressis, ostiolo bracteis apicalibus erectis numerosis acutis glabris 1-1.5 mm. longis ocluso: setis internis -1 mm. longis, flexuosis, copiosis, albidis: cellulis sclerotocis nullis. Tepala 4-5 fusco-rubra ovata-lanceolata libera glabra: florum pedicelli albidii glabri. Flores masculi ostiolares, sessiles v. breviter pedicellati, ordinibus duobus instructi: stamine 1, non mucronato, pistillodio plus minus bene evoluto. Flores cecidiophori sessiles v. pedicellati: ovario sessili, albido-luteo, ad basim lateris stylaris rubro-marginato. Cystolitha hypogena. Papua (Hoogland 3993, Alola, Iora valley. pr. Kokoda. 1200 m., alt.; *typus*, herb. Lae).

Ut *F. gul* Laut. et K. Schum. sed plus minus glabra; muriculata ut *F. copiosa* Steud; bracteis apicalibus erectis distinguenda.

F. primaria Corner sp. nov.—Arbor -20 m. alta: cortice griseo-brunneo pustulato, 12 mm. crasso: latice albido serifluo; foliis spiraliter dispositis. Ramuli, petioli, et costae (subtus) pilis rigidis patentibus albidis 1-2 mm. longis hispidi, nervuli pilis brevioribus v. puberuli: lamina supra hispido-scabrida. Ramuli 5-6 mm. crassi, brunnei. Stipulae 5-10 mm. longae, puberulae, caducae. Lamina 17-24 \times 8-11 cm., elliptico-obovata, breviter attenuato-acuminata, basi rotundato-subcordata, denticulata, membranacea, utrimque scabrido-hispidula, sicco brunneo-viridis: costis lateralibus utrinsecus 9-11, intercostis strictis -11, subtus valde elevatis: costis basalibus utrinsecus 2-3, ad $\frac{1}{4}$ laminae elongatis, glandulis basalibus 2: petiolo 36-65 mm. longo. Receptacula cauliflora ad ramulos breves congestos 8-14 mm. crassos, internodis vix evolutis: pedicello -55 mm. longo, sparsim hispidulo, bracteis lateralibus 3, 1.5 mm. longis, circum medium pedicelli dispersis, haud ternatis: corpore receptaculi 26 \times 22 mm. (immature), pyriformi, bracteis lateralibus nullis, scabrido-hispidulo pilis -0.3 mm. longis, ostiolo c. 5 mm. lato bracteis apicalibus parvis numerosis erectis v. recurvatis, ocluso: setis internis brevibus copiosis albidis: cellulis scleroticis nullis. Flores feminei (juveniles) sessiles v. pedicellati: tepala

4–5 libera glabra oblongo-spathulata, pallide carnea: ovario sessili albido: stylo valde laterali, glabro v. sub stigmatate clavato piloso. Cystolitha hypogena. Terr. New Guinea (Hoogland 4958, Madang district, Kokun River, pr. Jal, Gogol River Valley: *typus*: herb. Lae).

Species nobilis ut *F. montana* gigantea, sed ob flores masculos incognitos sedi incertis, forsan *F. griseifoliae* Corner affinis.

subject. Sycidium ser. Scabrae Miq.

F. cumingii Miq. var. **androbrot**a (Summerh.) Corner comb. nov.—*F. androbrot*a Summerh. J. Arn. Arb. 10 (1929) 143.—*F. dichroa* Summerh. id. 147.—This New Guinea variety differs from *v. cumingii* merely in the broadly elliptic lamina, 4–8 cm. wide, the numerous intercostals (3–11), the glabrous flower-pedicels, and the presence of a gall-ovary in the stalked male flowers adjoining the gall-flowers (not in the sessile male flowers round the orifice). Thus it approaches *v. worcesteri* with larger lamina. Some Philippine collections of *v. terminalifolia* (Elm.) Sata (= *F. terminalifolia* Elm.) match those of *v. androbrot*a in leaf and glabrous flower-pedicels: thus, it may not be possible to distinguish seed-plants.

Aet (Exp. Lundquist) 520; Branderhorst 53, 128 (det. *F. dichora*); Brass 800 (*F. androbrot*a, type), 1190 (*F. dichroa*, type), 8298, 8548; Carr 11208; Koch 4.

var. **angustissima** (Merr.) Corner v. nov.—*F. angustissima* Merr. Govt. Lab. Publ. Philip. 29 (1905) 11.—This differs from *v. cumingii* in the linear acuminate lamina (14–32 × 0.5–1.5 cm.) with 35–60 pairs of lateral nerves. It appears to be a shrub 3 m. high, but whether a sapling-form, a coppiced form, or a distinct variety is uncertain: a few collections are intermediate with *v. cumingii*. It is recorded from Luzon and Mindanao.

Merrill 2696 (*type*); Elmer 9357 (not seen), 13920; PNH 11067; Herb. Univ. Philip. 4907; Vidal 3818.

var. **worcesteri** (Merr.) Corner comb. nov.—*F. worcesteri* Merr. Philip. J. Sci. Bot. 9 (1914) 274.—This differs from *v. terminalifolia* (Elm.) Sata in the larger lamina (13–37 × 5–17 cm.; 4–17 × 1.5–6 cm. in *v. terminalifolia*) and the glabrous flower-pedicels. It lacks the gall-ovary in all the male flowers. That it is not a large-leaved sapling is shown by its sporadic distribution and the fact that small-leaved saplings of *v. terminalifolia* are known. Some collections, including the type, have pale pink tepals, which suggests that *v. worcesteri* links with *F. tonsa* Miq.

Bur. Sci. 7178 (Cavilli Isl. Sulu Sea; *type*); 24309, 24513 (Samar, Catubig River); 31029, 31067, 31369 (Panay, Capiz province, Jamindan), PNH 14315 (Samar, Mt. Mahagua).

F. fiskei Elmer var. **multinervia** Corner v. nov.—Sparsim muriculata. Lamina scabrida, basi utrimque cordata sed asymmetrica: costis lateralibus utrinsecus 8–11, costis basalibus haud elongatis. Tepala subrubra. Mindanao (Bur. Sci. 49506, Davao province, Mt. Mayo, det. *F. hemicardia* Merr., typus, herb. Bogor).

In v. *fiskei*, v. *cebuensis* Merr., et v. *laevifolia* Merr. costae laterales utrinsecus 5–8, basales ad $1/3$ – $1/2$ laminae elongatae. Var. *multinervia* foliis *F. oleraceae* Corner (Solomon Isl.) simillima, sed pilis muriculatis et setis internis deficientibus *F. fiskei* constat.

F. riedelii Miq. var. **minor** Corner v. nov.—Receptacula minora 6–8 mm. lata, pilis conicis –0.5 mm. longis vestita, bracteis lateralibus et apicalibus minoribus 1–1.5 mm. longis, pedicello 0–2 mm. longo: setis internis paucis brevibus. Lamina minor v. angustior. Frutex v. arbor parva. Celebes.

Beccari s.n., Kandari (R.Ist. Fir. 9346, det. *F. obscura* Bl. by King); Eyma 413, subdiv. Enrekang, inter Pasoeh et Rante Lomo, 600–1,300 m. alt. Eyma 3408, Menado, subdiv. Kolone Dale, inter Koroworo et Tompira (*typus*, herb. Leiden); Elbert 3329 (Kabaena Isl.), 3048 (distr. Rumbia, pr. Zankaya), S.E. Celebes; Kjellberg 357, 361 743, Kendari; 1385, Enrekang; 3779, Malili.

F. ampelas Burm. f. Fl. Ind. (1768) 226; emend. Miq. Hook. Lond. J. Bot. 7 (1848) 428 (excl. syn. Rheede).—There are two sheets in herb. Delessert (Geneva) named in Burman's hand *F. ampelas*. One, which I will call A, is the usual interpretation as given by Miquel, King, and Valetton. The other, which I will call B, is *F. montana* Burm. f. (= *F. quercifolia* Roxb.), though a leaf of *F. ampelas* is also attached to B. Both have been labelled "*F. ampelas* Burm. type" by Hochreutiner.

A. This sheet I have selected as the type because it maintains current usage and because it has written on it the full citation given by Burman, that is:—

Folium politorium.

Varinga Rumph. Herb. lib. 6 cap. 69 T63.

Terega H. Mal. tom. 3 p. 79 tab. 60.

The reference to Terega is to *F. montana* Burm. f. and was excluded by Miquel (1848).

B. This sheet bears the single erroneous citation "Rumph 4 p. 128 tab. 61", which should read "tab. 63". The specimen is typical *F. montana* with reticulate seed, and is to be excluded from *F. ampelas*.

The name was published as *F. ampelos*, but this is clearly a misprint for Burman wrote *F. ampelas* unmistakably on both sheets, and it is etymologically wrong. Miquel and King used the correct *F. ampelas*.

var. **linearis** Corner v. nov.—Frutex –2 m. altus. Lamina 3–6.5 × 0.5–0.9 cm., lineari-oblonga, subacuta, rigide coriacea, scabridissima: costis lateralibus utrinsecus 10–20, intercostis nullis: costis basalibus brevibus: petiolo 2–5 mm. longo. Receptacula 4 mm. lata: pedicello 2–3 mm. longo, bracteis lateralibus 2–3 dispersis. Stomata immersa. Celebes (Kjellberg) 3773, Waroe; *typus*, herb. Stockholm).

F. fallax Miq. (Celebes) revocans, sed setis internis, tepalis puberulis *F. ampelas* constat.

var. **soronensis** (King) Corner comb. nov.—*F. exasperata* Roxb. Fl. Ind. 3 (1832) 555.—*F. biglandulosa* Miq. Hook. Lond. J. Bot. 7 (1848) 229 (haud Fl. Ind. Bat. 1, 2, 1859, 298).—*F. asperior* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 291.—*F. soronensis* King, J. As. Soc. Beng. 55, 2 (1887) 411.—*F. blepharisepala* Warb. in Laut. et K. Schum. Nachtr. Fl. Schutzgeb. (1905) 246.—Tepala ciliato-puberula: florum pedicelli saepe hispiduli. Corpus receptaculi saepe bracteis lateralibus 1–2 praeditum. Lamina scabrida v. sublaevis, saepe subsymmetrica: costis lateralibus utrinsecus 6–9. Moluccas, Key Isl., Aru, New Guinea, New Britain.

Varietas orientalis plurinervia, in Moluccis specimina intermedia.

F. guyeri Elmer var. **sibuyanensis** (Elmer) Corner comb. nov.—*F. sibuyanensis* Elmer, Leaf. Philip. Bot. 4 (1911) 1319.—Lamina 5–15 × 3–8 cm., elliptica v. ovato-elliptica, apice acuminata 8–24 mm. longo v. subcaudata, laevis v. scabrida: costis lateralibus utrinsecus 3–6: petiolo 3–10 mm. longo. Pedicelli receptaculi 3–5 mm. longi, v. 15–18 mm. Luzon, Sibuyan, Panay, Samar.

Elmer 12236 (*typus*); Bur. Sci. 14509, 22811, 30846, 32284, 47345.

Ob setas internas longas *F. guyeri* ascripta, sed lamina ut in *F. ampelas* Burm. f.

F. cauta Corner sp. nov.—Arbor –15 m. alta, ? latice subnullo, foliis distichis, glabra. Ramuli 1.5–2 mm. crassi, straminei dein brunneoli. Stipulae 6–15 mm. longae, graciles. Lamina 8–20 × 3.5–7.5 cm., obovato-elliptica, apice acuminata –12 mm. longo, basi cuneata, integra v. dentato-angulata, membranacea v. subcoriacea, laevis v. subtus subscabrida, sicco griseo-viridis: costis lateralibus utrinsecus 3–5 (–6), curvato-ascendentibus, intercostis 1–4 laxis: costis basalibus utrinsecus 1, ad $1/3$ – $1/2$ laminae elongatis, glandulis basalibus 2 exiguis: petiolo 6–20 mm. longo. Receptacula axillaria solitaria: pedunculo 1–8 mm. longo: bracteis basalibus in collare ternatis, parvis, caducis: pedicello 2–15 mm. longo: corpore receptaculi 13–17 mm. lato (immature), bracteis lateralibus nullis, ostiolo plano bracteis apicalibus parvis numerosis occluso: setis internis et cellulis scleroticis nullis. Tepala 3–4 albida libera glabra, lanceolata v. oblonga. Flores masculi ostiolares, ordinibus duobus instructi, sessiles v. pedicellati: stamine 1, pistillodio minuto v. nullo. Flores feminei et cecidiophori sessiles v. pedicellis –1.5 mm. longis praediti: ovario sessili, pallido, stylo glabro. Semina 1–1.2 mm. longa, lentiformia, valde carinata, laevia. Cystolitha hypogena. Celebes, in silvis –1,200 m. alt.

Bunnemeyer 11477, Lombasang (*typus*, herb. Leiden); NIFS bb. 13517, Manado, Kakaskassen (det. *F. rostrata* Lam.); Forman 350, G. Lokon, Tetepangan, Minahassa; Kjellberg 2602 (Kosali Porema), 2691 (Porema); Koorders 19255, 19348, Minahassa, Menado; Reinwardt 1563, Minahassa; Sarasin 603 (det. *F. paucinervosa* Warb. ms., non Merrill); Teysmann 14022, Bonthain.

Lamina ut in *F. uniglandulosa* Wall. sed cellulis fibrosiformis deficientibus, habitu et receptaculis toto dissimilis. Affinitas incerta, forsitan *F. ulmifoliae* Lam.

F. goniophylla Corner sp. nov.—Arbor –10 m. alta, foliis brevipetiolatis distichis. Ramuli, petioli, et nervi pilis conicis –0.3 mm. longis sparsim hispiduli. Ramuli 1.5 mm. crassi, fusco-brunnei. Stipulae 2–3 mm. longae, perbreves, caducae. Lamina 3–9 × 1.7–4 cm., anguste elliptica, inequilateralis, utroque lobis brevibus 1–2 subangulatis, apice attenuata, basi cuneata, membranacea, utrimque scabrida, sicco griseo-viridis: costis lateralibus utrinsecus 3–4 (–5), rectangulatis, subtus elevatis, intercostis nullis: costis basalibus utrinsecus 1, ad $1/4$ – $1/3$ laminae elongatis, glandulis basalibus 2: petiolo 2–4 mm. longo. Receptacula cauliflora ad ramulos breves congestos efoliatos, pilis erectis 0.5 mm. longis hispidula, maturitate brunnea intus

rubescencia: pedicello 20–30 mm. longo, sursum gradatim dilatato, bracteis lateralibus 2–3 parvis dispersis: corpore receptaculi 20 mm. lato, obconico, bracteis lateralibus parvis 1–2 dispersis, ad apicem receptaculi applanatum numerosis umbonatis confertis 2–3 mm. longis, appressis v. incurvatis, ostiolo parvo plano bracteis apicalibus minoribus erectis occluso: setis internis brevibus sparsis albidis: cellulis scleroticis nullis. Tepala 4 oblonga, raro bifida, libera, glabra, albida. Florum pedicelli longi, glabri, in cecidiophoris 1.5–4.5 mm. Flores masculi ordinibus 2–3 instructi: stamine 1, pistillodio nullo. Ovarium sessile albidum. Cystolitha hypogena. Celebes (Kjellberg 1925, Todjamboe, c. 1,200 m. alt., in silvis: *typus*, herb. Stockholm).

Species insignis, foliis *F. tinctoriam* Forst. f. subsp. *gibbosam* (Bl.) Corner revocantibus, receptaculis *F. gul* Laut. et K. Schum., sed tepala albida. Planta feminea inquirenda.

F. melinocarpa Bl. var. **hololampra** (Diels) Corner comb. nov.—*F. hololampra* Diels, Engl. Bot. Jahrb. 67 (1935) 201.—*F. collinsii* Elmer, Leaf. Philip. Bot. 9 (1937) 3468.—Glabra sed scabridula v. foliis supra nitidis et laevibus. Receptacula setis internis praedita.

This is merely the glabrous state of *F. melinocarpa*, co-extensive from Sumatra to the Solomon Islands, but more abundant, apparently, in New Guinea. Intermediates with varying indumentum occur.

F. trachypison Laut. et K. Schum. var. **pallida** Corner v. nov.—Frutex v. arbor –15 m. alta, foliis distichis. Ramuli, petioli, et receptacula scabridi, haud v. vix hispiduli. Lamina tenuior, siccio pallidior griseo-viridis, intercostis subtus vix elevatis. Tepala albida, apice hirta. Terr. New Guinea, Papua, Solomon Isl. (Bougainville).

Ramuli 1–2 mm. crassi, brunneo-badii. Stipulae parvae caducae. Lamina 4–18 × 2.5–8.5 cm., elliptica. apice acuto attenuata v. subacuminata, basi late cuneata v. uno latere subcordata, subsymmetrica, denticulata v. integra, utrimque scabrida: costis lateralibus utrinsecus 5–9, intercostis –9: costis basalibus utrinsecus 1–2, ad $\frac{1}{4}$ – $\frac{1}{3}$ laminae elongatis, glandulis basalibus 2: petiolo 4–12 mm. longo. Receptacula axillaria et ad ramulos efoliatos fasciculata: pedunculo 2–5 mm. longo: bracteis basalibus ternatis 0.5–1 mm. longis: corpore receptaculi 6–9 mm. lato, globoso, bracteis lateralibus nullis: setis internis albidis copiosis brevibus: cellulis scleroticis nullis. Semina reticulata.

Brass 25346, Normanby Isl., Waikaiuna (*typus*, Gray herb. Harvard); A. W. Herre 223, Huon Gulf; Hoogland 3828, Terr.

New Guinea, north division, pr. Dobodura; Hoogland 4240, Terr. N.G., north division, Tufi subdistrict, pr. Guragura; NGF 5636, Lae; J. R. Saunders 39, Terr. N.G., north division, Tufi subdistrict, pr. Oi-ai on Penari-track; J. H. L. Waterhouse 32, Bougainville, Siwai.

Varietas incertae sedis propter affinitatem diversam, vix species ipsa. Facies ut *F. ampelas* Burm. f. var. *soronensis* (King) Corner sed differt in seminibus reticulatis, bracteis pedunculi basalibus ternatis, cellulis scleroticis in pariete receptaculi nullis, intercostis numerosis, qui sunt *F. melinocarpae* Bl. et *F. trachypison* proprii. Lamina parva et receptaculum parvum ut *F. trachypison*, sed eo *F. storckii* Seem. (Fiji) revocans. Plantae vivae juvenes et in statu cauliflori inspiciendae.

F. tonsa Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 234, 297.—Celebes, Talaud Isl.

Riedel s.n., Menado (HB 5705, *typus*); Boschpr. st. Cel/II—405, Malili, Kawata; Koorders 19057, 19063, 19193, 19247, 19274. Minahassa; Sarasin 588, Minahassa, Tomohon; Teysmann 11976 (Pangkadjena), 12648, 12737 (Balek Angin).

Lam 2627, Talaud, Karakelang, east of Beo; 3125, Talaud, Salibabu, east slope of G. Ajambana.

This is a large, but little known, tree relating *F. todayensis* Elmer and *F. irisana* Elmer of the Philippines with *F. leptoclada* Benth. of Queensland, through *F. tonsa* v. *leptodictya* of New Guinea. They may, indeed, be varieties of one species, but v. *tonsa* is characterised by sunken stomata.

var. **aspera** Corner v. nov.—Lamina 5–16 × 2–5.5 cm., utrimque scaberrima, anguste elliptica, breviter acuminata, basi subsymmetrica, uno latere cuneata altero subrotundata, apicem versus denticulata: costis lateralibus utrinsecus 5–8, intercostis strictis —8: costis basalibus 1 + 2, ad $\frac{1}{4}$ – $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 3–8 mm. longo. Receptacula minora, 8–10 mm. lata, scabra, bracteis lateralibus nullis: pedunculo 1.5–2.5 mm. longo: setis internis —1 mm. longis, copiosis albidis: cellulis scleroticis in pariete receptaculi interno copiosis. Tepala 4–5 rubra glabra. Cystolitha amphigena: stomata superficialia. Terr. New Guinea (NGF 4863, East Highlands, pr. Nondugl, arbor parva in querceto: *typus*, herb. Lae).

Ut forma *F. trachypison* Laut. et K. Schum. angustifolia, sed setis internis longis et cellulis scleroticis copiosis, bracteis lateralibus nullis ad *F. tonsam* pertinsens.

var. **leptodictya** (Diels) Corner comb. nov.—*F. leptodictya* Diels, Engl. Bot. Jahrb. 67 (1935) 196.—Costae basales ad $\frac{1}{3}$ – $\frac{1}{2}$ laminae elongatae. Stomata superficialia. New Guinea.

Brass 27291, Fergusson Isl., Agamoia; Carr 14799 (Boridi), 16059 (Isuarava); Eyma 4355, 4534, Wissel Lake; Hoogland 3914, Kokoda; Ledermann 12826, Sepik (typus); NGF 4183, Sogeri.

A var. *tonsa* vix distincta sed in regione novoguineensi et ad *F. wassa* Roxb. v. *nubigena* (Diels) Corner approximans.

var. **subcordata** Corner v. nov.—Folia appplanata disticha. Lamina 5–13 × 1.5–4.5 cm., anguste elliptica v. ovato-lanceolata, acuta v. subacuminata, basi rotundata v. subcordata, symmetrica, subscabrida: costis lateralibus utrinsecus 7–10, intercostis 2–4: costis basalibus utrinsecus 2, brevibus: petiolo 3–10 mm. Receptacula axillaria, solitaria, glabra, 9–10 mm. lata, bracteis lateralibus nullis: pedunculo 7–15 × 1 mm.: bracteis basalibus ternatis, 1 mm. longis: pedicello 1.5–8 mm. longo: setis internis brevibus copiosis: cellulis scleroticis nullis. Flores feminei sessiles v. pedicellis rubris glabris praediti: tepalis 4–5 fusco-rubris, apice hispidulis: stylo puberulo. Semina 1 mm. longa, lentiformia, subcarinata, laevia. Stomata superficialia. Solomon Isl. (Kajewski 1657, Bougainville, Kupei Gold Field, in silvis 950 m. alt., arbor communis –10 m. alt.; *typus*, herb. Br. Mus.).

A var. *leptodictya* lamina anguste elliptica, basi symmetrica subcordata, receptaculo minori, cellulis scleroticis deficientibus differt. Ad *F. leptocladam* Benth. (Queensland) approximans.

F. irisana Elmer var. **validicaudata** (Merr.) Corner comb. nov.—*F. guyeri* Elmer v. *validicaudata* (Merr.) Sata, Monogr. (1944) 290.—? v. *minimaefolia* Sata id.—*F. fastigiata* Elmer, leaf. Philip. Bot. 1 (1906, April 10) 44.—*F. validicaudata* Merr. Philip. J. Sci. 1 (1906, April 15) Suppl. 45.—This is a dwarf state of *F. irisana* with small leaves and figs, occurring on high mountains and exposed places: it may well be phenotypic. The red tepals and lack of internal bristles show that it does not belong with *F. guyeri* Elm.

Clemens 17386; Bur. Sci. 2571, 12644, 27032, 37487, 38099, 42157; Elmer 6072, 8001 (*F. fastigiata*, *typus*), 8555, 8577, 8710, 14284, 21944, 21999; For. Bur. 936, 5084, 18140, 20125; PNH 1879, 7692; Vanoverbergh 1033; Whitford 1201 (*F. validicaudata*, *typus*).

F. tenuicuspudata Corner sp. nov.—Arbor tenuiramosa, foliis brevipetiolatis distichis, glabra, praeter receptacula non scabrida. Ramuli 1–1.5 mm. crassi, brunnei. Stipulae –8 mm. longae, binatae, caducae. Lamina 7.5–11 × 2–3.5 cm., elliptica, apice valde caudato-acuminata 25–38 mm. longo, (1/3–½ laminae efficienti) basi cuneata, integra, laevis, sicco griseo-viridis: costis lateralibus utrinsecus 6–8, intercostis –3, subtus leviter elevatis:

costis basalibus utrinsecus 1, brevibus, glandulis basalibus 2: petiolo 1.5–4 mm. longo. Receptacula axillaria, ? solitaria, scabridula: pedunculo 2–3 mm. longo: bracteis basalibus ternatis, 0.5 mm. longis: pedicello 2–3 mm. longo: corpore receptaculi 8–11 mm. lato, bracteis lateralibus nullis, ostiolo parum depresso: setis internis copiosis minutis: cellulis scleroticis copiosis. Flores feminei sessiles v. pedicellis rubris, glabris v. hispidulis, –1 mm. longis praediti: tepalis 4–5 fusco-rubris liberis hispidulis: ovario sessili rubro, lateribus pallidis: stylo glabro. Semina 1 mm. longa, lentiformia subcarinata, laevia. Cystolitha amphigena, papillata.

v. *tenuicuspida*.—Celebes.

Boschpr. st. Cel 1/21, Bonthain; Bünнемeyer 12641, Bonthain. 1400 m. alt.: Elbert 2730, Buton Isl.; Eyma 1013, subdiv. Enrekang pr. Latimodjong (*typus*, herb. Leiden).

F. virgatae Reinw. simillima sed bracteis basalibus ternatis, seminibus lentiformibus, cystolithis papillatis, rectius prope *F. tonsam* Miq. et *F. irisanam* Elmer referenda.

v. **major** Corner var. nov.—Lamina –22 × 8 cm., apice 25–35 mm. longo, intercostis 4–7. Receptacula axillaria, solitaria v. fasciculato-ramiflora, glabra, majora, 12–15 mm. lata: pedunculo longiori 10–17 mm.; pedicello nullo. Tepala 3–4 glabra. Flores masculi sessiles v. rubro-pedicellati: stamine 1, haud mucronato, ad basim setulis circumdato, pistillodio nullo. Flores cecidiophori sessiles v. pedicellis glabris rubris –2.5 mm. longis praediti: ovario sessili albido. Flores feminei sessiles v. breviter pedicellati: ovario albido: stylo glabro rubro. Semina 1 mm. longa, lentiformia, subcarinata, laevia. Mindanao (Bukidnon province, Mahilucot River; Bur. Sci. 38635, *typus*, herb. Leiden; 38683).

F. cumingii Miq. v. *worcesteri* (Merr.) Corner similis sed tepalis rubris rectius inter *F. irisanam* et *F. tonsam* ascribenda.

F. elmeri Merr. Govt. Lab. Publ. Philip. 29 (1905) 9.—

F. semicordata Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 226, 293 (haud J. E. Smith).—This synonym must be re-instated as the correct name for *F. semicordata* Miq. in view of the oversight of *F. semicordata* B. Ham ex J. E. Sm. (= *F. cunia* B. Ham. ex Roxb.).

F. oleracea Corner sp. nov.—Arbor –20 m. alta, foliis distichis, glabra v. ramulis petiolisque pilis erectis pallidis mollibus, 2–3 mm. longis, laxe pubescentibus. Ramuli 3–5 mm. crassi, brunneoli. Stipulae 6–15 mm. longae, binatae, lanceolatae, glabrae, novellis subpersistentes. Lamina 16–35 × 5–12 cm. (–47 ×

15 cm., juvenilis), oblonga v. ovato-oblonga, apice breviter acuminata 10–20 mm. longo, basi plus minus valde cordata, symmetrica v. asymmetrica, uno latere late lobata et petiolum obtegenti, integra, coriacea, laevis v. subtus subscabrida, sicco griseo-viridis v. brunnea: costis lateralibus utrinsecus (7–) 9–12, (–16, foliis juvenilibus), divaricatis, intercostis 5–10, subtus leviter elevatis: costis basalibus utrinsecus 3–4, brevibus, glandulis basalibus 2: petiolo 5–12 × 2–4 mm., brevi, crasso. Receptacula axillaria, ramiflora et cauliflora, ad truncum in cumulis grandibus evoluta, maturitate e cremeo rubescentia: pedunculo 3–10 mm. longo: bracteis basalibus in collare ternatis, 1 mm. longis: pedicello 0–8 mm. longo: corpore receptaculi 15–32 mm. lato (25–48 mm., vivo), subgloboso, bracteis lateralibus nullis, ostiolo 2–4 mm. lato bracteis apicalibus 3–4 vix projicientibus ocluso: setis internis –0.6 mm. longis, albidis, copiosis: pariete 1–2 mm. crasso, cellulis scleroticis nullis. Tepala 4–6, rubro-carnea dein pallida, libera, glabra v. puberula, lineari-oblonga, ovarium superantia. Flores masculi ostiulares, ordinibus 1–2 instructi, pedicellati: stamine 1, pistillodio nullo. Flores feminei et cecidiophori sessiles v. pedicellis glabris albidis –4.5 mm. longis praediti: ovario sessili, pallido: stylo femineo valde laterali, glabro v. puberulo, stigmati simplici. Semina 1.2 mm. longa, lentiformia, vix carinata, minute reticulata. *Cystolitha amphigena*. Solomon Islands.

var. **oleracea**.—Kajewski 1721 (*typus*, herb. Kew), 1912, Bougainville, Kupei Gold Field et Buin; J. H. L. Waterhouse 133 (New Georgia), 124, B203, 779 (Bougainville, Siwai), 203, 847 (Bougainville, Maisua); ? R. B. Comins 174 (San Cristoval).

var. **pugnans** Corner v. nov.—Ramuli, petioli, costa (subtus), et receptacula pilis erectis pallidis, flavidis v. brunneolis, 0.5 mm. longis villosuli, ad nervulos brevioribus. Lamina supra scaberrima, subtus villosula. Kajewski 1941, Bougainville, Buin, Kugumaru (*typus*, herb. Kew).

Species *F. fiskei* Elm. revocans sed arbor altior, receptaculis majoribus, setis internis praeditis, costis curvato-ascendentibus, intercostis numerosis. *F. tonsae* Miq. et *F. elmeri* Merr. affinis sed foliis majoribus brevipetiolatis, receptaculis majoribus, habitu cauliflori spectabilis.

F. chrysochaete Corner sp. nov.—Arbor mediocris –10 m. alta, v. suffruticosa, ramis horizontalibus, foliis distichis et ad ramulos flabelliforme dispositis. Ramuli et petioli pilis albidis, aureis, v. brunneolis mollibus erectis, 1–2 mm. longis, villosi: costae

subtus sparsim et breviter puberulae, nervuli glabri v. scabriduli: lamina supra sparsim et appresse pilosa, glabrescens, costis subvillosis. Ramuli 1–2 mm. crassi, brunneoli, saepe alternis anfracti. Stipulae –12 mm. longae, binatae, novellis subpersistentibus, albido-pilosae. Lamina 11–25 × 3–8 cm., anguste oblongo-elliptica v. subovata, apice acuminata 7–20 mm. longo, basi leniter cordata symmetrica v. subasymetrica, latere acroscopico latiori, denticulata v. integra, chartaceo-subcoriacea, supra nitida et scaberrima, subtus hispidulo-velutinosa, sicco griseo-viridis v. olivacea: costis lateralibus utrinsecus 6–9 (–10), obliquis, intercostis 5–14, subtus elevatis: costis basalibus utrinsecus 3–4, ad $\frac{1}{4}$ – $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 5–10 × 1.5–2 mm. brevi. Receptacula axillaria, solitaria, pilis erectis 0.5 mm. longis hispidula, glabrescentia, scabridula, maturitate rubra: pedunculo 5–10 mm. longo, gracili: bracteis basalibus in collare ternatis, 1–1.5 mm. longis, ovato-acutis, appresse puberulis: pedicello 0–7 mm. longo: corpore receptaculi 8–10 mm. lato (12–15 mm., vivo), subgloboso, bracteis lateralibus nullis, ostiolo bracteis apicalibus parvis numerosis occluso: setis internis –1 mm. longis, albidis v. aureis, copiosis: cellulis scleroticis nullis. Tepala 5–6 albida libera, spathulato-oblonga, ovarium superantia, appresse hispidissima, stamine et ovario setulis circumdatis. Flores masculi ostiulares, ordinibus duobus instructi, sessiles v. pedicellati: stamine 1 (–2), pistillodio nullo. Flores feminei et cecidiophori sessiles vel pedicellis glabris –2 mm. longis praediti: ovario sessili, albido: stylo femineo puberulo. Semina 0.8 mm. longa, lentiformia, subcarinata, tenuiter reticulata. Cystolitha amphigena: pili laeves. Solomon Islands.

L. J. Brass 2960 (Ulawa), 3199 (Ysabel, Maringe, *typus* herb. Kew); Kajewski 1983, 2148 (Bougainville, Buin, Koniguru et Kugumaru), 2317 (Malaita); J. H. L. Waterhouse 201 (New Georgia), 232, 232a (Bougainville, Siwai).

Species lamina oblonga brevipetiolata, costis obliquis, intercostis numerosis strictis, aureopilosa facile distinguenda, inter *F. melinocarpam* Bl. et *F. fulvopilosam* Summerh. sed habitu humili frondoso-flabelliformi dissimilis.—*F. imbricatae* Corner comparanda.

F. imbricata Corner sp. nov.—Arbor –20 m. alta, ramulis divaricatis, foliis distichis. Ramuli, petioli, et costae (subtus) pilis erectis albidis v. flavidis 1–2 mm. longis plus minus villosi, nervuli subtus sparsim et breviter pilosi v. subglabri: lamina supra sparsim et breviter pilosa, glabrescens. Ramuli 1–2 mm. crassi,

brunneoli. Stipulae -10 mm. longae, binatae, lanceolatae, sparsim pilosae, caducae. Lamina 10-18 \times 3.5-7.7 cm., elliptica, inaequilateralis, apice acuminata -17 mm. longo, basi rotundata v. late cuneata et asymmetrica, saepe latere acroscopico auriculato-lobulato, denticulata v. integra, supra scabrida, subtus scabrido-pilosa, rigide membranacea, sicco griseo-viridis: costis lateralibus utrinsecus 4-7, obliquis curvatis, -10 intercostis, subtus elevatis: costis basalibus 2 + 3, ad $\frac{1}{4}$ - $\frac{1}{3}$ laminae elongatis, glandulis basalibus 2: petiolo 3-8 mm., brevi. Receptacula axillaria solitaria (? etiam ramiflora), pilis brunneolis rigidis -0.5 mm. longis hispidula, subglabrescentia: pedunculo 5-18 \times 1 mm.: bracteis basalibus in collare ternatis, 1.5-2 mm. longis, lanceolatis: pedicello 4-15 mm. longo, gracili: corpore receptaculi 10-12 mm. lato (-25 mm., vivo, ficiformi, apice appanato), subgloboso, bracteis lateralibus nullis, apicem versus plus minus contracto, ostiolo bracteis apicalibus parvis numerosis subprojicientibus ocluso: setis internis -0.5 mm. longis, albidis, sparsis: cellulis scleroticis nullis. Tepala 4-6 fusco-rubra, albescentia in receptaculis cecidiophoris, libera, lanceolato-oblonga, ovarium multo superantia, apicem versus hispidula. Flores masculi ostiulares, ordinibus 2-3 instructi, sessiles v. pedicellati: stamine 1, pistillodio nullo. Flores feminei et cecidiophori sessiles v. breviter pedicellati: ovario sessili, pallido: stylo glabro. Semina 0.7-0.8 mm. longa, lentiformia, subcarinata, subreticulata. Cystolitha hypogena: pili laeves. Solomon Islands (Bougainville).

Kajewski 1724, Kupoi village; J. H. L. Waterhouse B37 (Buka, Skotolan), 176, 818 (Siwai, *typus* 818 herb. Kew).

F. chrysochaete Corner affinis sed arbor major, receptaculo majori, setis internis paucis, tepalis rubris, laminae basi plus minus asymmetrico, costis lateralibus paucioribus. Auricula ad basim laminae acroscopica forsan ad plantas juveniles pertinens quod foliis in Kajewski 1724 (arbor alta) deficiens.

F. gryllus Corner sp. nov.—Arbor parva, foliis asymmetricis distichis. Ramuli, petioli, stipulae, receptacula, et costae (subtus) pilis albidis v. brunneis rigidis erectis 1-2 mm. longis hispidoscabridi: nervuli subtus pilis brevioribus: lamina supra pilis albidis erectis -1 mm. longis basi pustulato hispidoscabrida. Ramuli 5-6 mm. crassi, brunneoli, cavi. Stipulae 20-30 mm. longae, caducae. Lamina -35 \times 16 cm., ovata, asymmetrica, apice acuminata 30-40 mm. longo, base valde asymmetrica, uno

latere late et profunde cordata, altero cuneato-subcordata, dentata, membranacea, utrimque scabrida, sicco griseo-viridis: costis lateralibus utrinsecus 7-8, intercostis -12, subtus elevatis: costis basalibus 2 + 4, ad $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2: petiolo 10-40 \times 3 mm., sub auricula laminae condito. Receptacula axillaria solitaria hispidissima, maturitate aurantiaca: pedunculo 4-6 \times 2.5 mm.: bracteis basalibus in collare ternatis, 3-4 mm. longis, ovato-lanceolatis, acutis, hispidis: corpore receptaculi 15 \times 12 mm. (pilis exclusis), ellipsoideo, bracteis lateralibus 2-4 mm. longis sparsis, circum ostiolum pluribus confertis erectis hispidis 2-3 mm. longis: setis internis albidis -1.5 mm. longis, copiosis: cellulis scleroticis nullis (receptaculo femineo). Flores feminei sessiles vel pedicellis glabris -1.5 mm. longis praediti: tepala 5-6 albida spathulata libera, apicem versus hispida: ovario sessili albedo, setulis paucis circumdato: stylo sparsim puberulo. Semina 0.8-0.9 mm. longa, lentiformia v. breviter oblonga, subcarinata, laevia. Cystolitha hypogena: pili papillati. Solomon Islands (L. J. Brass 3407, Ysabel, Tiratona, in silvis c. 600 m. alt., *typus* herb. Kew).

Receptaculo horrido, lamina valde asymmetrica, species hispidissima facile distinguenda, *F. erinobotryae* Corner affinis.

F. erinobotrya Corner sp. nov.—Suffrutex v. arbor parva, foliis asymmetricis distichis. Ramuli, petioli, laminae, et receptacula pilis albidis v. brunneis erectis rigidis 1-2 mm. longis hispidi: nervuli subtus pilis brevioribus. Ramuli 2-3 mm. crassi, fusco-brunnei. Stipulae -12 mm. longae, pilosae caducae. Lamina 13-32 \times 5.5-14 cm., ovato-elliptica, apice acuminata -17 mm. longo, basi valde asymmetrica, uno latere cordata petiolum obtegenti, altero anguste subcuneato, denticulata v. subintegra, membranacea, supra scaberrima, subtus hispido-villosula, sicco griseo-viridis: costis lateralibus utrinsecus 7-11, inferioribus saepe glandulo axillari praeditis, -11 (-14) intercostis regulariter instructis, subtus elevatis: costis basalibus 3 + 5, ad $\frac{1}{3}$ - $\frac{1}{2}$ laminae elongatis, glandulis basalibus 2. petiolo 7-10 mm. longo. Receptacula axillaria solitaria, dein cauliflora ad ramulos efoliatis -12 cm. longis paniculatos, basi 5-20 mm., apice 2-3 mm. crassos, internodis vix evolutis, hispidissima, maturitate rubra: pedicello 7-9 mm. longo, bracteis lateralibus 1-2 dispersis parvis, haud in collare confertis: corpore receptaculi 7-10 mm. lato, subgloboso, bracteis lateralibus 0-2, apicalibus numerosis parvis vix projicientibus: setis internis -1 mm. longis, albidis v. brunneolis, copiosis: cellulis scleroticis nullis. Tepala 5-7 (vel 3-5 in floribus masculis) subrubra v. albida, lanceolata

v. *spathulata*, libera, glabra v. apicem versus sparsim hispidula. Flores masculi ostiolaris, ordinibus duobus instructi, sessiles v. breviter pedicellati, pedicellis hispidulis: stamine 1, pistillodio nullo. Flores feminei et cecidiophori sessiles v. pedicellis -1.3 mm. longis, hispidulis praediti: ovario sessili albido: stylo glabro v. subpuberulo. Semina 0.7-8 mm. longa, lentiformia, subcarinata, laevia. Cystolitha amphigena, supra saepe ut pili microscopici: pili laeves.

v. *erinobotrya*.—New Britain: G. Bateson 148, between Baining Mts. and Toma; Dept. Agr. T.N.G. A23, Malabunga Mission; NGF 3510, Galilo village (*typus*, herb. Lae); Warburg 20824, 20825, Ralum (ut *F. semicordata* Miq.); J. H. L. Waterhouse 268, Gazelle Peninsula.

Inter *F. elmeri* Merrill (= *F. semicordata* Miq.) et *F. fulvopilosam* Summerh., sed *F. gryllus* Corner affinis.

var. *solomonensis* Corner v. nov.—Pili ramulorum petiolorumque -1 mm. longi. Basis laminae minus cordatus, petiolum haud obtegens: costae laterales utrinsecus 5-8: petiolus 5-27 mm. Receptacula pedunculis 2-9 mm. longis, bracteis basalibus in collare ternatis, pedicellis 0-9 mm. longis praedita: corpore sine bracteis lateralibus. Tepala 4-5, florum pedicelli glabri. Cystolitha plerumque ut pili microscopici. Arbor -10 m, alta: ramulis 1-2 mm. crassis: lamina 6-26 × 3-13 cm., Solomon Islands.

L. J. Brass 3294, (Ysabel, Tasia), 3483 (Florida, Olevuga); Kajewski 2364, Malaita, (*typus*, herb. Kew); J. H. L. Waterhouse B99, B99a, 148, 794, (Bougainville, Siwai), 165 (New Georgia).

F. fulvopilosae Summerh. affinis et forsans subspecies sed foliis acute acuminatis, intercostis numerosis strictis, receptaculis minoribus, et habitu cauliflori dissimilis.

f. *glabrior* Corner f. nov.—Sparsim brunneo-hispidula vel glabra. Setae internae -0.5 mm. longae, copiosae. Cystolitha hypogena bene evoluta. Solomon Islands.

L. J. Brass 2557, San Cristoval, Waimamura: E. S. Brown 5054 (Guadalcanal, Aruligo), 5762, 5763 (Nggela, Soso; *typus* 5763, herb. Brit. Mus.), W/265 (San Cristoval, Aronopo); J. H. L. Waterhouse B260, B315 (Bougainville, Siwai).

F. storckii Seem. revocans sed lamina plus asymmetrica et acute acuminata, intercostis numerosis strictis, et cauliflora. *F. trachypison* Laut. et K. Schum var. *pallidae* Corner et *F. melinocarphae* Bl. var. *hololamprae* (Diels) Corner (species ? non cauliflora) comparanda.

F. opposita Miq. Hook. Lond. J. Bot. 7 (1848) 426.—*F. conjugata* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 222, 291.—*F. opposita* occurs in Australia and along the southern coast of New Guinea, extending to the Eastern Highlands in the Territory of New Guinea. *F. conjugata* was collected in Pulau Sangrang (Java), by Teysmann and de Vriese (type at Leiden), but has never been found thereabouts again. Nevertheless I can detect no difference from *F. opposita*, which is itself variable. The species of sect. *Sycidium* in Madagascar, however, are closest to the Australian alliance of *F. opposita* and this lone station of *F. conjugata* becomes significant.

var. **micracantha** (Miq.) Corner comb. nov.—*F. aculeata* Miq. var. *micracantha* (Miq.) Benth. Fl. Austral. 6 (1873) 175.—*F. aculeata* A. Cunn. ex Miq. Hook. Lond. J. Bot. 7 (1848) 426.—*F. orbicularis* A. Cunn. ex Miq. id.—*F. micracantha* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 221, 291.—That this is merely a small-leaved variety with aculeate hairs and slightly smaller figs is shown by intermediate collections, particularly from New Guinea.

var. **indecora** (A. Cunn. ex Miq.) Corner comb. nov.—*F. indecora* A. Cunn. ex Miq. Hook. Lond. J. Bot. 7 (1848) 426.—This has been confused with *F. orbicularis* (v. *micracantha*, above), but is distinguished by the foveolate areolae (stomatal pits) on the underside of the lamina and by the lack of the aculeate hairs. The few collections indicate that it is restricted to Western Australia, where it is close to *F. scobina* Benth.

Broadbent 774a, Yarru, Grey Creek; A. Cunningham 65 and 306 (1820), Careening Bay (type); Gardner 66, E. Kimberley, Moogerooga Creek; F. v. Mueller s.n., Victoria River (1855); Ostenfeld 1176, 1177, Derby; Perry 2578, pr. Carlton Station; Schultz 407, Port Darwin.

F. scobina Benth. Fl. Austral. 6 (1873) 176.—I take Schultz 410 as the type (lectotype) because Cunningham 124, also cited by Benth, is *F. opposita* Miq. v. *micracantha* (Miq.) Corner. *F. scobina* is very near to *F. cunninggii* Miq. of the Philippines, extending to New Guinea as v. *androbrotta* (Summerh.) Corner, so that it may be an Australian variety, but the collections are too few.

Schultz 160, 410, 499, Port Darwin; Schomburgk, s.n. Port Darwin; Specht 873, Arnhem Land, Yirrkala.

F. fraseri Miq. Hook. Lond. J. Bot. 7 (1848) 235.—*F. proteus* Bur. Ann. Sc. Nat. ser 5, 14 (1872) 250.—*F. stenocarpa* F.v. Muell. ex Benth. Fl. Austral. 6 (1873) 174.—This has been confused with *F. fraseri* (Miq.) Miq., based on *Urostigma fraseri*

Miq., and which is a synonym of *F. virens* Ait. The type of *F. fraseri* Miq. (Fraser 154, Brisbane River) shows that it is identical with the well-known *F. proteus*.

F. coronata Spin. Cat. H. St. Sebast. (1818) 29; Roehm. et Schult. Mant. 1 (1822) 327; Mant. 3, add. 2 (1827) 403.—*F. muntia* Link, En. Pl. 2 (1822) 450.—*F. stephanocarpa* Warb. Fedde's Rep. 1 (1905) 75.—*F. aspera* hort. et *F. scabra* hort., non verae.—I have examined the type of *F. coronata* Spin., which is well-preserved in the Turin-herbarium, and it is exactly the species known as *F. stephanocarpa* Warb.; indeed, the description is unmistakable, as is that, also, of *F. muntia*. It appears to have been one of the early species introduced to cultivation in European hot-houses.

F. aspera Forst. f. Prodr. Fl. Austral. (1786) 76, n. 404.—*F. parcelli* Veitch ex Cogn. et Marchal, Pl. Ornem. 2 (1874) t. 47.—*F. parcelli* is merely the variegated state of *F. aspera*, but there are few collections of this species, and none that is good. Indeed, it is difficult to know how it differs from *F. scabra* Forst. f., except in the larger villous figs and the more copious veining.

F. storckii Seem. var. **kajewskii** (Summerh.) Corner comb. nov.—*F. kajewskii* Summerh. J. Arn. Arb. 13 (1932) 103; Bull. B. Bish. Mus. 141 (1936) 53.—A character of *F. storckii* is the presence of abundant cystoliths on both sides of the lamina, and this is the surest distinction, in the herbarium, from glabrous forms of *F. scabra*, which has cystoliths only on the underside, Amphigenous cystoliths also distinguish *F. kajewskii*, which differs from *F. storckii* merely in the smaller leaves and figs. Thus, it may be the state of *F. storckii* in exposed situations, or it may represent twigs of old trees (10–15 m. high) with reduced size of leaf and fig; several more or less intermediate collections come from Fiji. However, var. *kajewskii* strongly resembles the widespread *F. ampelas* Burm. f. which differs mainly in the narrower and more asymmetric leaf-base, the basal bracts not ternate but scattered on the fig-stalk, and the presence of sclerotic cells in the fig-wall. I consider that they are parallel reductions, Malaysian and Polynesian, of the *F. melinocarpa* -stock.

New Hebrides.—Aubert de la Rue s.n. (Aug. 1937); E. S. Brown s.n., Espirito Santo; Kajewski 216, 233, 343, 737 (*typus*).

Fiji.—Parham 316; Degener 14517; A. C. Smith 460, 532, 1323, 5272, 6071, 6606, 7738, 8403.

subject. *Varinga* (Miq.) Corner, ser. *Cyrtophylleae* Corner

F. asperiuscula Kunth et Bouché, Ind. Sem. Hort. Berol. (1846) 21; Ann. Sci. Nat. ser. 3, 7 (1847) 253; Miq. Fl. Ind. Bat. 1, 2 (1859) 300; Ann. Mus. Bot. Lugd. Bat. 3 (1867) 292.—*F. coronata* Reinw. ex Bl. Bijdr. (1825) 470 (non Spin.).—*F. grewiaefolia* Kunth et Bouché id. (non Bl.).—*Covellia zollingeriana* Miq. Hook. Lond. J. Bot. 7 (1848) 460.—*F. leptorhyncha* Koord. et Val. Bijdr. Booms Java 11 (1906) 156.—*F. inaequilatera* Ridl. J. Str. Br. R. As. Soc. 1 (1923) 93.—I have not found the type of *F. asperiuscula* but there are several collections from Java at Leiden, identified as *F. coronata* Reinw., on which Miquel has written "*F. asperiuscula* Kth. et Bouche". As this species agrees with the description, I take Miquel's authority for the interpretation of *F. asperiuscula*. It occurs only in Sumatra and Java, the Malayan records being *F. obscura* Bl., which has been much confused with it. A diagnostic character is the hooked apex of nearly all the hairs.

F. cyrtophylla Wall. ex Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 282, 296.—*Covellia cyrtophylla* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 460.—*F. asymmetrica* Lévl. et Vant. Fedde's Rep. 4 (1907) 82.—This species was erroneously reduced to *F. obscura* Bl. by King. It is a species of northern India, upper Burma, Tonkin, and South China, allied with *F. praetermissa* Corner and with the East African species centred about *F. storthophylla* Warb. It parallels in a remarkable way *F. fulvopilosa* Summerh. of Fiji.

India (Assam, Bhutan, Khasia, Sikkim).—T. Anderson 222; C. B. Clarke 11961, 13571, 25411, 25508; Cooper and Bulley 1060; Gamble 1152a, 9654; Griffith 4643; Hooker s.n., Khasia and Sikkim; King 2370, 5066, 5132; N.E. Parry 784; Thomson s.n. Sikkim; Wallich 4532 (*typus*).

Burma.—E. M. Buchanan 18, Myitkyina; Kingdon Ward 171 (Ngawchang Valley, Htawgaw), 9112 and 12932 (Nam Tamai valley), 20576 (Sumpra Bum); J. H. Lace 5345, Kadu; S. Toppin 4085, Kachin.

China (Kweichow, Yunnan).—Bodinier 2577; Cavalerie 2716, 3596, 3598; Esquirol 2692, 3108, 3549, 5238; Forrest 9419, 11535, 27975; Henry 11462, 12180; T. T. Yu 17386, 17465, 20488.

Tonkin.—Balansa 747, 2943; Poilane 25473, 25492, 25960.

F. leptogramma Corner sp. nov.—Arbor -7 m, alta, glabra, foliis brevipetiolatis distichis. Ramuli 2-3 mm. crassi, pallide griseo-brunnei, sicco sulcato-striati, vetustiores frustis corticis elongatis

angustis vestiti. Stipulae -15 mm. longae, binatae, subpersistentes, striatae. Lamina 10-35 \times 2.7-14 cm., elliptica v. subovata, apice caudata -60 mm. longo, basi rotundata v. cuneata, breviter dentato-repanda, utrimque subscabrida, membranacea, sicco supra grisea, subtus brunneola; costis lateralibus utrinsecus 8-12, saepe glandula axillari praeditis, intercostis strictis -12, subtus leviter elevatis; costis basalibus utrinsecus 1-2, brevibus, glandulis basalibus 2: petiolo 3-12 (-20) mm. longo, sicco striato. Receptacula in cumulibus -12 cm. latis ad ramos breves efoliatis congestos cauliflora: pedicellis 17-25 \times 2-2.5 mm., bracteis lateralibus 1-3, 1-2 mm. longis, dispersis; corpore receptaculi 10-15 \times 10-12 mm. (16-20 \times 15-17 mm., vivo), subellipsoideo, lenticellis asperato, bracteis lateralibus numerosis 2-3 mm. longis et latis, dispersis, apicem receptaculi versus confertis, ostiolo bracteis apicalibus planis parvis ocluso: setis internis et cellulis scleroticis nullis. Tepala albida, libera v. leviter connata, glabra, anguste oblonga v. subspathulata, ovario equalia. Flores masculi 2-3.5 mm. alti, ostiolares, ordinibus 2-3 instructi, sessiles v. subpedicellati: tepala 3-4: stamine 1 (-2), submucronato, pistillodio nullo v. raro evoluto. Flores cecidiophori 2.5-6.5 mm. alti, sessiles v. pedicellis glabris -3.5 mm. longi praediti; tepala 5-6: ovario sessili v. substipitato, albido. Flores femineae similes sed pedicellis -2.5 mm., tepalis 5-8, ovario ad 1.5 mm. stipitato, stylo glabro, stigmatibus clavatis. Semina 1 mm. longa, lentiformia, subcompressa, laevia, haud carinata. Cystolitha amphigena, supra sparsa. North Borneo, Sarawak, in silvis.

Kinabalu.—Sing. F.n. 26754 (Menetendok River, 1,000 m. alt.), 27328 (Koung, 500 m. alt.; *typus*, herb. Singapore). Sarawak.—Corner s.n. (1959), Kuching, Bt. Kuap.

F. praetermissae Corner affinis sed inter alia cauliflora, receptaculis majoribus. Ramulis stipulis petiolisque siccis striatis facile recognoscenda.

F. praetermissa Corner sp. nov.—Gagnep. Fl. Gen. I-C. 5 (1928) 812 (ut *F. rostrata* Lam.).—Frutex, ? sarmentosus, v. arbor -6 m. alta, minute scabrido-puberula v. subglabra, foliis brevipe-tiolatis distichis. Ramuli 1.5-3 mm. crassi, brunnei. Stipulae parvae caducae. Lamina 7-25 \times 3.5-9.5 cm., elliptica v. anguste obovata, apice caudata 12-35 mm. longo, basi cuneata et subsymmetrica, dentato-repanda v. denticulata, membranacea, scabrida, sicco pallide brunnea: costis lateralibus utrinsecus 5-8 (-9), obliquis, intercostis strictis 3-7, subtus leviter

elevatis: costis basalibus utrinsecus 1, brevibus v. ad $1/3$ laminae elongatis, glandulis basalibus 1–2 v. nullis: petiolo 2–15 mm. longo. Receptacula axillaria, maturitate rubra dein nigra: pedicellis 2–5 mm. longis, bracteis lateralibus 1–2 parvis dispersis: corpore receptaculi 6–10 mm. lato, bracteis lateralibus 0–2 dispersis, ostiolo plano v. leviter depresso bracteis apicalibus parvis ocluso: setis internis et cellulis scleroticis nullis. Tepala 3–5 albida glabra libera, anguste oblonga, ovario longiora. Flores masculi ostiulares, ordinibus 2–3 instructi: stamine 1, pistillodio nullo v. parvo. Flores feminei et cecidiophori subsessiles: ovario sessili albido: stylo glabro v. sparsim puberulo. Semina sublenticularia v. breviter oblonga, vix carinata, laevia. Cystolitha amphigena copiosa. Tonkin, Laos, Thailand.

Tonkin.—Balansa 2970 (Mt. Bavi, *typus*, herb. Paris), 4457 (Moe Ha; subsarmentosa). Laos.—Poilane 1904 (prov. Sau Nena, Muong Pun), 26434 (Haut Laos, inter Tafu et Bettown-Sai); Spire 199 (Bai Som Pho); Thorel (Bang Mue, pr. Lakon). Thailand.—Kostermans 771 (prov. Kolug chada, Rau ti River valley); Winit 1763 (Nau, Nam Ken).

Species insignis praetermissa. A *F. sinuata* Thunb. (*F. rostrata* Lam.) intercostis numerosis strictis, cystolithis amphigenis, bracteis corporis receptaculi lateralibus, pistillodio florum masculorum deficienti profunde differt, et speciebus africanis, ut *F. urceolari* Welw. ex Hiern, vero affinis.

subject. Palaeomorpha (King) Corner ser. Pallidae Miq.

F. tinctoria Forst. f. Prodr. Fl. Austral. (1786) 76.—I distinguish four subspecies, three of which fill large geographical regions but with intermixture or overlapping at the boundaries. There is no specific difference in fig, flower, seed, or leaf, and it is possible to arrange specimens to form a continuous series. *F. tinctoria* and *F. virens* Ait. (subgen. *Urostigma*) are the most widespread species of *Ficus* and both are epiphytic stranglers, but this subject. *Palaeomorpha* does not extend to Africa, as does sect. *Urostigma* to which *F. virens* belongs.

subsp. **tinctoria**.—Arbor, saepe epiphytica et suffocans. Lamina 4–13 cm. lata, obtusa, subacuta, v. subacuminata, oblonga, elliptica v. ovato-elliptica, nec dentata nec angulata, basi subcordata, rotundata, v. late cuneata, laevis v. subscabrida, subtus brunneo-areolata: stomata immersa. Receptacula pedicellata. Hainan, Formosa, Philippines (incl. Palawan), Celebes.

Sumbawa, Moluccas, Alor, New Guinea, North Australia, Micronesia, Polynesia to Tahiti and Austral Isl.

This is the insular state of the species as opposed to the continental.

subsp. **swinhoei** (King) Corner comb. nov.—*F. swinhoei* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 81, p. 101 C.—*F. fenicis* Merr. Philip. J. Sci. 18 (1921) 66.—Subscandens ad saxa scopulosque, scaberrima, hispidula. Lamina -10×6 cm., minor, elliptica, obtusa v. acuta, subsymmetrica, basi subcordata v. late cuneata, rigide coriacea, subtus haud brunneo-areolata: stomata immersa. Receptacula 8 mm. lata: pedunculo brevi, -1.5 mm. longo, bracteis basalibus ternatis: pedicello 2–4 mm. longo. Formosa, Mindanao.

subsp. **gibbosa** (Bl.) Corner comb. nov.—*F. reticulata* Thunb. Diss. Ficus (1786) 6, 12.—*F. gibbosa* Bl. Bijdr. (1825) 466.—Arbor epiphytica suffocans, etiam littoralis ad saxa repens. Lamina $4-13 \times 2.5-6$ cm., anguste elliptica v. lanceolata saepe plus minus obovata, saepe subrhomboidalis, angulata v. utrimque 1–2 angulato-dentata, apice acuta v. valde acuminata, basi cuneata, coriacea, haud v. vix scabrida, subtus brunneo-areolata. Receptacula 7–12 mm. lata.

var. **gibbosa**.—Lamina flexibilis, stomatibus immersis. Receptacula pedicellata. South Andaman Isl., south China, Hainan, Indochina, Thailand, Malaya, Sumatra, Java, Borneo, Palawan, Celebes, Soembawa, Banda, Halmaheira.

var. **rigida** (Miq.) Corner comb. nov.—*F. rigida* Bl. Bijdr. (1825) 465, (haud Jack).—*F. pereng* Steud. Nomencl. ed. 2 (1840) 637.—*F. gibbosa* Bl. var. *rigida* Miq. Ann. Mus. Bot. Lugd. Bat 3 (1867) 276.—var. *rigida* (Bl.) Val. Bijdr. Booms. Java 11 (1906) 171:—Lamina rigide coriacea, acute acuminata: stomatibus haud immersis. Receptacula sessilia v. breviter pedicellata: bracteis basalibus ternatis, 1–2 mm. longis. Sumatra, Java, Soembawa, Alor. South Borneo.

This is the state of the species in South East Asia and Western Malaysia, but it intergrades with ssp. *tinctoria* in Celebes, Halmaheira, and Palawan, and with ssp. *parasitica* in Hainan, south China, Indochina, and the Andaman Islands. How the species is to be classified in these boundary-regions will be a problem for local botanists to investigate.

subsp. **parasitica** (Willd.) Corner comb. nov.—*F. parasitica* Willd. Mem. Acad. R. Sc. Bell. Lett. Fr. Guill. 2 (1798) 102, t. 3.—*F. gibbosa* Bl. var. *parasitica* (Willd.) King, Ann. R. Bot. Gard. Calc. 1 (1887) 6, pl. 2 a–b.—Lamina ut in ssp. *gibbosa* sed saepius

subrhomboidalis et angulata, tenuiuscule coriacea, scabrida v. laevis, saepe subtus puberula v. subvillosa, haud brunneo-areolata: stomatibus haud immersis. Receptacula pedicellata.

var. **parasitica**.—Arbor epiphytica suffocans. Receptacula 7–11 mm. lata. Ceylon, India, Burma, south China, Indochina, Andaman Islands, Nicobar Islands.

var. **anastomosans** (Wall. ex Kurz) Corner comb. nov.—*F. anastomosans* Wall. ex Kurz, For. Fl. Br. Burma 2 (1877) 455.—Frutex v. ad rupes calcareos repens. Glabra v. ramulis foliis receptaculisque albido-puberulis. Lamina 3–9 × 1–5 cm., elliptica v. subrhomboidalis, dentata v. pinnato-lobata, subscabrida: petiolo –5 mm. longo. Receptacula 6–8 × 5–6 mm., pedicello –15 mm. longo. Burma, Thailand.

Lobb s.n. Moulmein; Wallich 4513, Kogun, *typus*; A.F.G. Kerr 282 (Prachuap), 2510 (Sam Roi Yawt), 5239 (Mé Poi, Ching Dao), 6089 (Mé Lamung, Kampeng Pet), 12854 (Wang Kanai, Kanburi).

Varietas inspicienda. Forsan forma juvenilis fertilis. Folia ut in *Streblus asper* Lour.

F. virgata Reinw. ex Bl. Bijdr. (1825) 454.—*F. decaisneana* Miq. Fl. Ind. Bat. 1, 2 (1859) 312.—*F. firmula* Miq. et *F. trymatocarpa* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 224, 292.—*F. pinkiana* F.v.M. in Wing's South Sci. Rec. 2 (1882) 273.—*F. esmeralda* Bailey, Queensl. Agr. J. 1 (1897) 452.—*F. inaequifolia* Elmer, Leafl. Philip. Bot. 1 (1907) 242.—As this species was named by Reinwardt and published by Blume, the type is Reinwardt 1376 (Banda Major, Moluccas) in the Leiden herbarium, where it is named by both authors. Blume, however, added Java as a locality. No Javanese specimen exists and the species, as defined on Reinwardt 1376, does not occur there. Possibly, as others have suggested, Blume mistook a specimen of *F. subulata* for Reinwardt's species, but that does not mean that it should be reduced to *F. subulata*. I have carefully studied Reinwardt 1376 and am sure from its amphigenous cystoliths that it is the wide-spread species known as *F. philippinensis* and *F. decaisneana*. It is closely allied with *F. tinctoria* and with *F. subulata*, and most specimens have been wrongly referred to these species.

var. **philippinensis** (Miq.) Corner comb. nov.—*F. philippinensis* Miq. et *F. insularis* Miq. Hook. Lond. J. Bot. 7 (1848) 435.—*F. magnifica* Elmer, Leafl. Philip. Bot. 1 (1906) 51.—*F. setibracteata* Elmer, Leafl. Philip. Bot. 7 (1914) 2411, 2413.—Receptacula interne et tepala rubra, pallescentia: setis internis copiosis; pedicellis florum saepe hispidulis. Philippines, Formosa, Ryu Kyu.

var. *sessilis* (Bur.) Corner comb. nov.—*F. philippinensis* Miq. var. *sessilis* Bur. Ann. Sci. Nat. ser. 5, 14 (1872) 253. Ut v. *virgata*, tepalis albidis, sed receptaculis plus minus sessilibus: bracteis basalibus 3–6, 1–3 mm. longis. Philippines, Moluccas, New Guinea, New Britain, Solomon Isl., New Caledonia, Loyalty Isl., New Hebrides.

F. celebensis Corner nom. nov.—*F. irregularis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 224, 292 (non Steud.).—This willow-like tree is now cultivated in several parts of the tropics and subtropics, but its identity is generally not known. Hence this inevitable name-change will not be serious: it will indicate the origin of the plant and how little is yet known of it in the wild state.

subsect. Palaeomorphe (King) Corner ser. Subulatae Corner

F. subulata Bl. var. *gracillima* (Diels) Corner comb. nov.—*F. gracillima* Diels, Engl. Bot. Jahrb. 67 (1935) 194.—? *F. otariophylla* Diels, id. 209.—Over its great range from the Himalayas to the Solomon Islands and New Hebrides, var. *subulata* is remarkably uniform. In New Guinea there occurs this state, var. *gracillima*, with small lanceolate, caudate-acuminate lamina ($3-13 \times 0.9-3$ cm.) without intercostal veining, generally with one basal gland in the axil of one of the lower lateral nerves (not of a basal nerve), and with small figs 4–5 mm. wide (dried): further, the male flower lacks the gall-ovary. These plants are said to be slender epiphytes or scandent bushes in the mountains of New Guinea. Var. *subulata* is normally an epiphyte rooting to the ground, but not strangling, yet it, too, sends out slender creeping runners with reduced leaves and short adventitious roots whereby it attaches itself to other trunks. Several collections, also, from New Guinea bridge the difference in leaf-size. Therefore, though var. *gracillima* in the extreme looks a different species, it clearly grades into typical *F. subulata*. In the Himalayas *F. sikkimensis*, which I regard as synonymous with v. *subulata*, is a less reduced state, also lacking the gall-ovary in the male flower.

F. otariophylla, from New Guinea, has the short stipules and small figs of var. *gracillima*, but the figs are cauliflorous. Its main twigs bear large leaves (-30×9 cm., lamina) as in var. *subulata*, but the side-branches bear abruptly the small leaves of var. *gracillima*. Such a rapid change from large to small leaf on branching

occurs also in *F. virgata* Reinw. ex Bl. Hence, I suspect that *F. otariophylla* may be the sapling, or bathyphyllous, form of var. *gracillima*.

I refer the following to var. *gracillima*:

Brass 11391 (Neth. New Guinea, Bele River, 2,200 m. alt.), 13865 (Idenburg River, Bernhard Camp), 23280 (Milne Bay district, Mt. Dayman, 1,370 m. alt.); Carr 13261, 13353, 13449 (Boridi, 1,500 m. alt.), 15387 and 15430 (Isuarava, 1,500 m. alt.), 15980 (Lala River, 1,600 m. alt.); Clemens 5045 Morobe district, Ogeramnang, 5,900 ft. alt.); Docters v. Leeuwen 10121, 11110 (Rouffaer River); Ledermann 8174 (Sepik, *type*); Meyer-Drees 603 (Neth. New Guinea, Bernhard Biv.); NGF 6161 (Eastern Highlands pr. Goroka, 7,300 ft. alt.), 8477 (Morobe district, pr. Skindewai, 5,400 ft. alt.), 9433 and 9455 (Western Highlands, Mt. Hagen, 7,000 ft. alt.), 9565 (Eastern Highlands, 6,500 ft. alt.).

F. otariophylla Diels.—Ledermann 8572 (Sepik, *type*); Carr 15925, 16110a (Isuarava, 1,100 m. alt.).

subject. Palaeomorphe (King) Corner ser. Cuspidatae Miq.

F. sinuata Thunb. Diss. Ficus (1786) 6, 12.—*F. rostrata* Lam. Encycl. 2 (1788) 498.—Examination of Thunberg's type (Uppsala), shows that it is *F. rostrata* Lam. (type, Paris). Thunberg ascribed it to Ceylon, where this species does not occur, and he must have made a mistake for Java, where it is common.

ssp. *sinuata* var. *oblonga* Corner nom. nov.—*F. cuspidata* Reinw. ex Bl. var. *sinuata* King, Ann. R. Bot. Gard. Calc. 1, 2 (1888) 89, pl. 112 C.—This differs from v. *sinuata* in the narrowly oblong lamina with more numerous lateral nerves at right angles to the midrib. With the change in specific epithet, so King's varietal name must be changed.

Malaya.—King's coll. 7256 (Perak); Sing. F.n. 21338, 29023, 32502 (Johore). Sumatra.—O. Hagerup s.n. (1916–17, Lake Toba). Yates 1414 (East Coast). Java.—Zollinger 1674.

ssp. *cuspidata* (Reinw. ex Bl.) Corner comb. nov.—*F. cuspidata* Reinw. ex Bl. Bijdr. (1825) 464 (incl. α and B).—I cannot separate this from the variable *F. sinuata* except as a montane subspecies with smaller, subsessile, fig and smaller, more or less lanceolate, leaf. Small-leaved states of ssp. *sinuata* v. *sinuata* seem to merge into ssp. *cuspidata*, but its greater resemblance is with v. *oblonga*.

F. heteropleura Bl. Bijdr. (1825) 466.—*F. urophylla* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 429.—*F. caudatifolia* Warb. Perk. Fragm. Fl. Philip. 3 (1905) 194.—*F. eucaudata* Elmer, Leafl. Philip. Bot. 1 (1906) 40.—*F. rostrata* Lam. var. *urophylla* (Wall.) Koord. et Val. Bijdr. Booms. Java 11 (1906) 175.—Blume's type at Leiden is well-preserved and accompanied by a fine painting, which leaves no doubt of its identity.

var. **hirta** Corner var. nov.—Ut v. *heteropleura* sed ramulis, petiolis, costisque (subtus) pilis albidis dein brunneis 0.5–1 mm. longis hispido-villosis. Receptacula minora 5–10 mm. lata, pedicello breviori –3 mm. longo. Sarawak.

J. A. R. Anderson 9147 (Lundu); Beccari s.n. et 780 (Kuching); Bur. Sci. Pl. Saraw. 1938 (*typus*, herb. Leiden); Kep. F.n. 80038 (B.6 For. Res.).

var. **mindanaensis** (Warb.) Corner comb. nov. *F. mindanaensis* Warb. Perk. Fragm. Fl. Philip. 3 (1905) 195.—This is distinguished by its larger leaf and fig, but there are several intermediate collections from the Philippines so that it is with difficulty separable.

subject. Palaeomorphe (King) Corner ser. Minutuliflorae Sata

F. aurita Reinw. ex Bl. var. **auriculifera** (Merr.) Corner comb. nov.—*F. auriculifera* Merr. Univ. Calif. Publ. Bot. 15 (1929) 46.—Stipulae caducae. Lamina auricula basali minori –8 × 2 mm. praedita: costis lateralibus utrinsecus 4–7. Borneo, Celebes, Philippines, Amboina.

Borneo.—Clemens 10467, 26194, 26611, 30288 (Kinabalu); Elmer 20468 (Tawao, *type*); Endert 4667 (W. Koetai), Celebes.—Bloembergan 4106 (Menado, G. Ngila-laki); Kjellberg 2351 (Malili), NIFS Cel/V-284 (Malili, Kawata). Bohol.—Bur. Sci. 42744. Amboina.—Binnendyk 6820.

var. **celebica** (Reinw. ex Bl.) Corner comb. nov.—*F. celebica* Reinw. ex Bl. Bijdr. (1825) 461.—Stipulae persistentes. Lamina haud auriculata, basi cuneata: costis lateralibus utrinsecus 3–7. Celebes.

Reinwardt 1626, Kamanga, *type*; Koorders 19257, Menado; Riedel s.n., Gorontalo; Teysmann et de Vriese s.n., s.l.

subject. Palaeomorphe (King) Corner ser. Fibrosifoliae Corner

F. obscura Bl. Bijdr. (1825) 474.—This common and variable species of Western Malaysia has been much confused through King's error in identifying with it *F. asperiuscula* Kunth et

Bouché and *F. cyrtophylla* Wall. ex Miq. In subordinating the swarm of unnecessary species created by Miquel, King mistook *F. obscura* and used *F. pisifera* Wall. ex Miq. in its place. Four sheets named by Blume at Leiden leave no doubt what he intended, and on this basis I have re-constructed. In recognising five varieties I realise that intermediates occur which will require investigation, but most of the five hundred collections which have now been made fall into these categories without much difficulty. They seem to have little geographical significance.

var. **obscura**.—Receptacula 9–12 mm. lata (12–20 mm., viva), plus minus brunneo-hispida v. villosa (ut ramuli). Lamina supra scabrida. Java, Sumatra, Borneo, Celebes, Philippines, Talaud.

The large-fruited, hairy, and scabrid state, not known from Malaya, except for one plant of doubtful origin in the Penang Waterfall Gardens.

var. **angustata** (Miq.) Corner comb. nov.—*F. hypsophila* Miq. var. *angustata* Miq. Pl. Jungh. (1851) 60.—Plus minus glabra, laevis v. vix scabrida. Lamina basi anguste cuneata, vix asymmetrica, saepe coriacea et bullata, denticulata v. integra, stipulis caducis. Receptacula 5–8 mm. lata. Java, Sumatra, Lingga, Borneo, Celebes, Moluccas (Soela).

F. uniglandulosae Wall. ex Miq. similis, sed nervis ut in *F. obscura* et tepalis albidis. Forsan species distincta. *F. uniglandulosa* nondum in Java inventa.

var. **borneensis** (Miq.) Corner comb. nov.—*F. microtus* Miq. var. *borneensis* Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 273.—*F. pisifera* Wall. ex Miq. Hook. Lond. J. Bot. 7 (1848) 427; King, Ann. R. Bot. Gard. Calc. 1 (1887) 3, pl. 1.—Ramuli et petioli brunneo-villosi glabrescentes. Lamina plus minus scabrida. Receptacula 5–8 mm. lata, scabrida, brunneo-puberula glabrescentia: pedicello 2–6 mm. longo. Lower Thailand, Malaya, Riouw, Sumatra, Java, Borneo, Celebes, Philippines.

The commonest variety, as a small-fruited state of v. *obscura*.

var. **kunstleri** (King) Corner comb. nov.—*F. celebica* Reinw. ex Bl. var. *kunstleri* King, Ann. R. Bot. Gard. Calc. 1 (1887) 12, pl. 10 A.—*F. acuminatissima* Miq. Hook. Lond. J. Bot. 7 (1848) 233.—*F. lancifolia* Miq. id. 452.—Ut. var. *scaberrima* sed lamina lanceolata acuminata. Malaya (Perak), Sumatra (Fort de Kock), Bangka, Borneo, Celebes, Philippines.

Forsan v. *scaberrima* statu vetuso sed in Java non inventa. King's coll. 3927 (Perak, *typus*) in errore sub *F. celebica* (*F. aurita* var. *celebica*) disposita.

var. *scaberrima* (Bl.) Miq. Ann. Mus. Bot. Lugd. Bat. 3 (1867) 273.—*F. scaberrima* Bl. Bijdr. (1825) 474.—Ut in v. *obscura* sed receptaculis 6–7 mm. latis, sessilibus v. breviter pedicellatis –2 mm., brunneo-setosis, tarde glabrescentibus. Sumatra, Java, Borneo, Celebes, Philippines.

F. midotis Corner sp. nov.—Frutex v. arbor –11 m. alta, saepe epiphytica sed non suffocans, glabra, sparsim puberula, v. scabridula, foliis distichis. Ramuli 1–2.5 mm. crassi, brunnei dein lutescens. Stipulae –12 mm. longae, caducae. Lamina 11–33 × 3.5–13 cm., ovato-elliptica, oblonga, v. ad ramulos ultimos anguste elliptica, symmetrica, apice caudata 12–45 mm. longo, basi late v. anguste cuneata, symmetrica v. uno latere breviter decurrens et subauriculata, crenato-dentata v. integra, membranacea v. subcoriacea, utrimque subscabrida v. laevis, siccò brunnea: costis lateralibus utrinsecus (6–) 8–13, obliquis, saepe glandula axillari praeditis, intercostis 3–7, subtus leviter elevatis: costis basalibus utrinsecus 1–2, v. latere latiori –4, glandulis basalibus 1–2: petiolo 3–20 × 2–4 mm., Receptacula axillaria binata et ad ramos et truncum usque ad basim fasciculata, scabridula, maturitate e luteo rubescentia: pedicellis 3–25 mm. longis, brevioribus ad receptacula axillaria pertinentibus, bracteis lateralibus 1–2 minutis dispersis: corpore receptaculi 6–10 mm. lato (10–12 × 9–10 mm., vivo), raro bractea una laterali praedito, apice subumbonato, ostiolo haud v. vix depresso bracteis apicalibus parvis ocluso: setis internis nullis, v. paucis minutis: cellulis scleroticis nullis. Tepala albida, oblonga, acuta v. obtusa, puberula v. apicem versus denticulata, ad basim leviter connata. Flores masculi ostiolaris sessiles, ordine uno instructi: tepala 5–7: stamine 1, pistillodio bene evoluto. Flores feminei et cecidiophori sessiles: tepala 4–5: ovario sessili, vel cecidiophoro stipitato: stylo glabro. Semina 1.5 mm. longa, subcompressa, oblonga, apice carinata. Cystolitha hypogena: fibris sclereidiformibus in mesophyllo copiosis. Borneo in silvis planis et montanis –2,800 m. alt.

Br. North Borneo (in regionibus omnibus).—Amdjah 651 (det. *F. subulata*); Clemens (Kinabalu) 10366, 10469, 27017, 27685, 28667, 29650 bis, 30294, 30624, 36057, 31350, 31551, 31539, 32013, 32222, 32617, 33294, 33643, 33997, 40392, 40624; Elmer 21908; For. Dept. 1360, 1518, 1555, 7276, A 2936, A 3242, A 4714; Ramos 1441, 1478 (det. *F. pisifera*); Sing. F.n. 18987, 19061, 26324 (*typus*, herb. Singapore). 27331, 27380, 27854; D. Wood 1982 (det. *F. pisifera*). Koetai.—Endert 4774;

Kostermans 5563, 5626. S.E. Borneo.—v. Slooten 2132, Tanah boemboe, Batu Litjin (det. *F. pisifera*). Sarawak.—J. A. R. Anderson 8972; Beccari 843; Haviland 1612; Purseglove 4717.

F. obscurae Bl. affinis sed foliis quasi laevibus symmetricis plurinervis, stipulis caducis, receptaculis longipedicellatis, cystolithis hypogenis differt, et speciminibus jam numerosis certe distinguenda.

F. leptocalama Corner sp. nov.—Arbor 5 m. alta, glabra, foliis brevipetiolatis distichis. Ramuli 1 mm. crassi, graciles, pallide ochracei. Stipulae 8 mm. longae, plus minus persistentes, appressae. Lamina 8–15 × 2.5–4.5 cm., elliptica, subasymmetrica, apice caudata 30 mm. longo, basi cuneata uno latere minute auriculata, integra, membranacea, supra subscabrida, sicco griseo-viridis: costis lateralibus utrinsecus 7–10, intercostis 3, subtus leviter elevatis: costis basalibus utrinsecus 1, brevibus, glandulis basalibus 1–2: petiolo 1–2 mm. longo, brevissimo. Receptacula geocarpica ad ramulos graciles repentis efoliatis 1.8 m. longos, basi 10 mm. crassos, e basi trunco crescentes, binata, maturitate rubescentia: pedicello 1–2 mm. longo, bracteis lateralibus 2–3 minutis dispersis: corpore receptaculi 6–8 mm. lato, subgloboso, bracteis lateralibus 1–3 parvis dispersis, scabriusculo, ostiolo bracteis apicalibus parvis numerosis ocluso: setis internis et cellulis scleroticis nullis. Tepala 4 alba oblongo-lanceolata glabra libera v. vix connata. Flores feminei sessiles v. breviter pedicellati: ovario sessili: stylo glabro. Semina 1.2 mm. longa, oblonga, laevia, subcompressa. haud carinata. Cystolitha hypogena: fibris sclereidiformibus in mesophyllo copiosis. North Borneo (Sing. F. n. 26829, Kinabalu, Menetendok River, Kuala Serab, 1000 m, alt.; *typus* herb. Singapore).

F. midotis Corner affinis sed gracilior, geocarpica, et seminibus haud carinatis.

F. rubrocaudata Corner sp. nov.—Frutex v. arbuscula, saepe epiphytica, glabra, haud scabra, foliis brevipetiolatis distichis. Ramuli 1–1.5 mm. crassi, cremei v. pallide ochracei v. brunneoli. Stipulae 8 mm. longae, lanceolatae, caducae. Lamina 5–23 × 1.2–4.5 cm., elliptico-obovata v. lanceolato-elliptica, symmetrica, apice caudato-acuminata 45 mm. longo, basi cuneata, symmetrica, integra, membranacea, laevis, sicco griseo-viridis: costis lateralibus utrinsecus 5–10 (–14 in foliis juvenilibus), quasi rectangulatis, intercostis 0–1 (–2): costis basalibus utrinsecus 1, glandula basali 1: petiolo 2–6 mm. longo, gracili.

Receptacula axillaria binata, etiam ad ramulos defoliatos fasciculata, laevia, maturitate e luteo rubra: pedicello 0–1.5 mm. longo: corpore receptaculi 3–5 mm. lato, bracteis lateralibus nullis: setis internis et cellulis scleroticis nullis. Tepala 4 rubra, saepe aetate pallescentia, libera acuta glabra. Flores masculi ostiolaris, ordine uno instructi: stamine 1, pistillodio nullo v. minuto. Flores feminei et cecidiophori sessiles: ovario sessili albedo: stylo glabro. Semina 0.8 mm. longa, breviter oblonga, vix carinata, laevia. Cystolitha hypogena: fibris sclereidiformibus in mesophyllo copiosis. Borneo, in regionibus omnibus, in silvis –1,500 m. alt.

Amdjah 315; Brunei 5328; Clemens 20192, 25254, 26254, 26986, 30572, 30729, 30824, 31351, 31892, 40365, 40365 A; Endert 3066, 4677; For. Dept. B.N.B. 1808, 2977, 3117, A 4528, A 4647; Motley 1226; Purseglove 4671, 5470; Sing. F. n. 26339, 27323 (Kinabalu, Koung, 400 m, alt.; *typus* herb. Singapore).

F. microsphaerae Warb. (ins. philipp.) persimilis sed tepalis rubris, fibris sclereidiformibus in mesophyllo, costis quasi rectangularis, lamina haud scabrida differt, etiam in insulis philippinensibus nondum inventa. *F. sinuata* Thunb. ssp. *cuspidata* (Reinw.) Corner similis et eisdem modis differt, etiam seminibus vix carinatis. Vero *F. uniglandulosae* Wall. ex Miq. affinis.

F. rubromidotis Corner sp. nov.—Frutex vel arbor parva, saepe epiphytica, glabra v. ramulis stipulisque puberulis, foliis brevipetiolatis distichis. Ramuli 2–3 mm. crassi, griseo-ochracei. Stipulae 10–20 mm. longae, late lanceolatae, binatae, scariosae, striatae, brunneolae, saepe ramulos investientes, persistentes. Lamina 15–36 × 5–12 cm. oblongo-elliptica, apice attenuato-acuminata v. caudata 12–50 mm. longo, basi rotundato-cuneata uno latere breviter auriculata, integra, rigidiuscule subcoriacea, laevis v. subtus subscabrida, subbullata, sicco fuscolivacea: costis lateralibus utrinsecus (9–) 12–20, subtus valde elevatis, saepe glandula axillari praeditis, intercostis 6–10, subtus elevatis: costis basalibus utrinsecus 1, brevibus, glandulis basalibus 1–2: petiolo 1–10 × 3–4 mm., crasso, sub auricula plus minus condito. Receptacula axillaria binata et ad truncum ramosque fasciculata, maturitate e luteo rubra: pedicello 1–2 mm. longo vel receptaculo cauliflori 10–15 mm., gracili, bracteis lateralibus 2–3 minutis dispersis: corpore receptaculi 5–7 mm. lato, subgloboso, bracteis lateralibus nullis, ostiolo plano parvo: setis internis et cellulis scleroticis nullis. Tepala 4 rubra v. brunneorubra oblonga obtusa glabra libra. Flores masculi ostiolaris

sessiles, ordine uno instructi: stamine 1, pistillodio bene evoluto. Flores cecidiophori sessiles v. pedicellati, feminei sessiles: ovario sessili albido: stylo glabro. Semina $1 \times 0.5-0.6$ mm., oblongo, subcarinata, laevia. Cystolitha hypogena, fibris sclereidiformibus in mesophyllo copiosis. Sarawak, Brunei, in silvis humidis, praesertim ripariis.

W. M. A. Brooke 9125 (Kuching); Brunei 5331, 5340 (Ulu Belalong); Clemens 20539 (Kuching, G. Tiang), 20699 (Bidi Cave Mountain; typus, herb. Kew), 22117 (Gat, Upper Rejang River).

Stipulis scariosis striatis persistentibus, costis numerosis valde distincta, *F. midotis* Corner affinis.

Posthumous Publication of New Dipterocarp Species from North Borneo

Footnote:—These notes are put together from material supplied by the Forest Department of North Borneo and the Forest Research Institute of the Federation of Malaya, and are now published to validate the new species, descriptions of which the authors had left in manuscript.

Editor.

1. *Dipterocarpus exalatus* van Slooten sp.nov. (§ Angulati).

A *D. kunstleri*, cui simillima, ramulis magis applanatis, internodiis virgularum glabris, foliis adultis angustioribus, fructibus validius angulatis, laciniis accrescentibus perbrevioribus vel carentibus haec species sat distincta.

Arbor elata circa 40 m. alta, cum trunco 90 cm. in diam. *Folia* chartacea vel coriacea, lanceolata, interdum elliptico- vel oblongo-lanceolata, apice abrupte caudato-acuminata, basin versus cuneata, margine crenato-sinuata, 12–22 cm. longa, 5.5–9 cm. lata, costis nervisque subtus minute lepidotis exceptis utrinque glabra, nervis lateralibus utrinsecus 15–20 praedita, petiolis 2–3 cm. longis stipitata. *Inflorescentia* in ramulis producta, axillaris vel apicalis, solitaria, ad 22 cm. usque longa, in ramulos sympodiales 4–8 floribus praeditos 1–3-plo divisa. *Flores* alternati, vel fere secundi; calyx infundibuliformis, coriaceus vel ligneus, in pedicellum 10–15 mm. longum attenuatus, prominenter 5-angulatus, apice in lobos duos majores ad 10 mm. usque longos et in tres alteros fere dimidios divisus; petala oblique spathulata, basi connata, in alabastro torta et extus minute stellato tomentosa. *Fructus* valde 5-angulatus, 4–5 cm. longus, 2.3–3.5 cm. in diam. glaber, cum laciniis 2 reductis vel interdum accrescentibus ad 12 cm. usque longis, ad 3 cm. usque latis, alteris 3 excrescentibus auriculatis. *Nux* ovoideus, 4 cm. longus, 2 cm. in diam., superne pubescens, in stylopodium exsertum, angulato-costatum, paullatim attenuatus.

BORNEO: Parte orientale indonesiana, apud Balikpapan (bb. 13,913, holotypus in BO). Parte septentrionale britannica, Sandakan, (SAN 1721, paratypi in SAN & BO).

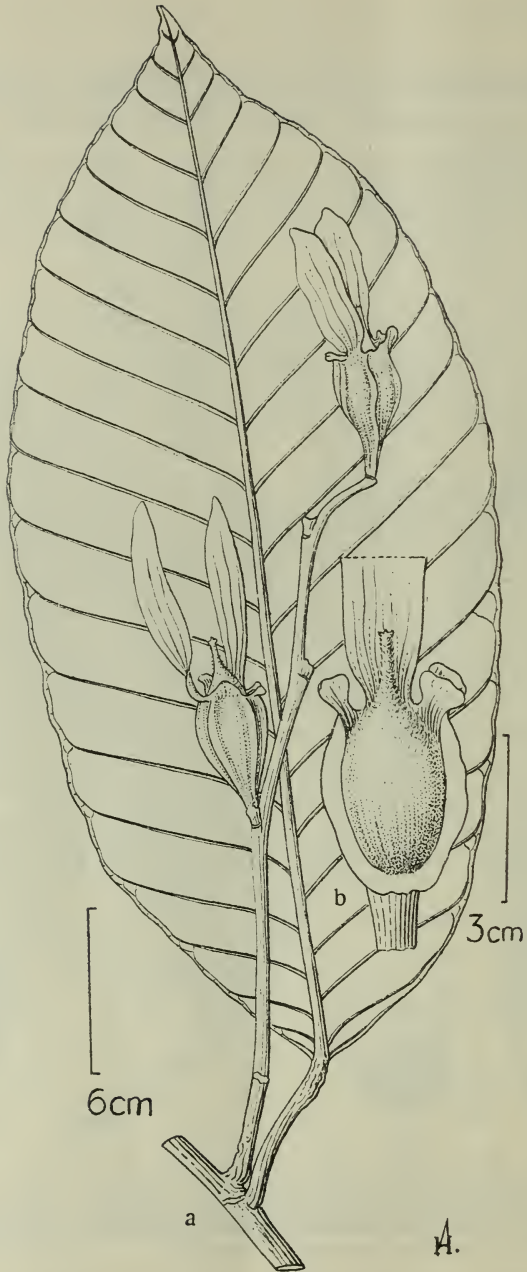
This species is very like *D. kunstleri* but differs from that in more flattened twigs, glabrous internodes of the young shoots, narrower leaves, more prominently-angled fruits, much shorter accrescent lobes of the fruit.

[The name has been used before as a *nomen nudum*. The drawings with notes were prepared by Dr. van Slooten.]



Diptercarpus exalatus v. Sl. (bb. 13,913, holotypus)

- a, Ramulus floriferus. b, Alabastrum ante anthesin. c, Flos post anthesin.
d, Ibid. apertus ut stamina ovariumque appareant. e, Calyx longitudinaliter
dissectus ut ovarium appareat. f, Stamina.



Diptercarpus exalatus v. Sl. (SAN 1721: paratypus)
a. Ramulus fructiferus. b. Fructus juvenilis cum calyce dissecto.

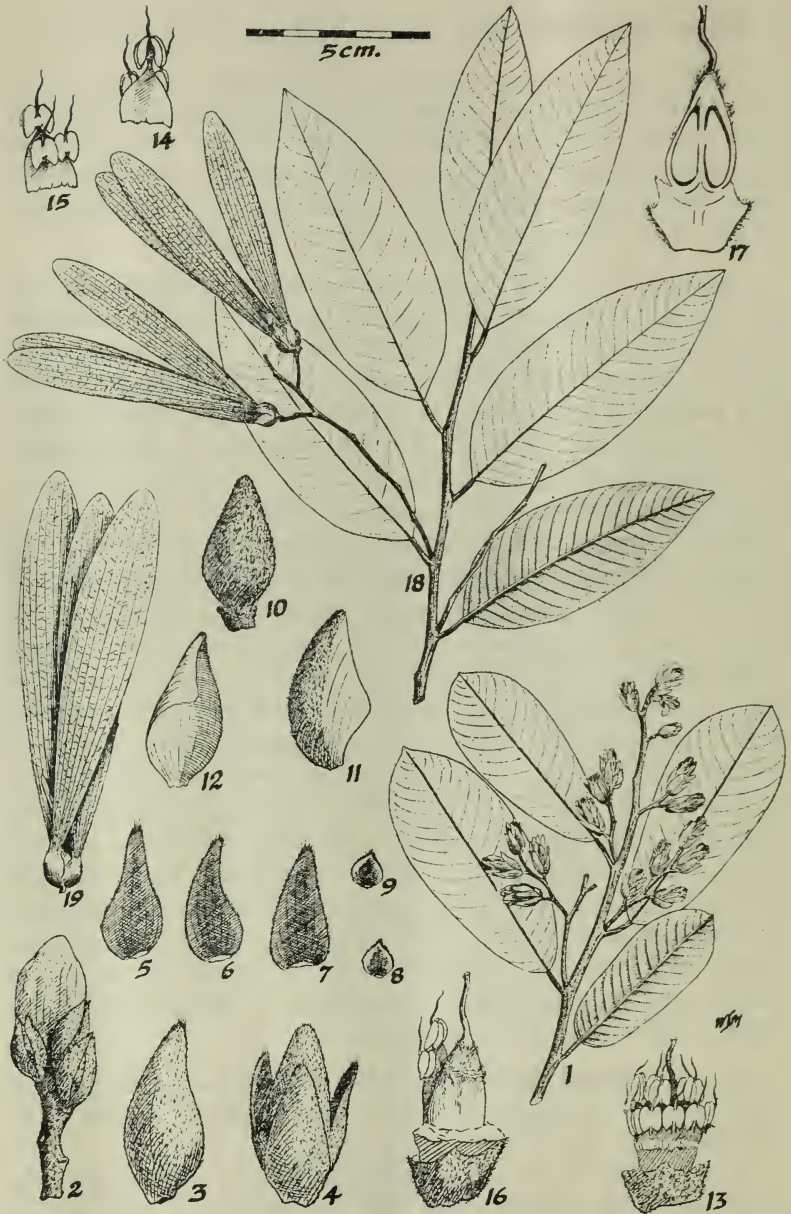
2. *Shorea argentifolia* Sym. sp.nov. (§ Grex "Red Meranti")

Ponenda inter species staminibus 15 biseriatim dispositis; antheris quadriloculatis ad anthesin interdum reflexis; appendiculis haud ciliatis, interdum reflexis in serie interiore quam anthera plerumque brevioribus. *S. leprosulae* Miq. similis, sed foliis minoribus, nervis eorum lateralibus pluribus, floribus conspicue pedicellatis, stylis brevioribus haec species sat dissimilis.

Arbor elata, circa 50 m. alta, cum ramulis apice applanatis, griseis, stellato-tomentosis, et gemmis latentibus fulvo-tomentosis. *Stipula* conspicua, oblongo-elliptica, acuta, 1–2 cm. longa, circa 9-nervia, extus tomentosa, intus lepidoto-puberula, diu persistens, dein decidua. *Folia* oblonga vel obovato-oblonga, interdum elliptico-oblonga, 5–9 cm. longa, 2–4 cm. lata, basi abrupte cuneata vel rotundiuscula, apice attenuata, acuta vel subito acuminata, supra glabra, subtus dense tomento-stellata fulvo- vel argenteo-brunnea, utrinsecus 20–25—nervia, petiolis 0.75–1.25 cm. longis eodemmodo stellato-tomentosis stipitata. *Inflorescentia* paniculata, ad 14 cm. usque longa, eodemmodo tomentosa, in ramulis secundariis flores 4–8 congestos producta, cum bracteis bracteolisque pubescentibus, diu persistentibus dein deciduis. *Flores* ante anthesin 3.5 mm. longi, breviter pedicellati, extus argenteo-tomentosi; sepala majora 3, ovato-oblonga, extus tomentosa, intus glabra, altera 2 multo minora, ovata, extus partim tomentosa; petala albescentia, in parte ante anthesin exposita tomentosa excepta, glabra; stamina 15 biseriatim disposita, 5 interiora exterioribus 10 fere duplo altiora, basi dilatata. *Fructus* 5-angulatus, luteo-brunneus; calycis lobi stellato-puberuli, concavi, cum laciniis accrescentibus 3, obovato-lanceolatis, 8–11 cm. longis, 1–2 cm. latis, laciniis alteris 2 excrescentibus, linearibus, 0.8–1.5 cm. longis, ad 2 mm. usque latis. *Nux* ovoideus, in stylopodium conicum attenuatus, minute tomentosus 0.75–1.5 cm. altus.

BORNEO: **Brunei**, Batu Apoi (KEP 39,617, paratypus in KEP; KEP 40,471, paratypus in KEP). **North Borneo**: Tawau (KEP 38,838=SAN 4462, holotypus in KEP).

This tall tree has a bole with regular fissures with brown outer bark and purple brown inner one. The leaves are very narrow. The tomentum which varies in colour from grey or silvery grey to yellowish brown is found on the underside of the leaves, branchlets, inflorescence axis, bracts and the flower parts exposed in the buds. Similar to *S. leprosula* Miq., but leaves smaller having more



Shorea argentifolia Sym. (fig. 1-17; KEP 38,838; fig. 18; KEP 39,617; fig. 19: KEP 40,471)

- 1, Ramulus floriferus. 2, Paniculæ fragmentum. 3, Bractea. 4, Alabastrum. 5-9, Sepala. 10, Alabastrum sepalis remotis. 11 & 12, Petala. 13, Flos sepalis desumptis. 14 & 15, Stamina. 16, Flos sepalis, petalis staminibus remotis ut pistillum appareat. 17, Ovarium longitudinaliter discissum. 18, Ramulus fructiferus. 19, Fructus (Amussis cum fig. 1, 18 et 19 tantum congruens; alteræ figuræ ampliatae).

lateral nerves, flowers more distinctly pedicelled and style shorter. It belongs to the *S. parvifolia* group of the Red Meranti (cf. Symington, Malay For. Rec. 16, 1943, p. 4 & 58-59).

[The drawing was made by Mr. Wong Sze Moy under the direction of Symington whose notes have been also incorporated here. The name has been used in literature as a *nomen nudum* even in A. L. Howard's "A Manual of the Timbers of the World" (1948)].

3. *Shorea superba* Sym. sp.nov. (§ *Eushorea* subsect. *ciliata*)

Inter omnes hujus subsectionis species truncis fere levigatis griseis, basi longitudinaliter paulo-tabularibus; foliis multinervatis, supra griseo rubris, subtus brunneis vel argenteo-griseis, fructibus parvis cum laciniis 3 majoribus et 2 multo minoribus haec species sat distincta.

Arbor elata, circa 60-75 m. alta, cum ramulis apice brunneis, minute stellato-tomentosis. *Stipula* ovato elliptica, mox decidua, roseo-viridis, 1-1.5 cm. longa, 4-5 mm. lata, eodemmodo stellata. *Folia* oblongo-lanceolata, 5-9 cm. longa, 2-3 cm. lata, acuminata vel caudato-acuminata, basi cuneata vel rotundata, supra costis deciduo-tomentosis exceptis glabra, nitida, brunnea, subtus minute stellato-tomentosa, vetustiore fere glabra glaucescentia, utrinsecus 15-25 nervia. *Inflorescentia* in ramulis apicem versus oriens, terminalis axillarisque, axi stellato-tomentosa, in ramulos primarios vel secundarios floriferos divisa, bracteolis deciduis, multinerviis tomentosus praedita. *Flores* per ramulum floriferum 2-8, ante anthesin 2-4 mm. longi, pedicellis brevissimis circa 1 mm. longis suffulti; sepala 3 majora quam altera 2, omnia ovata, apice acuta vel fere, tomentosa; petala linearia, undulata, in alabastro torta, puberula, extus grisea, intus brunnea; stamina 28-32 altitudine variabilia, in appendiculas apice 1-5 ciliatas terminata. *Fructus* breviter stipitatus, laciniis puberulis praeditus, 3 accrescentibus spathuloideis 5-6 cm. longis 1.25 cm. latis, alteris 2, minoribus, angustioribus, linearibus, apice acutis vel obtusis, 3 cm. longis, 3-4 mm. latis. *Nux* ovoideus, sericeo-tomentosus, in stylopodium abrupte angustatus, ad 1.2 cm. longus, 0.75 cm. in diam.

BORNEO: North Borneo: Sandakan: Bettotan (KEP 38,853= Puasa SAN 4,477, holotypus in KEP, isotypi in SAN & SING): Tawao (Elmer 21,714, paratypus in SING).

This species produces relatively smooth, grey bole with irregularly scaling or cracked bark, small buttresses, many nerved



Shorea superba Sym. (fig. 1-14: Holotypus; fig. 15: Elmer 21,714)
 1, Ramulus floriferus. 2, Paniculae fragmentum. 3, Alabastrum. 4-8, Sepala.
 9-10, Petala. 11-12, Stamina. 13, Flos sepalis, petalis staminibusque
 desumptis ut pistillum appareat. 14, Ovarium longitudinaliter discissum.
 15, Fructus. (Amussis cum fig. 1 et 15 congruens; alterae fig. ampliatae).

leaves which are shining brown above and pale fawn or silvery grey with minute stellate hairs below, silky tomentose flowers and small fruits with minutely pubescent wings.

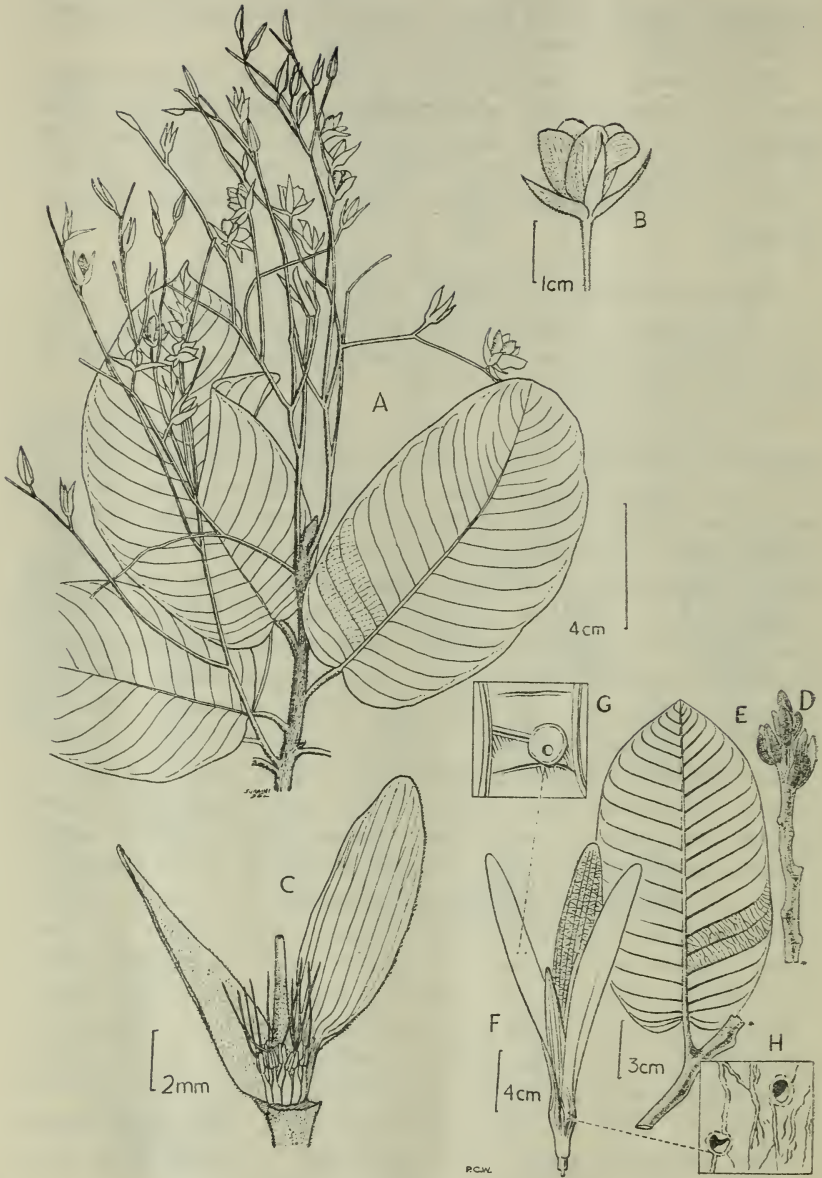
[The drawing was made by Mr. Wong Sze Moy under the direction of Symington, whose notes have been incorporated here. The species has been listed as *Shorea* sp. 'B' (not to be confused with Symington's *Shorea* sp. "B" of *Malayan Forest Records*, No. 16, 1943, p. 95) in the herbarium of the Forest Research Institute, Kepong.]

4. *Shorea symingtonii* Wood sp. nov. (§ Anthoshorea)

A *S. virescente* Parijs, cui affinis haec species differt nervis foliorum lateralibus pluribus, petalis latoribus, fructibus basi valde attenuatis, laciniis eorum longioribus.

Arbor elata, circa 60 m. alta, cum ramulis juventute applanatis, dense fulvo-tomentosis, dein fuscentibus parce tomentosis. *Stipula* 1–1.5 cm. longa, 2–5 mm. lata, tomentosa decidua. *Folia* oblonga vel oblanceolata, 12–16 cm. longa 6–7 cm. lata, obtuso-apiculata vel acuminata, interdum bullatula, basi rotundata vel saepe cordulata, utrinque fulva vel brunnea, supra glabra, subtus secus costas et nervos parce puberula, margine revoluta, utrinsecus 16–24 nervia, petiolis 2 cm. longis, brunneis, minute stellato-tomentosis suffulta. *Inflorescentia* terminalis vel etiam in parte ramuli infra-terminale axillaris, circa 20 cm. longa, laxe multiramosa, deciduo bracteata, florum bracteolis deciduis, puberulis. *Flores* remoti, ante anthesin oblongi vel lanceolati 10–13 mm. longi, 3–4 mm. in diam., pubescentes, fusci, pedicellis ad 5 mm. usque altis, apicem versus crassioribus, concoloribus, pubescentibus suffulti; sepalis linearis-lanceolata, coriacea, margine incrassata, leviter cymbiformia, utrinque fusco-pubescentia, inaequalia, tria alteris duobus maiora, omnia conformia; petala oblonga, apice obtusa vel truncata multinervosa, chartacea, in partibus alabastri expositis albotomentosa; stamina 15, per series duas disposita, interiora 5 altiora quam exteriora 10. *Fructus* 5-laciniatus, basi valde angustatus, pedicello 2–3 mm. longo suffultus, interdum glandulosus, laciniis 3 longioribus linearis-oblongis, apice sensim arcuato-acutis, 12–17 cm. longis, 1.6–2 cm. latis; alteris laciniis 2, linearibus, apicem versus angustatis, acutis, 8–10 cm. longis 7–10 mm. latis. *Nux* ovoideus, 2–2.5 cm. longus, minute pubescente rugosus.

BORNEO: North Borneo: Sandakan, Sepilok (KEP 35,608—SAN 16,522, holotypus in SAN, isotypi in KEP, SING et al; SAN 15481, paratypus in SAN, isoparatypi in KEP, SING, etc.).



Shorea symingtonii Wood (A-C: KEP 35,608; D-H: SAN 15481)

A, Ramulus floriferus. B, Flos. C, Ibid. petalis partim remotis ut dispositio staminum appareat. D, Surculus cum bracteolis. E, Folium. F, Fructus. G & H, Glandula ampliata.

This large tree with shallow fissured and large buttressed bole, has large leaves 12–16 cm. long, 6–7 cm. wide, often cordulate at base, having 16–24 pairs of lateral nerves, the midrib and lateral veins being minutely hairy below; the fruit 5-winged (3 large and 2 shorter ones) narrowed at base, shortly pedicelled. It is an ally of *S. virescens* Parijs, but has more lateral nerves to the leaves, flowers more apart, petals wider, fruits strongly attenuate at base and bearing longer lobes.

[The drawing with fruit was prepared by Miss P. W. Wood at Kew, the one with flowers has been made from the isotype specimen in Singapore by the Singapore artist.]

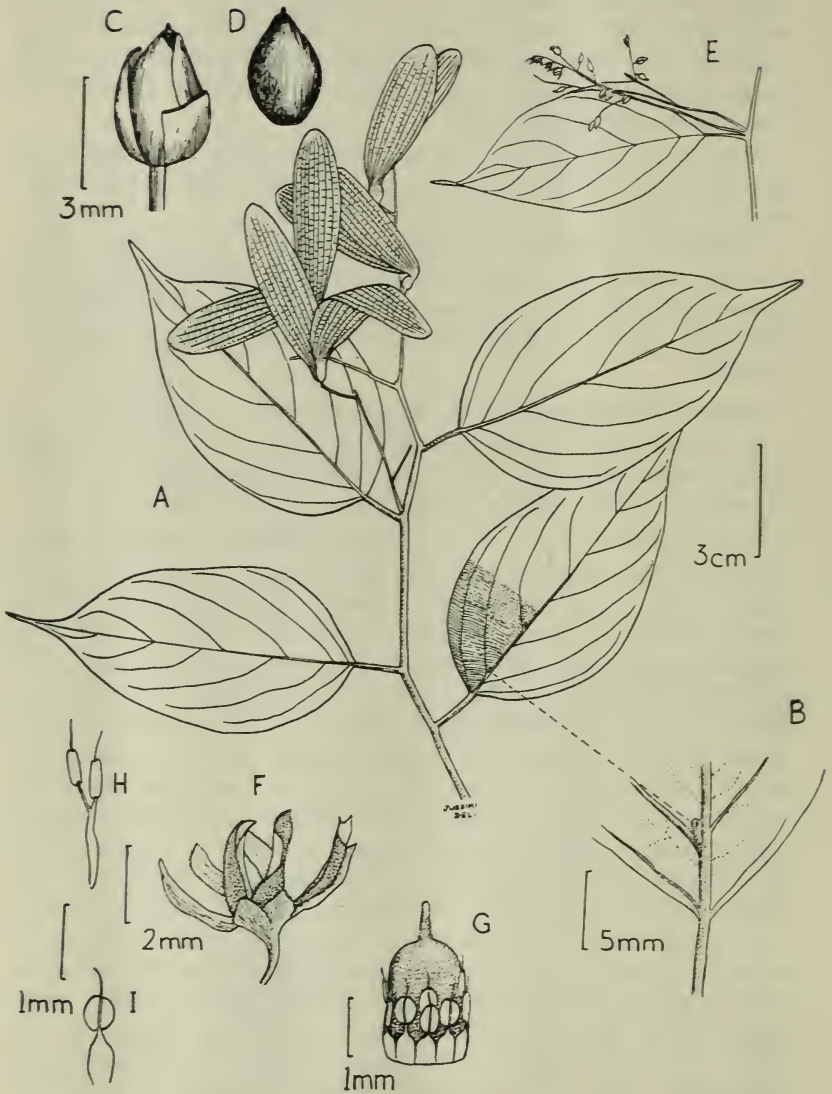
Originally this species was separated as new by Symington but was not named. Some specimens have been distributed as *S. symingtoniana* which is a pre-occupied name. It has been listed as *Shorea* sp. 'L' in the herbarium of the Forest Research Institute, Kepong.

5. *Hopea pentanervia* Sym. ex Wood sp. nov. (§ Euhopea)

H. nutanti Ridl. similis, sed foliis minoribus glabrisque, nervis eorum lateralibus paucioribus utrinsecus plerumque 5, floribus minoribus, laciniis fructus angustioribus sat dissimilis.

Arbor circa 30 m. alta. *Folia* ovata vel elliptica, olivaceo-viridia, 6–9.5 cm. longa, 2.5–5 cm. lata, caudato-acuminata, basi paulo oblique rotundata vel breviter cuneata, utrinque glabra, supra nitida, utrinsecus nervis lateralibus 4–7 plerumque 5, porrectis subtus prominenter, supra dibilter percursa, petiolis circa 1–1.3 cm. longis stipitata. *Inflorescentia* axillaris, solitaria vel interdum binaria, in ramos secundarios floriferos ad 1.5 cm. usque longos divisa, bracteis deciduis, axi omnino glabra. *Flores* in alabastro ovoidei, cum pedicellis 4 mm. altis circa 2 cm. longi; sepala utrinque glabra, 2 majora petalis paulo longiora, lingulata, externe longitudinaliter reflexa, olivaceo-brunnea, altera 3 minora ovata vel fere orbicularia, albescentia, margine fimbriata; petala linearia, apicem versus paulo angustata, obtusa, margine fimbriata, extus albo-tomentosa, intus fere glabra vel minute puberula, flavescencia; stamina 15, per series 2 disposita, inaequalia. *Fructus* bi-laciniatus, omnino glaber, fusco-brunneus, pedicello 1.5–2 mm. longo stipitatus; laciniis majoribus 2 spathulatis, 4.5–5.5 cm. longis, 1 cm. latis; minoribus 3, circa 5 mm. longis, quam nux cum stylopodio brevioribus. *Nux* ovato-conicalis, breviter apiculatus, 6 mm. longus, 2.5 mm. in diam.

BORNEO: Sarawak, Baram (SAR 1257, holotypus in KEP, isoholotypus in SAR). North Borneo, Bongawan—Paper (Mail, SAN A. 1753, paratypus in SAN, isoparatypus in KEP & SING).



Hopea pentanervia Wood (A-D: A-1753 in SING; E-I: SAR 1257 in KEP)

A, Ramulus fructiferus. B, Folii fragmentum cum glandula (ampliatum).
 C, Fructus. D, Nux. E, Ramulus floriferus. F, Flos. G, Ovarium cum staminibus. H & I: Stamina.

The leaves are glabrous, provided usually with 5 pairs of nerves and often with domatial glands in the axils of basal nerves. Bole often fluted, somewhat cracked and flaking. The species is similar to *H. nutans* Ridl., but differs in smaller glabrous leaves having fewer lateral nerves, smaller flowers, and in the fruit wings being narrow.

[The drawing is made by the artist of the Botanic Gardens, Singapore, from the specimens in Kepong Herbarium.]

G. H. S. Wood, M. A., F. L. S.

(A tribute)

[Footnote:—Mr. G. H. S. Wood died on 6th May, 1957 in the Kuala Belait hospital, Brunei State, as a result of burns received in an accident at his camp. A short obituary notice will be found in the *Malayan Forester* Vol. XX, p. 121. The following account of his last collecting trip was written shortly after his death. Apart from his numerous collections he left some work nearly ready for publication, including field notes on all and completed descriptions of two of the new species published in this number. His contribution to the botany of Borneo was far greater than his published work can ever indicate, and it is fitting that it should not be forgotten.

Since then Mr. P. S. Ashton has been collecting continuously in the forests of Brunei until his departure in February 1960, and Dr. W. Meijer in 1959 joined the Forest Department in North Borneo as successor to Mr. Wood. Thus the work of botanical collecting, which Wood did so much to further, is being faithfully carried on after his departure.

B.E.S.]

*"For Lycidas is dead, dead ere his prime
Young Lycidas, and hath not left his peer."*

IN 1957 the late Geoffrey Wood, then Forest Botanist, North Borneo, had only recently returned from his first long leave in England (where I had visited him working in the Kew Herbarium). He wished to widen his field knowledge of North Borneo trees by studying them in their Brunei habitat, and a tour was arranged for that purpose. Peter Ashton, Forest Botanist, Brunei, (with whom Geoffrey travelled out in the *Canton*) and myself were privileged to be with him almost continuously for what were destined to be the last few weeks of his life. You cannot, for long, live under the same tarpaulin or share the same longhouse verandah with a man without obtaining a clear idea of his character and qualities; this brief tribute is an attempt to give some idea of how he lived and worked and appeared to us during these last days.

He arrived in Brunei on 13th March, bringing with him three of the North Borneo forest staff. Two of these, Kapis and Kalukut by name, were Dusuns from the upper reaches of the Kinabatangan River; the third was a Christian forest guard from Jesselton. The two Dusuns were expert tree climbers; given time they could climb any tree, by building a bamboo ladder up it if necessary. Kapis, the elder man, was frequently and proudly referred to by Geoffrey as the finest jungle man in North Borneo and it was an exceedingly

odd tree if neither Kapis, with his partly inherited and partly self-taught native jungle lore, nor Geoffrey, with his patiently acquired scientific knowledge, could "place" it.

The Dusuns were the most taciturn and inscrutable of men; they hardly ever spoke, except in Dusun amongst themselves, and it was impossible to guess most of the time what was in their minds. Yet Geoffrey had won their confidence and their loyalty in a remarkable way. He used to work very long hours, out in the forest from 7 a.m. to 3 p.m., often 4 p.m., sometimes 5 or even 6 p.m.; a short break on return to camp; and then the laborious work of trimming and putting away the day's collections, usually three to four hours' work ending up by the light of the battered old Tilley lamp that he carried. Yet they never groused or complained. As a party they were perhaps the most efficient collecting unit the forests of Borneo had seen up till then. Not since the days of Beccari, nearly a century ago, had any botanist collected the trees month after month over a period of years, as Geoffrey did. And when it was all over, perhaps the most moving moment in the funeral service was when these two Dusuns came forward to the graveside, side by side, to sprinkle earth on the coffin.

Sporadic collecting had been done over the past 23 years in Brunei by successive State Forest Officers and by the forest staff, but only twice before had a qualified botanist toured in Brunei. The late C. F. Symington came over from Malaya for two weeks in 1938, and Mr. J. Wyatt-Smith spent a week here during his visit to Borneo in 1954. This previous work had given us a general picture of the Brunei forests. The plan for Geoffrey's strong party was intensive collecting at a number of localities known to be of special interest.

The first month was spent in the Temburong district, with camps at Kuala Belalong (submontane country in the upper Temburong), Bangar (exploring the Biang ridge), Labu Estate (Bukit Patoi and Bukit Peradayan and Labu swamp forest). The second month (interrupted by Easter week, during which Geoffrey sailed for Sandakan at the Kuala Belait interport regatta) was spent in the *Shorea albida* forests behind Seria, and in the Andulau Forest Reserve. Priority was given to the Dipterocarps, of which many interesting collections (mostly sterile) were made, but trees of other species were collected if in flower or fruit. The collections amount to some hundreds of species, which will take a long time to classify and name. Several Dipterocarps new to Brunei (and to science ?) were obtained, and by running through the sheets in the Brunei herbarium Geoffrey was able to clear up a number of puzzles.

The fates were against him on this trip. On the day we left Brunei to start the tour his ankle swelled up alarmingly and turned blue—delayed reaction from a blow from a hockey stick in a game just before he left Sandakan. For over a week he could only hobble a few steps, and had to confine his collecting to what he could see from a dug-out. In botanically virgin country this must have been terribly disappointing, but he never complained, and derived some satisfaction from poring over the collections Peter and I brought back daily from the surrounding ridges; his presence in camp was invaluable, because his knowledge enabled him to direct our efforts to best advantage. Any kind of dead leaf that looked as if it might be a dipterocarp was picked up and brought in. Geoffrey could tell infallibly (*a*) if it was a dipterocarp or not; (*b*) if it was, to which group it belonged, and whether it was worth collecting or not. Rest and hot fomentations eventually reduced the swelling, and for the last day or two at that camp he was able to climb the hills. For the rest of that month in Temburong district the fates relented, and he was on top of his form; but during the sailing regatta he contracted a chill, and was troubled with a severe cold and fever during the last week in the Andulau Forest Reserve.

Looking back over those two months, what impressions remain? First, I think, must come his intense interest in his work, and his already deep and extensive knowledge of Bornean plants. He was extremely conscientious and thorough; however hot the day, however trying the leeches, painted flies, mosquitoes, sandflies, or other pests, he resisted the temptation to scamp the work, and the notes written on each collection were always full and detailed. This attribute alone marked him out as a great field collector, in the tradition of Beccari and Symington.

Next, perhaps comes his endless patience. His Dusun climbers were sure but often slow, yet never did he betray the slightest impatience with them, but was wont to jolly them along with cheerful cries and imitations of the Helmeted Hornbill's weird notes. How inappropriate therefore that the fates should have exacted so severe a penalty for a moment's impatience with a refractory camp fire.

Never again shall we see him, clad in jungle green, gazing up at the tree-tops in search of fertile material, with the binoculars he always carried—sometimes standing, but as often as not lying flat on his back on the leechy forest floor. Never again shall we see him sitting on the ground, puffing away at his pipe, writing those endless notes in his field book on some specimen which his climbers were busy collecting. On a long trip such as this he let

his beard grow, I suspect chiefly because the few minutes saved by not shaving every day could be devoted to writing some extra notes. Never again shall we see him snipping away with a large pair of clippers, as he used to do hour after hour trimming his material to give at least a dozen specimens; for he collected not only for Sandakan Herbarium but for the great herbaria of the world, Singapore, Kepong, Kew, Leiden, Arnold Arboretum, and the rest, to which duplicates were distributed.

It is difficult to write of his other interests; chiefly because we were so enveloped and caught up by his enthusiasm on this trip, and usually so tired out by the time the last specimen was put to bed, that I cannot remember any subject other than botany being discussed at length. We shared a common interest in mountains (when in England he had asked me to propose him for membership of the Himalayan Club) and sometimes talked of the Cuillins, or the Himalayas, or the Silvretta. He was interested in photography and carried two cameras, one for monochrome and one for colour, but these were chiefly used to picture the barks of trees or colourful figs.

"Lycidas is dead, dead ere his prime." Had he been spared and devoted enough years to the work he might have become a great botanist; but he was cut off when he was only just beginning to tackle taxonomic work and describe new species. I have already suggested that he was a great collector, and he had the luck to be in the field during 1955, one of the great dipterocarp flowering and fruiting years, when he obtained many species in flower or fruit for the first time in botanical history; the magnificent material he collected and distributed round the world will be his memorial. According to Milton,

"Fame is the spur that the clear spirit doth raise
To scorn delights and live laborious days."

I doubt whether botanist explorers follow their arduous calling in the hope of achieving fame so much as from sheer curiosity and love of travel. However Geoffrey might have answered the question we do not know, for he has now joined the select few, including George Forrest and Reginald Farrer, who died in harness, or (in the words inscribed on Farrer's lonely tombstone in far Northern Burma), who "died for love of beauty, and in search of rare plants."

B.E.S.

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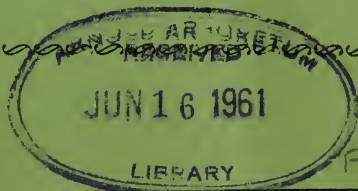
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Note: Part 2 page headings—*for Vol. XVII (1958) read Vol. XVII (1959)*

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p. 271	line 37:	<i>for</i>	Vittaria flexuosa Fee	<i>read</i>	Vittaria scolopendria (Bory) Thw.
p. 389	Section heading:	<i>for</i>	Ser. Validae (Miq.) Corner	<i>read</i>	Ser. Subvalidae (Miq.) Corner
pp. 395 & 396	Section heading:	<i>for</i>	Subsect Benjamina Miq.	<i>read</i>	Subsect Benjamina (Miq.) Corner
p. 414	penultimate line:	<i>for</i>	<i>Smithii</i>	<i>read</i>	Smithii
p. 419	last line:	<i>for</i>	Wall. ex. Miq.	<i>read</i>	(Wall. ex. Miq.) King
p. 445	line 17:	<i>for</i>	<i>Adenospermal</i>	<i>read</i>	<i>Adenosperma</i>
p. 448	line 9:	<i>for</i>	<i>inconspicula</i>	<i>read</i>	inconspicua
p. 450	line 11:	<i>for</i>	<i>minanassae</i>	<i>read</i>	<i>minahassae</i>
p. 481	line 3 from bottom	<i>for</i>	<i>retuso</i> √	<i>read</i>	<i>retusto</i> √

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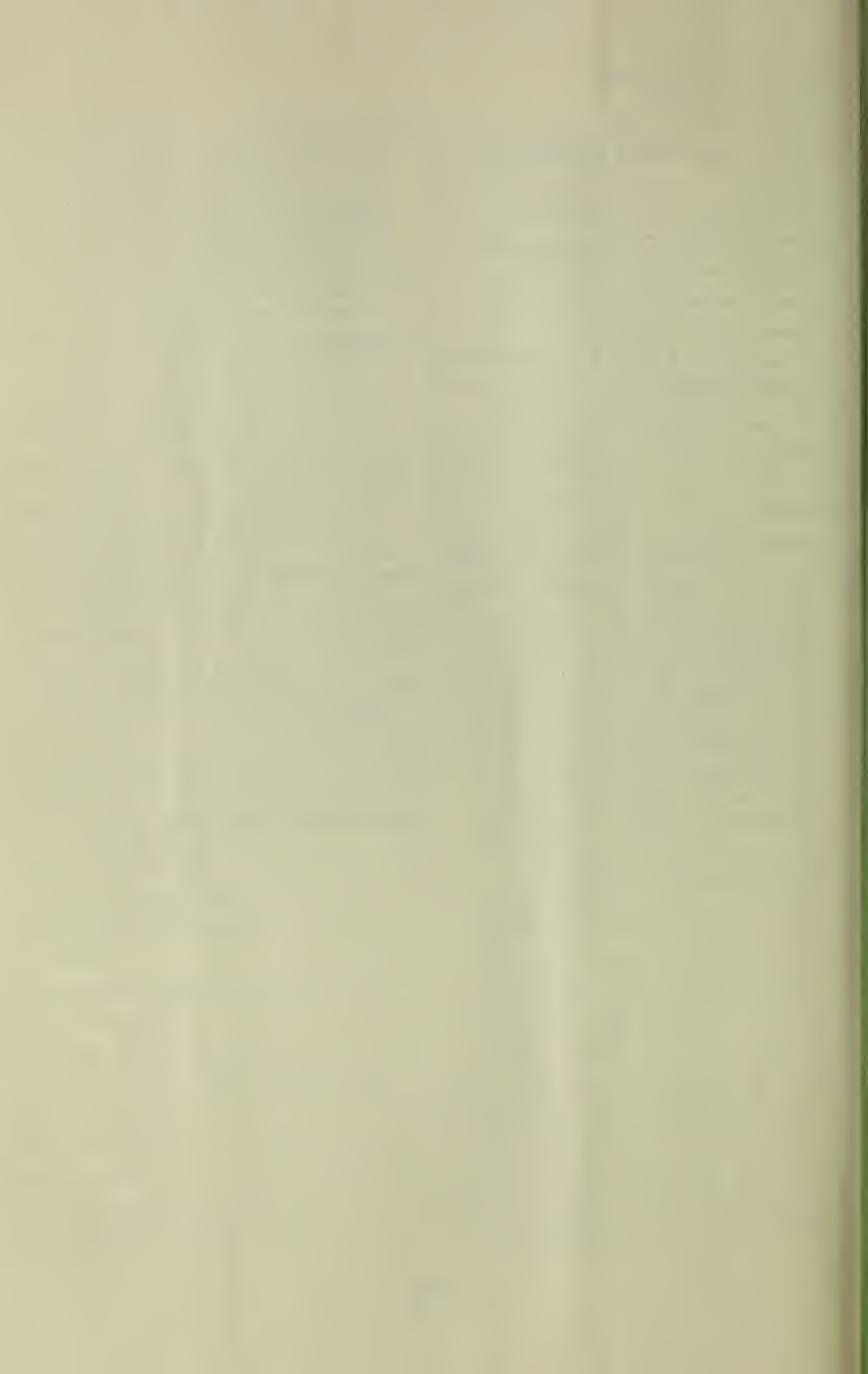
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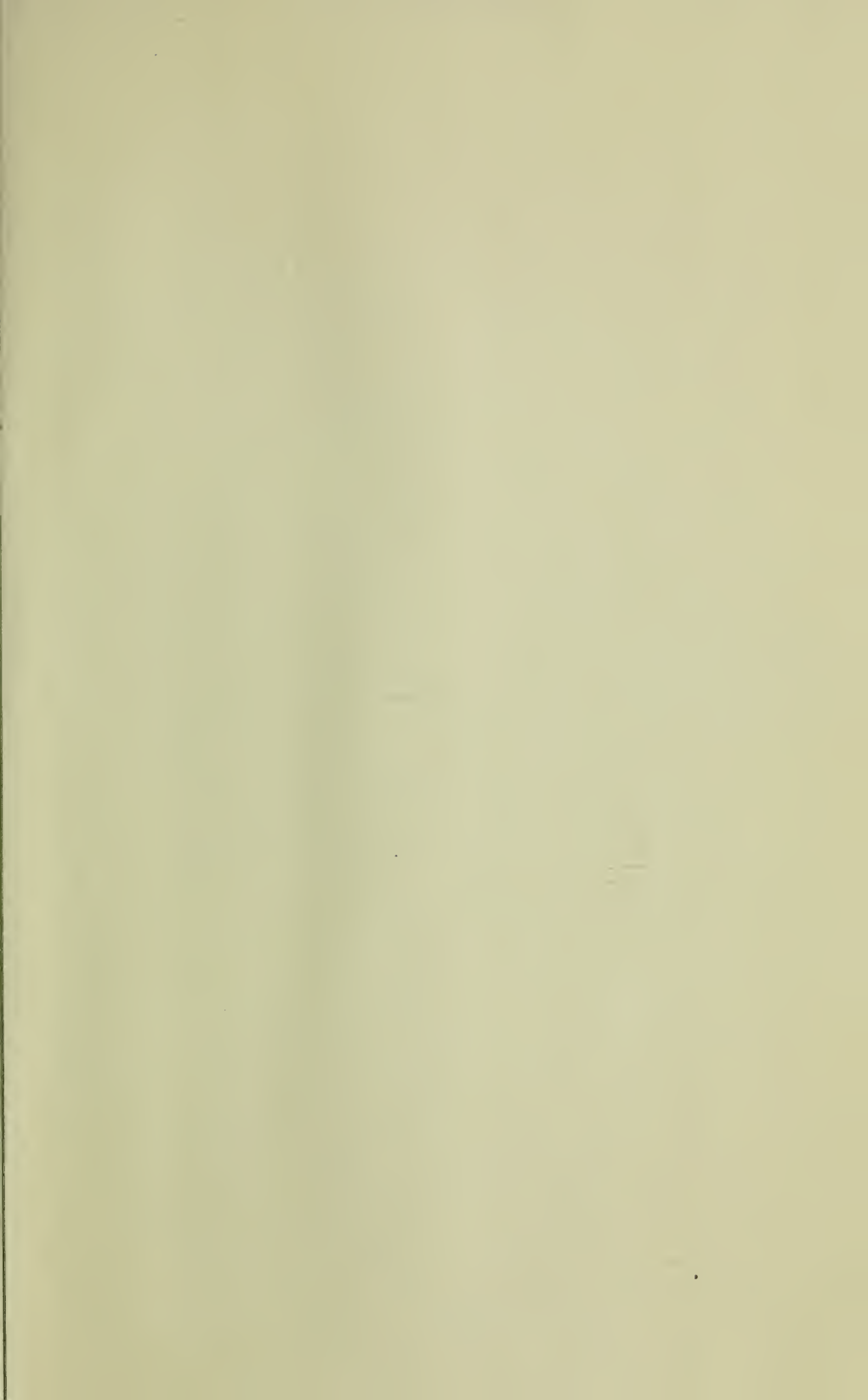
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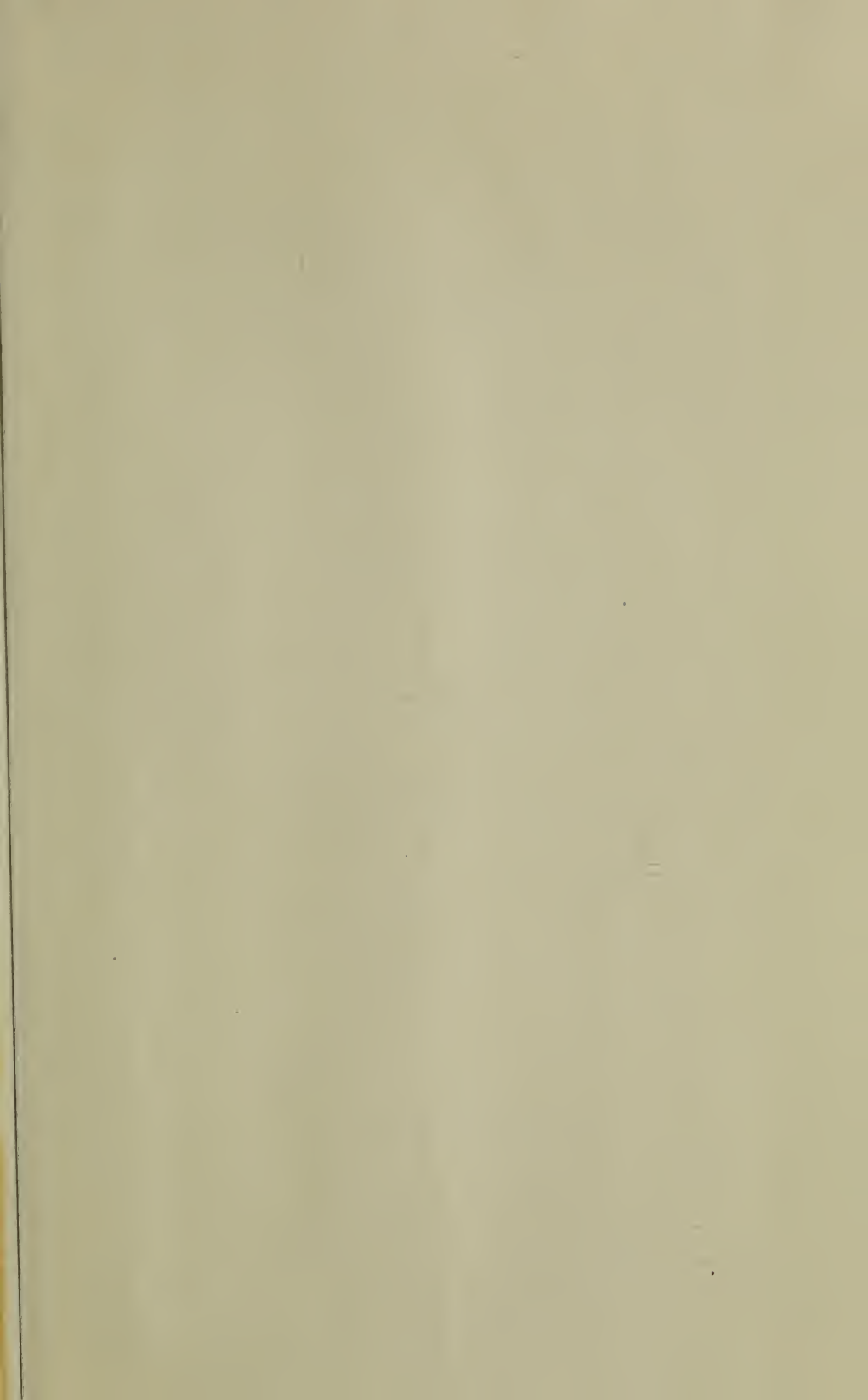
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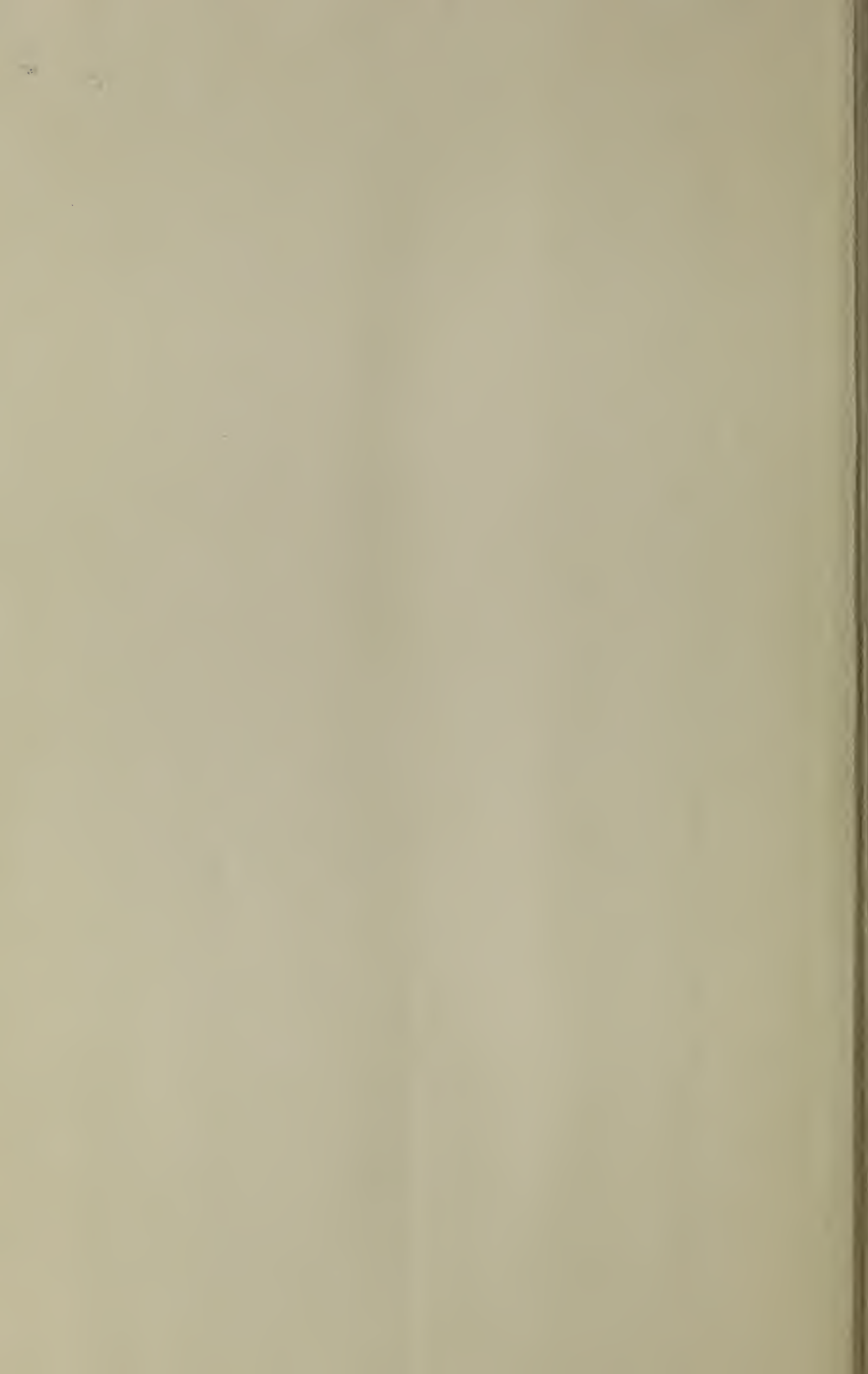
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