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SINGAPORE

Volume 36
(1983)

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Singapore

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Two copies of the manuscript should be submitted, typed on one side only with double-line spacings and a margin of at least 4 cm. Do not type all the letters of any word in capitals. Underline only in pencil: with a straight line for italic type face and wavy line for bold type face. Authors should see the layout of other papers recently published in this journal to ensure that papers submitted conform as closely as possible to the accepted pattern. Numerical data should only be included if it is essential to the argument and this can be presented either in the form of tables or diagrams.

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Editorial Note

The first serial publication to reflect the interests and work of the Singapore Botanic Gardens was the *Agricultural Bulletin of the Malay Peninsula*, edited by H. N. Ridley and published in 1891. This was eventually replaced by I. H. Burkill with *The Gardens' Bulletin, Straits Settlements* in 1912 which became *The Gardens' Bulletin, Singapore* in 1949. Early issues of *The Gardens' Bulletin* dealt with the diverse botanical and horti-agricultural studies undertaken by the Gardens' personnel. However, a largely taxonomical status was assumed in the later issues.

The present Editorial Committee is again widening the scope of *The Gardens' Bulletin, Singapore* by welcoming authors in the field of tropical ornamental horticulture to also submit research articles for consideration to be published in the Bulletin. Desirable are descriptions of newly introduced tropical and subtropical species, and original papers on the propagation and care of annual and herbaceous plants, lawn and other turf grasses, bulbs and tubers, foliage and succulent plants, and trees and shrubs. *The Gardens' Bulletin* appears regularly twice yearly. Guidance on the presentation of manuscripts and other information are available on the inside covers of recent issues or behind the contents page.

S. Y. GEH

*Editor*
Architecture and Phyllotaxis of *Anisophyllea disticha* (Rhizophoraceae)

J. R. VINCENT and P. B. TOMLINSON

*Harvard Forest, Harvard University, Petersham, U.S.A.*

**Conspectus**

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**Abstract**

*Anisophyllea disticha* does not show distichous phyllotaxis. Erect (orthotropic) shoots with $\frac{3}{2}$ spiral phyllotaxis and radial symmetry give rise to tiers of sylleptic branches at regular intervals. The branches are horizontal (plagiotropic) and have marked dorsiventral symmetry. Their phyllotaxis is unique and consists of four ranks of alternately arranged leaves, two ranks of scale leaves on the dorsal side and two ranks of foliage leaves on the ventral side, dorsal and ventral leaves of the two ranks alternating regularly along the stem on opposite sides. Homology between the three kinds of leafy appendage is indicated by their constant unilacunar node, but dorsal (adaxial) scales on plagiotropic axes do not subtend axillary buds. The leaf arrangement is assumed to maximize photosynthesis and corresponds closely to ideal systems established by theoretical considerations.

**Introduction**

In the present study attention is drawn to some aspects of morphology and anatomy of a species of *Anisophyllea, A. disticha* (Jack)Baillon which allows a better comparison with its putative relatives. The genus *Anisophyllea* R. Br. ex Sabine includes about 25 species of trees and shrubs distributed primarily in tropical Africa, Ceylon, India and Southeast Asia (Ding Hou, 1958). Its relatively recent discovery in South America (Sandwith, 1952) where 3 species are presently known (Pires and Rodrigues, 1971) makes its known range almost pan-tropical. Species vary from treelets of the lower forest storey to tall, canopy trees.

The taxonomic position of *Anisophyllea* is somewhat controversial. Most authors have included it in the Rhizophoraceae, usually within a separate tribe
Plate 1. *Anisophyllea disticha*

A. Habit of sapling, obliquely from above.
B. Terminal tier of 5 plagiotropic branches from above, apex of orthotropic axis quiescent.
C. Part of plagiotropic branch tier from above, with second-order branches.
D. Detail of plagiotropic branch from above showing pronounced anisophyllly.

*A* and *C* from Ektachrome transparencies provided by Dr. J. B. Fisher (Kedah collection); *B* and *D* from Singapore collection.
Anisophylleae, together with Combretocarpus, Polygonanthus and Poga. These four genera differ from other members of the family in having alternate, exstipulate leaves (rather than opposite, stipulate leaves). The other three genera in the tribe have more limited distribution than *Anisophyllea: Combretocarpus* (1 sp.) is restricted to Sumatra and Borneo, *Poga* (1 sp.) to West Africa and *Polygonanthus* (2 spp.) to Amazonia (Pires and Rodrigues, 1971). This tribal aggregation is strongly supported by evidence from wood anatomy (van Vliet, 1976). A contrasted view is to segregate a separate family Anisophylleaceae (Schimp.)Ridl. (e.g. Takhtajan, 1969; Airy Shaw, 1973), but van Vliet points out similarities of the Anisophylleae to other Rhizophoraceae especially in its resemblance to the tribe Gynotrocheae.

It should be useful to establish the comparative phyllotaxis of members of the family, since the contrast between the tribes in this character is extreme. *Anisophyllea disticha* is significant in this respect because of the pronounced heterophyll of some of its axes which might represent a transition between the stipulate and exstipulate conditions, especially as the smaller leaves are often described as “stipule-like”.

*Anisophyllea disticha*, “leechwood”, is restricted to the Malay Peninsula, Sumatra and Kalimantan (Borneo) where it is a characteristic understorey treelet up to 7.5 m high occurring on a diversity of soils, ranging from swampy areas to drier granitic sands and ridges (Ding Hou, 1958). According to Hallé *et al* (1978, p. 200) the architecture of some *Anisophyllea* species represents an extreme expression of Massart’s model, which refers to trees with an orthotropic, monopodial trunk which grows rhythmically and produces tiers of plagiotropic branches at regular intervals. *Anisophyllea disticha* in particular, stands apart from most other members of the genus in the extreme plagiotropy of the horizontal branches which are anisophyllous, with an apparent distichous series of scale leaves superimposed on the distichous foliage leaves (cf. Tay, 1977). This condition is occasionally found in *A. scortechinii* so that there is a possible phyletic link between *Anisophyllea disticha* and the rest of the genus (Ding Hou, 1958).

The present study establishes to what extent the phyllotaxis of the plagiotropic, anisophyllous branches is primary (i.e. determined by their method of inception at the shoot apex) or secondary (i.e. modified by later re-orientation through differential growth or torsions). Previous description has not addressed this problem (e.g. Ding Hou, 1958) and has not described microscopic details of anatomy of different leaf types (cf. Geh and Keng, 1974).

**Materials and Methods**

Two collections of fluid-preserved (FAA) material which included young orthotropic and plagiotropic axes were available for this study (J. B. Fisher, 5.vii.77, Kedah Peak, Malaysia and P. B. Tomlinson, 5.viii.82, Garden’s Jungle, Singapore Botanic Gardens).

The distal 1 to 2 cm of a number of both types of axes were embedded in “Paraplast” and then serially sectioned at 8 μ with a rotary microtome. The sections
were mounted on slides and stained in safranin and fast green. In order to facilitate investigation of leaf development and nodal anatomy the individual sections were photographed in series through a Wild microscope with a Bolex movie camera, using the cinematographic drawing method described by Zimmermann and Tomlinson (1966).

Single transverse and longitudinal sections of mature leaves from these two collections were also prepared, using a sliding microtome to cut sections of 20-30 μ. These sections were mounted in glycerine and examined unstained. Finally, leaves from these collections were cleared in 5% alcoholic NaOH and examined unstained.

Diversity in external leaf size, form, and disposition was explored by examining the collections of *A. disticha* in the Harvard University Herbaria, which consisted mainly of plagiotropic axes.

**Results**

**Architecture.** Massart’s model is well represented by this species in the orthotropic (trunk) axis which produces a tier of horizontal plagiotropic axes (branches) at wide regular, intervals (Plate 1A). There are usually 5 branches in each tier (Plate 1B). Our material did not include seedlings but the older trunk axis which we studied seems similar to the seedling axis described by Geh and Keng (1974). Germination is described as hypogeal and the plumule bears spirally-arranged scale leaves. Growth of the axis is rhythmic, eventually with the production of a tier of branches at the end of each of flush. We have had no opportunity to make extensive phenological studies but the apex of the orthotropic shoot immediately above the tier undergoes an extended period of rest before growth is renewed and the next vertical increment is made. Individuals within a population seem asynchronous with regard to flushing since orthotropic shoots at various stages of development can be found at any one time. Field study of marked individuals is needed, however, to monitor events precisely.

Leaves on orthotropic shoots are spirally-arranged with $\frac{2}{3}$ phyllotactic arrangement (Fig. 1A, 2A). At maturity the leaves are separated by extended internodes at the base of the shoot, but they are crowded towards the region of tier insertion. Leaves are scale-like, usually appressed to the stem and each subtends a minute lateral bud which normally undergoes no further development (Fig. 2D). Leaves towards the end of the flush are somewhat larger than those found at the beginning. Branches (Fig. 1A, arrows) are produced at the end of each flush by syllepsis (Halle et al., 1978), each branch subtended by a scale leaf. Usually five branches are produced i.e. one for each orthostichy in the phyllotactic spiral (Plate 1B). The subtending leaves apparently represent the last 5 leaves of the series produced by the apex of the orthotropic shoot before it undergoes rest. Although there is a short hypopodium, there is something of a transition in leaf size along the axis at its base (Plate 1B).

Branches extend almost horizontally and are markedly dorsiventral. They branch infrequently to produce daughter axes of a second and even third order which repeat
the plagiotropic organization (Plate 1C). Evidence for rhythmic growth of these plagiotropic axes is limited since the only articulations are the daughter branches themselves, which are usually produced in pairs from adjacent internodes (Plate 1A, C). No discrete terminal resting buds are produced and there is no regular fluctuation in size of the two kinds of leaf. Direct measurement of growth frequency is required to demonstrate rhythmic growth, if it exists.

Dorsiventrality is determined by phyllotaxis, as shown in serial sections of buds, with no secondary reorientation of leaves other than their separation by internodal extension (Fig. 2E-F). Leaves are four-ranked (Fig. 2E) and consist of two ranks of scale-leaves arranged alternately on the upper side of the branch (dorsal scales) and two ranks of larger foliage leaves on the lower side of the branch (ventral foliage leaves). The internodes between them are extended such that in an acropetal direction the sequence of leaves is – left scale – left foliage – right scale – right foliage – left scale … etc. (Plate 1D; Figs. 1B & 5A). In terms of the genetic spiral, the

---

Fig. 1. Anisophyllea disticha (Singapore collection). Morphological details.
A. Apex of orthotropic shoot; sylleptic branches forming terminal tier cut off (arrows).
B. Detail of plagiotropic axis from above to show relative position of branch scales and foliage leaves; LS-left scale; RS-right scale; LF-left foliage leaf; RF-right foliage leaf; branch scale – stippled (cf. Fig. 4).
C. T.S. trunk axis at level of insertion of trunk scale to show position of multiseriate gland; vascular tissue-solid black.
D. Detail of multiseriate gland.
following values represent observed angular divergences proceeding acropetally (n = 11):

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Angle of Divergence</th>
</tr>
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<tbody>
<tr>
<td>Left scale – left foliage</td>
<td>46° ± 13</td>
</tr>
<tr>
<td>Left foliage – right scale</td>
<td>180° ± 0</td>
</tr>
<tr>
<td>Right scale – right foliage</td>
<td>314° ± 13</td>
</tr>
<tr>
<td>Right foliage – left scale</td>
<td>180° ± 0</td>
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</tbody>
</table>

In Figure 5B, these four sequences are indicated by the numbered sequences 4-5, 5-6, 6-7, and 7-8, respectively.

Scale leaves subtend no axillary buds (Fig. 2K) whereas foliage leaves always subtend at least one bud (Fig. 2I) which usually develops as an inflorescence, but occasionally as a vegetative branch which grows out by syllepsis and, as stated, repeats the construction of its parent axis.

Reiteration of the architecture in the sense of Hallé et al. (1978) is seen in the production of additional orthotropic shoots from the trunk axis, presumably from dormant lateral buds. This most typically occurs in damaged stems with the resulting "repair" of the original crown. However, lower buds occasionally grow up without obvious damage to the plant. Since the architectural crown-form is so precise and plagiotropic shoots never produce orthotropic axes, the result is always a narrow cluster of orthotropic axes each with its own set of branch tiers which become somewhat internested.

Leaf morphology. Three types of leaves can be recognized on the basis of morphology and position. Symmetrical scale leaves are the leaves of orthotropic shoots, asymmetrical (dorsal) scale leaves and (ventral) foliage leaves are the two kinds on plagiotropic shoots (Fig. 3A, C and E). These three types will be referred to as trunk scales, branch scales, and foliage leaves, respectively. Representative dimensions from the two fluid-preserved collections are included in Table 1 to show that the two types of scale leaves are about the same in length. Herbarium specimens confirm these observations in terms of relative size, but several specimens had unusually large foliage and scale leaves, up to 80 x 35 mm and 10 x 5 mm, respectively. Ding Hou (1958) notes that the size of leaves (referring only to foliage leaves) is "variable" and comments that "all specimens from the Malay Peninsula have small leaves". There may be some overlap in size between leaves of different types, with large distal scales on orthotropic shoots approaching the size of proximal foliage leaves on plagiotropic shoots. The two contrasted leaf types on plagiotropic shoots always retain their relative size difference, with transitional forms restricted to the branch base.

Mean length of foliage leaves in the two collections varied from 16 mm (Kedah collection) to 25 mm (Singapore collection) and mean length was in both cases two to three times greater than mean width. Both types of scale leaves in both collections were about the same mean length, 5 mm, but trunk scales were fifty percent wider than branch scales (cf. Fig. 3C and E).
Fig. 2. *Anisophyilea disticha* (Singapore collection). Phyllotaxis and nodal anatomy.

A-D. Orthotropic shoot.
A. T.S. bud 8 μ below shoot apex.
B-D. T.S. three successive levels to show nodal anatomy.
B. Leaf trace with single leaf gap. C. Branch traces from margin of leaf gap. D. Level of axillary bud.

E-F. Plagiotropic shoot.
E. T.S. bud at level of shoot apex.
F. T.S. bud 64 μ below shoot apex.

G-I. T.S. three successive levels to show: G. Departure of foliage leaf trace; H. Departure of bud trace.

J-K. T.S. insertion of branch scale to show: J. Unilacunar node; K. Absence of bud.

Vascular tissue – solid black; branch scale – stippled; axis – cross-hatched.
Table 1. Comparative leaf dimensions (in mm)

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<td>16 ± 2.4 × 7.0 ± 1.3 (n=42)</td>
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<td></td>
<td>4.9 ± 0.6 × 1.1 ± 0.4 (n=47)</td>
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<tr>
<td></td>
<td>5.2 ± 1.8 × 1.7 ± 0.5 (n=7)</td>
<td></td>
</tr>
<tr>
<td>Singapore:</td>
<td>Foliage</td>
<td>25 ± 2.2 × 9.0 ± 1.1 (n=33)</td>
</tr>
<tr>
<td></td>
<td>Branch scale</td>
<td>5.3 ± 0.4 × 1.7 ± 0.3 (n=33)</td>
</tr>
<tr>
<td></td>
<td>Trunk scale</td>
<td>5.5 ± 1.4 × 2.5 ± 0.9 (n=17)</td>
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Foliage leaves (Fig. 3A) are rhombic but asymmetrical, with an acute tip and an acute, unequal base; branch scales (Fig. 3C) are asymmetrical, lanceolate-ovate but somewhat falcate with an acute tip and an acuminate or rounded but unequal base. Trunk scales (Fig. 3E) are almost symmetrical, with an acute tip and an attenuate or rounded, unequal base. The margins of all leaves are entire, those of the foliage leaves sometimes slightly inrolled abaxially.

The venation of foliage leaves may be described as acrodromous (Fig. 3A) with a mid-vein which is prominent below (Fig. 3G). Two pronounced secondary (lateral) veins originate basally from the mid-vein, with a third lateral vein originating suprabasally from the anodic or acrodromic side of the lamina. All three secondary veins run almost to the apex and are connected by regularly arranged cross-veins (tertaries) which form a scalariform pattern (Fig. 3B). Venation of both types of scale leaf is much simpler and may be described as camptodromous and cladodromous (Fig. 3D, F). The single mid-vein gives rise to minor secondaries which extend towards and sometimes along the margins and interconnect only occasionally to form an open reticulum.

Both leaves and stems are covered with fine, brown, apparently uniseriate hairs. These differentiate early, when the leaf primordium is at about the fourth to sixth plastochron. Each originates from a four-celled basal complex of cells which gives rise to a single elongated distal cell, which becomes thick-walled in the mature leaf. The indumentum of the two types of leaf on plagiotropic shoots is somewhat contrasted, since hairs are usually absent from the scale leaves except along the leaf margins whereas the foliage leaves are quite densely hairy, on the surface but especially along the margins. Trunk scale leaves have frequent abaxial hairs, especially at the base of the lamina, as well as marginal hairs.

Multicellular clavate glands, in pairs or sometimes fours occur at the base of each type of leaf in a stipular position (Fig. 1C, D). They are not vasculated, and develop precociously so that they are conspicuous in the buds.

Leaf anatomy. Leaves of the three types are of comparable thickness, measured halfway between base and apex and mid-rib and margin, shown in Table 2, but mesophyll structure varies appreciably.
Fig. 3. *Anisophylea disticha* (Singapore collection). Leaf anatomy.

A-B; G-H. Foliage leaf.
C-D; I-J. Branch scale.
E-F; K-L. Trunk scale.

A, C, E. Leaf outline showing major veins, from cleared specimens.
B, D, F. Details of venation in same leaves.
G, I, K. Outline of complete leaf (half-leaf in G).
H, J, L. Detail of mesophyll anatomy.
Colourless hypodermis - lumen dotted in H and K.
All leaves have a thin, smooth cuticle. The epidermal cells have a sinuous outline in surface view. Stomata occur on all three kinds of leaves and are restricted to the abaxial surface, except for a few adaxial stomata towards the leaf apex in the trunk scale leaves. As shown in Table 3, differences in stomatal distributions are greatest between foliage leaves and branch scales. Stomata are each surrounded by 4-7 epidermal cells with somewhat less sinuous anticlinal walls.

Differences among the three leaf types occur mainly in the mesophyll. Foliage leaves (Fig. 3G, H) have a single almost continuous, colourless abaxial hypodermal layer and a well-differentiated mesophyll consisting of a single adaxial palisade layer and 2-4 layers of spongy mesophyll. Trunk scale leaves (Fig. 3K, L) may also have a single layer of colourless hypodermal cells below the abaxial surface (Fig. 3L) but in neither type of scale leaf is the central mesophyll of 2-4 layers differentiated into palisade and spongy tissue (Fig. 3J, L). Branch scale leaves (Fig. 3J, J) are distinguished by the numerous epidermal tannin cells, staining dark red with safranin, which differentiate early but become less conspicuous in mature leaves. Tannin cells are otherwise common in the mesophyll of all three kinds of leaf. The general conclusion is that the biggest differences in leaf anatomy are between the two types of leaf on plagiotropic axes.

Table 3. Comparison of stomatal frequency and stomatal index in different leaf types (n=10 for each leaf type).

<table>
<thead>
<tr>
<th></th>
<th>Foliage Leaf</th>
<th>Branch Scale</th>
<th>Trunk Scale</th>
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<tbody>
<tr>
<td>Stomatal frequencies (stomata/mm²)</td>
<td>93 ± 10</td>
<td>55 ± 18</td>
<td>70 ± 18</td>
</tr>
<tr>
<td>Stomatal index (stomata/epidermal cells)</td>
<td>.060 ± .008</td>
<td>.049 ± .012</td>
<td>.061 ± .013</td>
</tr>
</tbody>
</table>

Nodal Anatomy: Ciné-analysis shows that all leaves have a single leaf trace derived from a single leaf gap (Fig. 2B-D; G-I; J-K). Geh and Keng (1974) report the nodal anatomy for the family as "many-traced, trilacunar", and thereby imply that this also applies to Anisophyllea disticha. This is a curious discrepancy but it is possible that these authors refer to the two lateral traces from the upper margins of the leaf gap which are actually traces to the axillary bud and not the leaf (Fig. 2C, D; H, I).

Table 2. Comparative Leaf Thickness (in microns) (n = 10)

<p>| | |</p>
<table>
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<tr>
<td>Foliage</td>
<td>130 ± 11</td>
</tr>
<tr>
<td>Branch scale</td>
<td>140 ± 18</td>
</tr>
<tr>
<td>Trunk scale</td>
<td>140 ± 19</td>
</tr>
</tbody>
</table>
**Internode length.** Evidence was sought to show that the scale leaves on plagiotropic shoots had a constant association with a foliage leaf, since this could relate to their interpretation as stipules. Figure 4 shows that in the Singapore population (lower histogram) there was an average greater length of the internode between a scale leaf and foliage leaf on the same side of the axis than between scale leaf and foliage leaf on opposite sides of the axis. However, this relationship was reversed in the Kedah sample (upper histogram). Herbarium specimens provided further examples of variation in spacing between the two types of appendage. In many examples, spacing is about equal. This leads to the conclusion that there is no constant association between the scale leaf and adjacent foliage leaf which might assist in an interpretation of the distinctive phyllotaxis.

![Graph showing internode length](image)

Fig. 4. *Anisophyllea disticha.* Histogram of average internode length along plagiotropic branch in two collections (Kedah, Singapore); vertical lines above bars represent standard error, numbers within bars represent sample size. Internodes are those between left scale and right foliage leaf (*LS-LF*); left foliage leaf and right scale (*LS-RS*); right scale and right foliage leaf (*RS-RF*) and right foliage leaf and left scale (*RF-LS*); cf. Fig. 2B.
Discussion

Phyllotaxy. Evidence from nodal anatomy demonstrates that the 3 kinds of leaves in *Anisophyllea* are homologous since they all have the same unilacunar, single-trace vascular configuration, and therefore cannot be regarded as referring to two categories, viz. leaf and stipule, even though accounts of the branch scale leaves have referred to them descriptively as either "stipule-like" (Ding Hou, 1958) or "appearing as stipules" (Corner, 1952). Nor are they consistently associated with foliage leaves in a way which might suggest that they are leaf-opposed stipules (Fig. 4). Further evidence is provided by the similar anatomy of scales on orthotropic and plagiotropic shoots (Fig. 3). The homology between trunk scales and leafy appendages is not disputed since these scales are solitary, with a normal spiral phyllotaxis and subtend axillary buds. Morphological evidence that the branch scales are stipules therefore comes solely from the absence of axillary buds. The suggestion that they might be stipular can otherwise be based only on out-group comparison since stipules are a characteristic feature of other tribes within the Rhizophoraceae (e.g. Rhizophorae, Gynotrocheae). The microscopic glands at the leaf base are not stipule homologues despite their position (Fig. 1C).

If we rule out the possibility that *Anisophyllea* possesses stipules, the phyllotaxis of the different shoot systems becomes easier to interpret. The orthotropic shoots have a regular spiral phyllotaxis (Fig. 2A) and offer no interpretative problems. However, the four-ranked leaf arrangement of the plagiotropic shoots (Fig. 2E) is difficult to interpret as a modification of any more regular or familiar phyllotaxis without envisaging major rearrangement of appendages. Each of these major arrangements may be considered in turn: –

1. Spiral. To accommodate a genetic spiral of the type found in spiral phyllotaxis, in which the angular divergence between successive leaves in the spiral is some regular Fibonacci fraction of the total stem circumference, would require modification of each leaf position. A change from 144° (the Fibonacci angle) for a $\frac{3}{2}$ phyllotaxis would have to result in different displacements for each successive leaf (cf. the values on p. 8). Such a modified spiral is a difficult interpretation to accept.

2. Distichous. A distichous leaf arrangement in the plagiotropic shoots could only exist if it is hypothesized that two independent sets of distichous leaves are present. Two such arrangements can be hypothesized. Following one interpretation, one series would consist of foliage leaves (leaves 1-3-5-7 in Fig. 5A, B), and the other series would consist of scale leaves (leaves 2-4-6-8 in Fig. 5A, B). The orthostichies of these separate series would be set an angle of approximately 135° to each other (Fig. 5B). The sequence of initiation of appendages which is continuously acropetal, without any evidence for the suggested two separate series, does not support this interpretation. Furthermore, this interpretation is purely descriptive, and does not explain the phyllotaxis as a modification of a more standard arrangement.

Alternatively, the two series could each consist of a scale and a foliage leaf on opposite sides of the stem, that is one series of left foliage-right scale (leaves 1,2,5,6 in Fig. 5A, B) and the other of right foliage-left scale (leaves 3,4,7,8 in Fig. 5A, B). The orthostichies of the two series in this case would be set at an angle of approx-
Fig. 5. Anisophyllea disticha (Singapore collection). Leaf arrangement on plagiotropic shoot (Diagrammatic).

A. Plagiotropic axis from above, with foliar appendages (both foliage leaves and branch scales) numbered acropetally from 1 (oldest, basal) to 8 (youngest, distal). Odd-numbered appendages are foliage leaves; even-numbered appendages are branch scales (stippled).

B. Diagram (not to scale) of axis (cross-hatched) shown in A, with the eight numbered appendages projected onto a transverse plane, in their four orthostichies. Angles between orthostichies are approximate (see text).

imately 45° to each other (Fig. 5B). This interpretation requires that the sequence of leaves of each series be interrupted alternately by 0, 2, 0, 2, etc., leaves of the contrasted series. This is hardly a standard distichous arrangement.

3. Decussate and bijugate. Particularly difficult problems exist if the phyllotaxis of the plagiotropic shoots is considered to be a modification of a system in which leaves are opposite with pairs either at right angles (decussate) or some other regularly repeating angle (bijugate). The last arrangement needs to be considered for com-
parative purposes because the phyllotaxis of the Rhizophoreae is of this kind (Tomlinson and Wheat, 1979) and it seems also to occur in at least some of the non-mangrove genera (e.g. Carallia, Crosstylis, Gynotroches, Pellacalyx). In Figure 5A, B, a bijugate arrangement would be represented by pairing a foliage and a scale leaf in the fashion 1-2, 3-4, 5-6, 7-8. However, to accommodate such a modification would require internodes to be separated, the bijugate angle to be changed both in magnitude and direction and the development of anisophyllly between members of a pair.

**Adaptive considerations.** The conclusion is therefore that there are constant difficulties in seeking for a hypothetical ancestral form of shoot with any kind of orthodox phyllotaxis from which Anisophyllea disticha might be derived. The present conclusion must be that the leaf arrangement on the plagiotropic shoots is unique and represents a departure from those arrangements usual in angiosperms. A careful examination of architecture in other species of Anisophyllea might throw light on the subject.

Contrasted leaf arrangements on plagiotropic and orthotropic shoots are not unusual in tropical trees conforming to Massart’s and Roux’s models (Hallé et al., 1978) but do not usually take the extreme form found in Anisophyllea disticha. It is reasonable to interpret them as mechanisms for maximizing photosynthesis by maximizing the surface area exposed and minimizing overlap both among leaves within one branch complex, and, between branch complexes of different tiers. The adaptive success is particularly appreciated because Anisophyllea disticha is a treelet of forest understorey and seemingly able to survive under a closed canopy under relatively dense shade. At the same time it is, according to Ding Hou (1958), the most widespread species of Anisophyllea, both geographically and ecologically. Givnish (1979) has hypothesized that optimizing the shape of leaves in planar arrays in order to minimize overlap will result in a leaf that “must be modified from a wedge-shaped form to one in which the leaf margin roughly parallels the midrib over much of the midleaf and tapers toward either end. The apical section should remain roughly wedge-shaped”. His diagram of such a theoretical system (Fig. 6) shows an uncanny resemblance to the arrangement and shape of foliage leaves in Anisophyllea disticha (cf. Fig. 1B). Givnish suggests that this modification of leaf shape from wedge to parallelogram results in a more efficient “ribbon of photosynthetic tissue along the branch”. Anisophyllea disticha seems not only to have brought this theoretical model to life, but to have improved upon it as well. Scale leaves further increase the surface area of the “ribbon of photosynthetic tissue” by patching the holes within it i.e. filling the gaps between the bases of the foliage leaves as well as covering the dorsal side of the branch. This interpretation does not, of course, rule out the possibility that the scale leaves have some other function not associated with photosynthesis. For example, they may be involved in close-packing of appendages within the dorsiventrally flattened shoot apex as a consequence of its apparently continuous growth.

Although the phyllotaxis of these plagiotropic branches may be unique within the angiosperms, the same leaf arrangement occurs in other groups. Several writers have commented upon the considerable similarity between species of Selaginella (section Heterophyllum) and Anisophyllea disticha (e.g. Corner, 1952). However, in Selaginella leaves are in pairs. Dengler (1983a, b) has recently described leaf
development in plagiotropic shoots of *Selaginella martensii* which shows a similar dorsiventrality determined by primary leaf arrangement. Her studies were undertaken to show that appendages which are “homologous” diverge considerably from each other very early in ontogeny and that the development of small dorsal leaves cannot be regarded as a simple truncating of the developmental process which occurs in larger, ventral leaves.

Our initial observations lead to the same conclusion in *Anisophyllea disticha* since dorsal and ventral leaves can be distinguished histologically within three to four plastochrons of their inception. At their third plastochron primordia which will develop into foliage leaves have six cell layers (at a point midway between longitudinal axis and margin) versus only five layers in scale primordia at the same developmental stage. Foliage primordia also show evidence of an abaxial ridge corresponding to the position of the midvein (Fig. 2E), and stain more densely with safranin than do scale primordia. Dengler’s work (1983a, b) provides a model for the further investigation in developmental differences between contrasted leaf types in *Anisophyllea disticha*. Such an investigation would complement our initial observations and would contribute considerably to our understanding of the morphological plasticity of the vegetative parts of higher plants in response to limiting environmental circumstances.

**Bibliography**


AMESIODENDRON AND LITCHI (SAPINDACEAE): New Records for the Malay Peninsula

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Forest Research Institute, Kepong, Malaysia

EFFECTIVE-PUBLICATION DATE: 14TH OCT. 1983

Abstract

Two genera of Sapindaceae, previously not recorded for the Malay Peninsula, have been confirmed to occur in local forests. They are Amesiodendron and Litchi, each represented by one species.

Introduction

A total of 16 genera of the Sapindaceae were recognised as occurring in the Malay Peninsula by King (1893). Ridley (1922, 1925) added a further four genera, Tristira Radlk., Curtisina Ridl. Napeodendron Ridl. and Phoenicimon Ridl., with the last three described as new and monotypic. However, all these three genera were later reduced as Curtisina penangensis was proved to be conspecific with Dacryodes longifolia in Burseraceae (Lam, 1932), Napeodendron altissimum with Walsura neuroides in Meliaceae (Symington, 1937), and Phoenicimon rubiginosus as a species of Glycosmis of the Rutaceae (Leenhouts 1967).

In his monograph of the family, Radlkofer (1932) added two more genera for the Malay Peninsula, Euphoria Commers. and Pseudonephelium Radlk. Subsequently Leenhouts (1969) reduced Aphania Bl., Erioglossum Bl. and Otophora Bl. to Lepisanthes Bl. The two genera Euphoria and Pseudonephelium were reduced to Dimocarpus Lour. (Leenhouts, 1971) while Tristira sensu Ridley was later reduced to Glenniea Hook. f. (Leenhouts, 1975). A new record, Ganophyllum falcatum Bl. was added by Whitmore (1969) from a specimen collected from south-east Johore.

The present study documents a further two genera that have not been previously recorded for the Malay Peninsula viz. Amesiodendron Hu and Litchi Sonn. Each of the two genera is represented by one species in this region.

Amesiodendron Hu


Plates 1 & 2, Fig. 1

Basionym: Paranephemelium chinense Merr., Lingnan Sci. J. 14 (1935) 30 & fig 10. Medium tree 20-30 m tall, 30-60 cm diameter; crown dense, spreading; bole fluted; bark brown to greenish brown, slightly dippled; inner bark red, laminated.

Twigs glabrous, lenticellate; leaves paripinnate, up to 20 cm long, with 4-6 pairs of alternate leaflets; leaflets 5-10 cm long, 1.5 cm wide, glabrous on both surfaces, with
Fig. 1. Flowers of *Amesiodendron chinense* (Merr.) Hu — a: part of inflorescence with the male flower at anthesis; b: female flower; c: the bilobed petal of the male flower; d: the bilobed petal of the female flower; e: stamen of the female flower; f: stamen of the male flower; g: transverse section of the ovary.
toothed margin, pink when young, dull green when mature. Inflorescences paniculate, rather erect, terminal and axillary from the distal nodes, with both male and female flowers on the same panicle. Male flowers: sepals 5, valvate; petals 5, bilobed, outer lobe of each petal overlapping the feathery inner lobes; stamens 8(-9), inserted on a raised disc, filaments scantily hairy and exert; anthers dorsifixed and extrorse. Female flowers: smaller than the male flowers, sepals 5; petals 5, bilobed as in the male flowers; stamen short, not exert from corolla; ovary hairy with 3(-4) locules; styles hairy. Nuts developing from 1 - 3 lobes of the ovary, usually hard, dark brown when ripe, dehiscing longitudinally into two; seeds smooth, hard and brown, 2 × 3 cm; germination hypogeal; seedling epicotyl with numerous scale-leaves; seedling leaves in spiral phyllotaxy, each with 2 - 3 pairs of leaflets and a scale-like extension on the rachis tip.

The genus is distinct from others in the Malayan Sapindaceae by the combination of paripinnate leaves and serrate leaflet margins.
SPECIMENS EXAMINED:

Kedah: Everett FRI 14145, Gunong Bungsu Forest Res. (KEP! SING; SAN; K; L; A); Kochummen KEP 98760, Jitra, Bt. Bintang (KEP!)

Perak: Whitmore FRJ 15670, Cameron Highlands Road, 18th milestone (KEP; SING; L); Yap FRI 29392, Cameron Highlands Road, 20th milestone (KEP!)

Selangor: Kochummen FRI 16150, Genting-Gombak Road (KEP!; SING; SAR; K; A), Yap FRI 30656, Gombak Forest Res. (KEP!)

Negri Sembilan: Yap FRI 28488, Kuala Kelawang (KEP!)

Pahang: Burgess FRI 19370, Lipis (KEP!); Kochummen KEP 97776, (KEP!), FRI 2584, Bentong (KEP! SING; K; L; A); Whitmore FRI 229, Bt. Tinggi (KEP! SING; K; L; A)

This species occurs in valleys of hill forests, at 300 - 400 m elevation. Observation on two individuals in the Gombak Forest Reserve, Selangor revealed that flowering and fruit formation extended over a period of about six months. Over 40% of the fruits were found to be viable.

Geographical distribution: Sumatra, Indo-China, Malay Peninsula and South China.

_Litchi_ Sonn.

*Litchi chinensis_ Sonn., Voy. Ind. Or. Chine 2 (1782) 230; Radlk., Pfl. R. Helft. 98 (1932) 914-921. Plate 3

Plate 3. Infructescence of _Litchi chinensis_ Sonn.

_L. chinensis _subsp. _chinensis_, Leenhouts (1978), Blumea 23: 395-403. Medium trees 25-30 m tall, 40-70 cm diameter; crown compact; inner bark orange. Leafy twigs up to 3 mm diameter. leaves paripinnate, 10-20 cm long, with 2-4 pairs of leaflets; rachis glabrous; leaflets stiffly held erect, coriaceous, glaucous below, 6-13 cm long, 2-3 cm wide, midveins distinct below and slightly sunken above, secondary veins inconspicuous, petiolules dark brown to black on drying. Infructescences paniculate, terminal and axillary from distal nodes, rather erect, 8-18 cm long.
Fruits developing from one (rarely two) lobes of the ovary, globose 2.5 × 3 cm, indehiscent; pericarp leathery and muricate (warts up to 1 mm high); arillodes thin but succulent and easily detached; seed ovate with glossy black testa.

Germination hypogeal, seedling leaves paripinnate with one pair of leaflets and scale-like extension of the rachis tip, dull red and limp when young.

The stiffly held coriaceous leaflets that are glaucous underneath separate this genus from the other Malayan Sapindaceae.

**SPECIMENS EXAMINED:**

Kedah: Corner SFN 31543, Jitra (SING!; L) cultivated; Taib KEP 105323, Gunong Inas Forest Res., Kulim (KEP!); Ghazali KEP 105272, Gunong Inas Forest Res. (KEP!); Othman KEP 74976, Sik, Enggang Forest Res. (KEP!)

Penang: Yap FRI 30652, FRI 30653, Botanical Garden, Penang (KEP!) cultivated.

Perak: Chan FRI 19124, Gunong Bubu Forest Res. (KEP!); Wyatt-Smith KEP 76728, Dindings, Lumut Forest Reserve (KEP!)

Trengganu: Mahirden KEP 79825, 37th milestone, Jerangan, Dungun (KEP!)

Negri Sembilan: Loh FRI 17092, Tampin Forest Res. (KEP!; SING; K; L; A) Yap FRI 30451, Bt. Tampin (KEP!), Yap FRI 30696, Bt. Tampin (KEP!)

Selangor: Motan & Sow KEP 52214, Bt. Lagong (KEP!)

Leenhouts (1978) regarded the two species of *Litchi* recorded in Radlkofler (1932) as the same but recognised three subspecies viz. *chinensis*, *javensis* Leenh. and *philippinensis* (Radlk.) Leenh. Comparison with non Malayan specimens annotated by Leenhouts (at the Singapore Herbarium) confirmed that the Malayan specimens belonged to subsp. *chinensis*. In contrast to subsp. *chinensis*, subsp. *philippinensis* has fewer leaflets (2 pairs as opposed to 3 pairs) and has more pronounced warts on the fruit pericarp. The subsp. *javensis* has inflorescences with a few spike-like branches thus differing from the subsp. *chinensis*. In the Malay Peninsula, *L. chinensis* subsp. *chinensis* occurs on ridges of low hills up to 800 m elevation. With the wild form previously only recorded from Indo-China, the present records therefore extend the geographical range of this subspecies further south than was previously known.

*Litchi chinensis* is grown for its highly favoured fruits (popularly known as 'lychee'). The introduction of *Litchi* trees to China is recorded as far back as 100 B.C. and extensive selection for the quality of the fruits has resulted in many cultivars. Three types of flowers are found on the cultivated lychee viz. male, hermaphrodite but functioning as male, and hermaphrodite but functioning as female. These flowers appear consecutively on the same panicle with a very gradual transition from one type to another (Mustard, Liu & Nelson, 1954). The same authors also indicated that a favourable range of temperature and humidity encourages fruit set. This may explain the rarity of flowers and fruits on the cultivated lychee tree in the Malay Peninsula. The discovery of indigenous *Litchi chinensis* in the forests of the Malay Peninsula has important implications for the potential cultivation of this species.
Geographical distribution: Indo China and Malay Peninsula but widely cultivated in subtropical countries.

Acknowledgement

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References


Several Unusual Malesian Diplazia

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Summary

The affinities of four small and deceptively similar species of Diplazium (Filices: Athyriaceae) are discussed. Five names are newly reduced to synonymy and two new combinations are made.

In Genera Filicum, Copeland (1947, p. 151) said he was tempted to describe a new genus for the Malesian diplazia with narrow dark fronds and abundant black paleae, of which he accepted six species. He reiterated his belief that they constitute a well-marked natural group in Fern Flora of the Philippines 3 (1961, p. 412). In 1973 (British Fern Gazette 10: 258) I added what I thought was an additional species and expressed the opinion that my new species provided a link with Diplazium, so that separating the group from that genus would be unjustified.

I have now examined types of what I believe are all relevant names and have seen many other specimens from K, L, MICH, NY, P, PNH, UC, and US, finding that only four species are involved, and that they belong in three different not very closely related lines within the genus Diplazium. However, they agree in the following characters: rhizome short-erect, with thick wiry black roots; fronds narrowly elliptic, pinnate or subpinnate, apex coadunate, segments numerous, usually dark; paleae abundant on stipe and rachis, narrow, usually dark and shiny; veins free. The four species may be distinguished as follows:

Key to the species

1. Fronds pinnate except near apex; rachis blackish beneath paleae
   2. Pinnae lobed or incised; grooves of pinna-costae entering rachis groove; paleae strongly toothed
      1. D. egenolfioides
   2. Pinnae subentire; rachis channel uninterrupted; paleae entire
      2. D. fuliginosum
   1. Fronds pinnatifid except sometimes at the very base; rachis brownish beneath paleae
   3. Paleae blackish, numerous on stipe, rachis, costae, and veins beneath, also present above where costae meet rachis; frond narrowing gradually towards base, drying dark greenish brown
      3. D. lomariaecum
  3. Paleae brown, present on stipe, rachis, and costae beneath; frond not or only moderately narrowed downwards, drying dull greyish brown
     4. D. porphyrorachis


Paleae black, shiny, strongly and regularly toothed, to $8 \times 0.8$ mm, tapering evenly, abundant on stipe and rachis, few on costae beneath. Stipes to 10 cm long. Lamina to $42 \times 15$ cm, narrowly elliptic, fully pinnate nearly throughout. Pinnae to $8 \times 2$ cm, lanceolate, the lowest on stalks to 1 mm, sessile upwards and truncate at base, apex acute, margins cut up to $\frac{3}{4}$ of the way to costa into segments to 6 mm broad. Colour very dark green. Rachis groove above open to and joining grooves of pinna-costae, the raised cartilaginous sides of grooves of pinna-costae joining the sides of the rachis groove, not paleate. Indusia pale brown, margin slightly undulate. Spores pale brown with a broad plane median wing.

**Distribution:** Luzon, the type locality (several collections) and Nueva Vizcaya, Sta. Fe, Mts. N. of Imugan, c. 1200 m. L.L.Co 1460 (MICH, PNH, PUH).

**Notes:** The prevalent type of axis architecture in *Diplazium* is confluent raised cartilaginous ridges bordering the grooves of rachises and costae. Of the four species treated here, only *D. egenolfioides* has this axis character, which immediately links it to the bulk of the genus. Of species with which I am familiar, fairly close to *D. egenolfioides* are *D. banahaense* (Copel.)C.Chr. and *Diplazium symmetricum* (Copel.)Price, comb. nov. (basionym: *Athyrium symmetricum* Copel. Philip. J. Sci. 81 (1952) 41. Lectotype: Philippines, Samar, Mt Cabayanan, Edano PNH 15148, MICH).


Paleae blackish, shiny, brittle, entire, to $6 \times 1$ mm, abundant on stipe, rachis, costae and veins beneath. Stipes to 16 cm long. Lamina very narrowly elliptic, to $79 \times 13$ cm, fully pinnate in at least the lower $\frac{1}{2}$. Pinnae to $8 \times 2$ cm, lanceolate, sessile and truncate at base, apex sharply acute, margins subentire, very thin and translucent. Colour very dark green, when living succulent with a bluish cast. Rachises above concave or channelled but without raised cartilaginous sides, insertion of pinnae not affecting channel, not paleate. Indusia blackish with a thin brown outer edge. Spores pale brown with broad crisped pale anastomosing wings.
Unusual Malesian Diplazia

Distribution: Bismarck Arch. (New Ireland), New Guinea (widespread), North Borneo (Mt Kinabalu, common), Philippines (Leyte, one collection), occurring in shaded moist ravines in montane forests, c. 1000-3000 m.

Notes: Diplazium acrocarpum has sori confined to the pinna-apices but this character is inconsistent and unreliable, as both fully fertile and only apically fertile pinnae may occur on a single frond, for example as in Holttum SFN 25529 from Mt Kinabalu (US). Athyrium longissimum has narrow fronds (c. 5 cm broad) but agrees in all essential characters. Hoogland 9323 (NY) is aberrant in having shallowly lobed pinnae.

D. fuliginosum is one of the most unusual of all diplazia, and was not transferred to that genus until recently. It is strikingly peculiar by the smooth rachis channel without raised sides, uninterrupted by the insertion of pinna-costae. In small fronds, and distally on large fronds, the rachis is almost flat above. Other of its features unusual to Diplazium are sori uniformly extending from costa to margin, and thin translucent pinna-margins.

Rather than to the other three species treated here, I believe that the closest relationship of D. fuliginosum is to D. cumingii (Presl) C.Chr., with which it agrees in dark frond colour and black axes aging to greyish; axes without cartilaginous ridges; paleae on stipe abundant, dark, entire; and indusia black with very narrow pale brown margin, curling back at maturity; even though D. cumingii is very different in its conform frond apex and broadly elliptic pinnae. However, it should be noted that almost exactly the same frond form (and even margin structure) as D. fuliginosum was independently evolved in the Central American D. harrisonii (Bak.) C.Chr., which otherwise differs markedly in paleae and the architecture of the axes.


Paleae blackish, shiny, entire, to 9 × 1 mm, gradually narrowed to a hair-tip, abundant and persistent on stipe, rachis, costae, and veins beneath. Stipes of fertile fronds to 15 cm long, of sterile to 9 cm. Lamina narrowly elliptic, to 50 × 9.5 cm, deeply pinnatifid, one pair of reduced basal pinnae sometimes free and sessile. Lobes to 4.5 × 1 cm, oblong-lanceolate, narrowing towards apex, subentire, blunt. Colour dark greenish-brown, ± shiny below when dry, dark bluish-green when living. Rachises above with a channel formed by raised cartilaginous sides, either continuous or interrupted at each junction with a mid-vein of a lobe, and paleate at that point whether or not interrupted. Indusia brown, margin erose. Spores brown, with irregular short wings.

Distribution: Philippines, including Luzon (Ilocos Norte – Price 2932, Rizal, Quezon), Mindoro, Leyte, Negros, Mindanao, Basilan; Borneo, including Sabah, Sarawak, and Kalimantan; Celebes, Ceram, New Guinea (collected only in North-east), in moist montane forest, 400-2000 m.

Notes: Diplazium merrillii was a small plant only partially fertile. The holotype was destroyed in 1945 at the PNH so I here designate the MICH specimen as lectotype. D. porphyrolepium and D. porphyrophyllum are not exceptional in any way. The latter had a syntype purportedly from Sumatra, Brooks 322S which I have not seen and from where this species is otherwise unknown. I designate the specimen from Ceram at L as lectotype. Athyrium altum is a form with narrow fronds not otherwise distinguishable. Three specimens from eastern Kalimantan (Kostermans 9089, Meijer 577, 872 – all L) differ by having fewer and brownish paleae but agree in distribution of paleae, and in frond form and colour. Diplazium lomariaceum is very closely related to D. porphyrorachis and until now the name seems to have been ignored since Christ himself reduced lomariaceum to porphyrorachis in Ann. Jard. Bot. Buitenz. 15 (1898, p. 119).


Paleae dull brown, entire, to 5 × 0.5 mm, rapidly narrowed to a hair-tip, present on stipe, rachis and costae beneath but relatively inconspicuous. Stipes of fertile fronds to 37 cm, of sterile to 13 cm long. Lamina lanceolate, to 35 × 9 cm, deeply pinnatifid with up to two free pairs of sessile opposite basal pinnae. Lobes to 5.5 × 1 cm, narrowly oblong with mostly parallel sides, apex usually rounded and denticulate, bluntly acute in the largest fronds. Colour dull greyish-brown when dry, dark green when living. Rachises above with a channel formed by raised cartilaginous sides, continuous or interrupted at each junction with the midvein of a lobe, not paleate. Indusia brown, margin erose. Spores pale brown with short irregular translucent wings.

Distribution: Borneo, including Sarawak (where often common), Brunei,
Sabah, and Kalimantan, terrestrial on embankments and petrophytic, in forest shade, 300-1000 m.

Notes: Christensen gave the unpublished varietal name *murudense* to a large specimen narrowed towards the base with long-pointed lobes (Sarawak, Mt Murud, *Sar. Mus. Nat. Coll*. 2937, PNH). Similar specimens have been found on the nearby Gunong Mulu (*M. Hotta 15188*, L) and at Matang (*Sinclair & Kadim 10346*, K).

The two species *D. porphyrorachis* and *D. lomariaceum* are very closely related and some specimens show signs of apparent gene interchange. They were combined by Christensen (1934) but seem to be amply distinct by the characters utilized in the key. I believe that the closest relationship of these two with other species is not at all with the other two treated in this paper, but, of the diplazia I know, with *D. sorzogonense* (Presl)Presl. *D. sorzogonense* has similarities to especially *D. porphyrorachis* in paleae, indusia, spores, frond colour and texture, and the structure of the pinna axes of the former is similar to the rachis structure of the latter.
The Limestone Hill Flora of Malaya IV*

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Angiosperms—Monocotyledons cont.

GRAMINEAE

1. Inflorescence a series of successive nodal spikelet-clusters on a leafless axis. Bamboos ..... 2
   Inflorescence different, paniculate or spicate. Not bamboos ........................................... 3

2. Leaves soft-hairy beneath ................................................................. Dendrocalamus elegans
   Leaves not soft-hairy beneath .............................................................. Dendrocalamus dumosus

3. Inflorescence from the upper leaf-axis, female spikelets enclosed within a hard bead-like sheath
   ......................................................... Coix lacryma-jobi
   Inflorescence different, female spikelets with no bead-like sheath ................................. 4

4. Inflorescence of a single unbranched spike, usually at the end of the stem; or of 2 or more spikes
   radiating from or near the end of the stem; or the inflorescence compact and sparsely branched;
   all branches whorled ................................................................................................................. 5
   Inflorescence different; much branched, paniculate ................................................................ 21

5. Inflorescence of a single spike at the end of stem or upper leaf-axils; or compact and sparsely
   branched, branches whorled ..................................................................................................... 6
   Inflorescence of 2 or more unbranched spikes radiating from or close together at or near the end
   of the stem ................................................................................................................................. 15

6. Inflorescence hairy or bristly, the bristles from the base of spikelets or as awns from the glumes
   or lemmas ................................................................................................................................. 7

7. Inflorescence covered with fluffy hairs ................................................................. Imperata cyllindrica var. major
   Inflorescence different ........................................................................................................... 8

8. Spikelets, each with 2 awns ......................................................................... Pogonantherum paniceum
   Spikelets, each with 1 awn, some without ............................................................................... 9

9. Spikelets in pairs, 1 sessile and 1 pedicelled ......................................................... 10
   Spikelets in groups of threes .................................................................................................... 12

10. Leaf-base narrowed gradually; lower glume of the pedicelled spikelet with a 3 point-tip ....
   .................................................................................................................................................. Dichanthium mucronulatum
   Leaf-base subcordate; lower glume of the pedicelled spikelet truncate .................................... 11

11. Leaves usually less than 0.5 cm wide; spikelets imbricate; nodes of stem glabrous ........
   .................................................................................................................................................. Dichanthium caricosum
   Leaves usually more than 0.5 cm wide; spikelets distantly spaced, axis visible; nodes of stem
   hairy ............................................................................................................................................ Dichanthium annulatum

12. Inflorescence a spike-like raceme; 1 spikelet of each group pedicelled, 2 sessile ..............
   .................................................................................................................................................. Polytrias amaura
   Inflorescence a small panicle, branches in whorls; 2 spikelets in each group pedicelled, 1 sessile 13

* This is the final part. Parts I, II and III appeared in the Gardens’ Bulletin xxx (1977) 165-219, xxxii (1979) 64-203 and xxxv (1983) 137-190, respectively. The author expresses his profound thanks to Dr. Chang Kiaw Lan for her painstaking assistance.
13. Creeping grasses. Leaves to 5 cm long .................................. *Chrysopogon aciculatus*
   Erect grasses. Leaves more than 15 cm long .................................. 14
14. Awns 2-3.5 cm long; leaves to 35 cm long; the joint beneath the 3 spikelets swollen .......... *Chrysopogon fulvus*
   Awns 4-5 cm long; leaves to 20 cm long; the joint beneath the 3 spikelets not swollen .......... *Chrysopogon orientalis*
15. Spikelets with awns ......................................................... 16
   Spikelets without awns .................................................. 18
16. Leaves linear-acuminate, to 20 by 0.3 cm; base not cordate. Only from Langkawi ........... *Eulalia quadrinervis*
   Leaves shorter and broader, more than 0.6 cm wide; base cordate or not ..................... 17
17. Leaf bases gradually narrowed to the petiole; inflorescence of 2 often closely-opposed racemes ........... *Ischaemum timorense*
   Leaf bases cordate; inflorescence of 2-many racemes from the end of a common peduncle ............ *Arthroxon prionodes*
18. Spikelets fringed with fine hairs (from the upper glume) .................................. *Paspalum conjugatum*
   Spikelets not fringed with hairs ........................................................................... 19
19. Spikelets flat, with 4-6 florets arranged alternately ............................................. *Eleusine indica*
   Spikelets not flat, florets 2 .................................................................................. 20
20. Inflorescence single, from the topmost leaf axil; lemma of the upper floret thin, margin flat ........... *Digitaria violascens*
   Inflorescence usually 2, from the topmost leaf axil; lemma of the upper floret thickened, margin inrolled .................. *Axonopus compressus*
21. Inflorescence with fine silky hairs from the spikelets ............................................ 22
   Inflorescence with hairs not silky if present ....................................................... 23
22. Plant tall and reed-like; inflorescence much branched, 30-50 cm long. Florets 4-8, hairs from the lemma .................. *Neyraudia reynaudiana*
   Plant not reed-like; inflorescence smaller, 10-15 cm long. Florets 2, hairs from all over the spikelets, often pinkish .......................................................... *Rynchelytrum repens*
23. Leaves with fine longitudinal pleats .............................................................................. 24
   Leaves not pleated ........................................................................................................ 25
24. Leaves broad, 5 cm or more wide ................................................................................. 25
   Leaves narrower ........................................................................................................... 26
25. Leaves elliptic, usually 20-25 by 5-6.5 cm. Lemmas with 5 or more nerves. Plant to 1 m tall .......................................................... *Leptaspis urceolata*
   Leaves lanceolate, usually 40-45 by 5-6.5 cm. Lemmas with 1-3 nerves. Plant to 3 m tall .......................................................... *Thysanolaena maxima*
26. Spikelets, all or some with awns .................................................................................... 27
   Spikelets without awns, short bristle present or not ................................................... 29
27. Tufted, coarse grass; leaves to 100 cm long ............................................................... *Cymbopogon calcicola*
   Different; leaves shorter ............................................................................................... 28
28. Inflorescence of 3-7 spike-like racemes arranged alternately on the axis. Spikelets in pairs ........... *Opismenus compositus*
   Inflorescence different. Spikelets in ultimate groups of threes ................................... *Apluda mutica*
29. Spikelets with prominent bristles or hairs. Culms tufted ........................................... 30
   Spikelets without prominent bristles or hairs; glabrous or with inconspicuous bristles. Culms scrambling .......................................................... *Panicum sarmentosum*
30. Leaves more than 1.5 cm wide. Spikelets with stiff, backward pointing hairs on the distal half of the lemma of the upper floret .......................................................... *Cenotheca lappacea*
   Leaves narrower, 0.2-0.9 cm wide. Spikelets with soft erect hairs all over the outer surface of the upper glume .......................................................... *Isachne langkawiensis*
Limestone hill flora of Malaya IV


*A. varia* Hack. var. *intermedia* Hack., in DC., Monogr. Phan. 6 (1889) 196; Ridl., Mats. 3 (1907) 164; id., Fl. 5 (1925) 207; Henders., J. Mal. Br. R. As. Soc. 17 (1939) 86.

Slender grass, 1-2 m tall. Leaves pale bluish green, blade to 30 by 1.5 cm. Inflorescence as terminal panicle of numerous racemes with three spikelets each; the lowermost spikelet with an inflated joint.

Distributed in Ceylon, India and Australia. In Malaya, only from the northern half, not common but often on limestone.


Slender decumbent grass, leafy almost to the inflorescence. Blades 3-6 by 0.8-1.5 cm, lanceolate with cordate base. Inflorescence of several slender racemes to 6 cm long. Spikelets paired, one sessile and the other pedicelled. Sessile spikelet 5.5 mm long; the lower glume lanceolate, the upper boat-shaped, both with a wide hyaline margin. Upper lemma with an awn 4.5 mm long. Stamens 3. Pedicelled spikelet awnless, with a short 2-lobed lemma.

Distributed in India. Recorded once from Malaya, from limestone crevices on the summit of Gunong Baling.


*Paspalum platycaulon* Poir., Ridl., Mats. 3 (1907) 125.

Probably the commonest lawn and wayside grass in Malaya. Recorded from disturbed localities on limestone.


**Cenchrus lappaceus** L., Sp. Pl. ed. 2 (1763) 1488.

All over the secondary and disturbed forests. Recorded several times from limestone.


*Andropogon aciculatus* Retz., in Ridl., Mats. 3 (1907) 166.

Common all over Malaya, in lawns, by wayside and in cultivated area. Recorded once from the disturbed summit of Bukit Takun.

**Chrysopogon fulvus** (Spreng.) Chiov., Fl. Somala 1 (1929) 327; Gillil., Fl. Mal. 3 (1971) 237.

Recorded twice in Malaya, once from Pulau Burong in Pahang (not limestone) on dry, sandy or stony soil and the other from limestone on Bukit Wang, Kedah (Haniff 649).


*C. wightianus* (Nees ex Steud.) Thw., in Ridl., Fl. 5 (1925) 208.

*Andropogon wightianus* Nees ex Steud., in id., Mats. 3 (1907) 167.

Recorded in Malaya from limestone in Langkawi and from sandy coastal areas of the east coast. Like *C. fulvus*, this is a species of dry, well-drained, open localities.


Common in Malaya, in cultivation or in wasteland near villages. Recorded from limestone near the railway station at Merapoh in Pahang, probably an escape from nearby villages.


Culms tufted. Blades linear, to 100 by 1.5 cm. Inflorescence a much branched panicle, characterised by numerous brown spathes each subtending a pair of spike-like racemes.

Distributed in peninsular Thailand. Recorded in Malaya from Kedah and Pahang; abundant on the exposed rocky slope of Bukit Chintamani. Restricted to limestone. Faintly but distinctly scented.


Culms to 5 m long and 2.5 cm thick. Culm-sheaths to 18 cm long; auricles small, bristly; ligule 1.5 mm tall, toothed. Blades usually 18 by 1.8 cm, sometimes larger. Spikelets, 1-flowered, tufted at nodes of slender leafless branches. Palea 7 mm long, 7-veined, thin, not keeled. Stamens 3-6; ovary glabrous.

Distributed in the southern Thai islands. In Malaya from Langkawi and mainland Kedah, probably restricted to limestone. Resembles *D. elegans* (which see).


Culms to 6 m long and 2.5 m diameter. Internodes to 26 cm long; culm-sheaths not seen. Blades to 12 by 1.2 cm, lower surface densely short hairy. Auricle small; ligule short. Spikelets in dense tufts at nodes of inflorescence branches, about 8 mm
long, glabrous. Florets 1 or 2; lemma of upper floret 7 mm long. Palea of lower floret 2-keeled, short-hairy on the keels. Upper palea 4-veined. Anthers 6. Ovary smooth; style slender, stigma plumose.

So far known only from Langkawi and probably restricted to limestone. (The original plant from which the species was described is cultivated at the Penang Botanic Gardens, but with the source unknown. Subsequent collections have all been from limestone).

This species is very much like *D. dumosus* but differs in the hairy leaves, the 6 instead of 3-6 stamens, the glabrous upper half of the ovary and the frequent presence of 2 florets with the lower palea keeled and the upper with 4 instead of about 7 veins. However, in one specimen (*Chin 523*), the leaves are glabrous, the stamens number 3-6 and the upper palea has 4-7 veins, yet the upper half of the ovary is glabrous and there are 1-2 florets.

The position of these two species would be clearer if more specimens were examined; there is possibly a gradation of morphological characters from one species to the other.


Slender, branched, erect grass to 1 m tall. Blades to 30 by 0.8 cm. Inflorescence 1-several spike-like racemes from almost every leaf-sheath.

Distributed in Africa, India, Burma and Borneo. In Malaya restricted to limestone and then only found in Kedah and Selangor; the note in Gilliland, l.c., that it has been recorded from Singapore is an error and could have been intended for *D. mucronulatum* (which see).


*Andropogon caricosus* L., Sp. Pl. ed. 2 (1763) 1480.


Slender grass to 75 cm tall. Blades narrowly linear to 30 by 0.3 cm, glabrous. Inflorescence a terminal spike-like raceme about 2.5 cm long. Spikelets in pairs, one sessile, one pedicelled. Sessile spikelet with lower glume 7-nerved and margin inflexed, the upper glume 3-nerved. Pedicelled spikelet with the lower glume tipped with 3 points.

Endemic to limestone in Malaya. Ridley recorded that this species appeared in the Singapore Botanic Gardens, and, apart from this very unusual occurrence (details not available) this species has been recorded only from Pahang and Selangor. A plant of dry rocky and exposed or partially exposed places.


*D. chinensis* sensu Ridley, Fl. 5 (1925) 215, *non* Hornem.
Pan-tropical. Found all over Malaya from the lowlands and hills to 1600 m. Recorded once from the disturbed summit of Bukit Takun, and according to Ridley from Gua Batu.

*Eleusine indica* (L.) Gaertn., Fruct. 1 (1788) 8; Ridl., Mats. 3 (1907) 174; id., Fl. 5 (1925) 250; Gillil., Fl. Mal. 3 (1971) 78.

*Cynosurus indicus* L., Sp. PI. (1753) 72.

A common grass all over Malaya in open places and a weed of cultivation. Recorded once from the disturbed summit of Bukit Takun.

*Eulalia quadrinervis* (Hack.) Ktze, Rev. Gen. Pl. 2 (1891) 775; Gillil., Fl. Mal. 3 (1971) 244.

*Pollinia quadrinervis* Hack., DC., Monog. Phan. 6 (1889) 158.

*Culms slender, densely tufted, 50-100 cm tall. Blades linear to 20 by 0.3 cm. Inflorescence of 3-6 racemes arranged subdigitately at the end of a peduncle.

Distributed in India, Burma, Thailand and China. (Restricted to the limestone in Langkawi, Malaysia.)


Widespread everywhere in Malaya, often on disturbed summits of limestone hills.

*Isachne langkawiensis* Jansen, Reinw. 2 (1953) 284; Gillil., Fl. Mal. 3 (1971) 120.

Tufted, slender grass to 40 cm tall. Blades 2-8 by 0.2-0.9 cm. Inflorescence a terminal panicle 5-12 by 4 cm, with many very fine branches. Spikelets ovate, upper glume with many rows of hairs with bulbous base.

Endemic to the limestone in Langkawi, often abundant in open places with little moisture and thin soil cover. Distinguished by the finely hairy leaves and the very finely bristled upper glume.


*Ischaemum timorense* Kunth, Rev. Gram. 1 (1830) 369; Ridl., Fl. 5 (1925) 203; Gillil., Fl. Mal. 3 (1971) 264.

*I. macrurum* Stapf. ex Ridl., Fl. 5 (1925) 203.


*Pharus urceolatus* Roxb., Fl. Ind. 3 (1832) 611.

Distributed in lowland and hill forest, recorded once from limestone (Gunong Pondok, Perak, Chin 886).

Triraphis madagascariensis sensu Ridley, Fl. 5 (1925) 251.

Common in the North as a grass of open wastelands. It has been collected as part of secondary vegetation on dry summits of limestone. On the top of Gua Musang, Kelantan, it was common (in 1971) about 1½ years after a fire had destroyed the original vegetation and on the Perak Cave Temple limestone (in 1971) it formed a prominent part of the vegetation in the disturbed areas. Though frequently recorded as a grass of damp ground it tolerates the dry conditions on limestone very well, growing in soil pockets amidst boulders.


A true forest grass of lightly shaded places; common in the northern part of Malaya and recorded from limestone in Langkawi, Kedah mainland and Perlis only.

Panicum sarmentosum Roxb., Fl. Ind. 1 (1820) 311; Ridl., Fl. 5 (1925) 227; Gillil., Fl. Mal. 3 (1971) 139.


Widespread in lawns, waysides and cultivated ground. Recorded from disturbed areas on limestone.


P. saccharoideum Beauv., in Ridl., Fl. 5 (1925) 195.

Common in Malaya by rocky streams, growing from rock crevices, on steep earth banks and other rocky places. Recorded several times from limestone.

Polytrias avara (Buese) Ktze, Rev. Gen. Pl. (1891) 788; Gillil., Fl. Mal. 3 (1971) 244.


Eulalia praemorse (Nees) Stapf. ex Ridl., Fl. 5 (1925) 197.


Saccharum repens Willd., Sp. Pl. 1 (1798) 322.


S. plicata sensu Ridl., Fl. 5 (1925) 236, non Cooke.
**Stenotaphrum helferi** Munro ex Hk.f., F.B.I. 7 (1896) 91; Ridl., Fl. 5 (1925) 220; Henders., J. Mal. Br. R. As. Soc. 17 (1939) 87; Gillil., Fl. Mal. 3 (1971) 205.


**Agrostis maxima** Roxb., Fl. Ind. 1 (1820) 319.

**T. agrostis** Nees, in Ridl., Fl. 5 (1925) 241.

**Dubious Record**


An endemic species and according to both Ridley and Gilliland l.c., recorded only from Kedah Peak (not limestone). Henderson however, mentions that it is known from Langkawi limestone. I have not seen any specimens of this plant from limestone and believe that Henderson was mistaken.

**NOTE**

**HYDROCHARITACEAE**

**Hydrilla verticillata** (L.f.) Roy.

Widely distributed in the Old World tropics and the sub-tropics, common in most permanently wet places. Recorded from Tambun, Perak in a stream underlain by limestone.

**HYPOXIDACEAE**


**LILIACEAE**

1. Plant scandent, stem long; leaves reduced to scales and with needle-like branches (cladodes) in the axils .............................................................. *Asparagus racemosus*

   Plant not so, stem short; leaves large, elliptic to lanceolate, cladodes absent .......................... 2

2. Leaves slightly plicate with prominent longitudinally parallel veins, elliptic-lanceolate, to about 30 cm long, often less .............................................................. 3

   Leave not plicate, veins not so, lanceolate, usually about 60 cm long ................................. 4

3. Flowers greenish with shades of purple. Fairly common on limestone ... *Peliosanthes lurida*

   Flowers deep purple. Rare on limestone .............................................................................. *Peliosanthes violacea*

4. Flowers pedicelled, white, perianth lobes linear-acuminate; inflorescence a raceme or panicle.

   Leaves about 60 by 5 cm; petioles not distinct ............... *Chlorophytum orchidastrum*

   Flowers sessile, dark purple, perianth lobes broad and short; inflorescence a spike. Leaves about 60 by 10-15 cm; with a long narrowly winged petiole .......................... *Tupistra grandis*

Plant, scandent. Leaves reduced to scales. Racemes solitary or fascicled, sometimes branched. Flowers small, 0.2-0.3 cm across.

Distributed in Africa, across to India, SE Asia and southwards to Java and Australia. A very rare plant in Malaya, and so far known only from a single collection from Langkawi on the limestone. (Curtis 1674).

Chlorophytum orchidastrum Lindl., Trans. Hort. 6 (1825) 79; Ridl., Fl. 4 (1924) 327.


Endemic to Malayan, not uncommon in rocky forest and on limestone, usually in shaded spots.

Peliosanthes violaceae Wall., Cat. (1831) 5084; Bak., J. Linn. Soc. Bot. 17 (1880) 502; Hk.f., F.B.I. 6 (1894) 266; Ridl., Fl. 4 (1924) 324.


Endemic to Malaya and apparently quite rare. Molesworth-Allen reports that the inflorescence smells strongly of male cats! It has been collected twice from limestone (in Kedah and Kelantan).

LOWIACEAE


Endemic and uncommon; probably abundant locally, as in the forest at the University of Malaya Field Study Centre (270 m) at Gombak, off the 16th mile Gombak Road, Selangor. (Sporadic flowering late April and early May, 1972). Recorded once from limestone (Henderson 26023), Lenggong, Upper Perak).

MARANTACEAE

Stemless. Petioles to more than 100 cm; flower pairs without bracteoles .......................... Stachyphrynium cylindricum

Stems 200-300 cm. Petioles much shorter; flower pairs subtended by small bracteoles .......

............................................. Donax grandis


Plants tufted; leaves from the base, at ground level; petioles to 120 cm long, blade to 60 by 20 cm. Inflorescence on an erect scape from the base of plant, spicate with 2 rows of overlapping bracts.

Endemic to limestone in Malaya, rare; recorded from Kelantan, Perak and Kedah.

MUSACEAE


This variety is recorded from limestone and is known only from Perlis; it is the only Musa collected from limestone.

Cheesman in Kew Bull. 3 (1948) 17-28, has reduced M. malaccensis Ridl., together with M. truncata Ridl., and M. zebrina Van Houtte ex Planch. to M. acuminata Colla. Used in this sense M. acuminata is a very widespread species in Malesia; it is then very variable, and as yet there are no attempts to subdivide it, apart from the original consideration of three species. M. malaccensis sensu stricto, on the other hand, occurs only in the forest of Malacca, Selangor and Perak in Malaya where it is common. The var. minor Ridl. however, could be specifically distinct, but this needs more study.

M. acuminata sensu lato is, however, not to be found on precipitous cliffs or on the pinnacled domes of hills though it has been frequently seen on the bases of hills in partly shaded localities with accumulation of some soil and debris.

ORTHIDACEAE

An introductory key is provided. The numbers on the right hand side refer to the ones in the main key with which one should continue.

In the main key at lead 5 a little difficulty may be experienced in deciding whether to go on to No. 6, "plant terrestrial or on rocks; not with a climbing stem", or to No. 38, "plant epiphytic or with a climbing stem ...."

Plants with a climbing stem pose no problems, however plants without a distinctive climbing stem may prove difficult, as epiphytes have been frequently found growing on rocks and roots at ground level, this being especially so on hill tops with a dense herbaceous and mossy ground flora. However, if such plants are also commonly found as epiphytes on the limestone hills and tend to be epiphytic outside the limestone field according to past records, then they are included under lead No. 38.
There are some plants which are generally regarded as epiphytes or rockplants; however, if on the limestone they are more frequently found on rocks, then they are included under lead No. 6. *Coelogyne asperata* and *Coelogyne pandurata* form very good examples in this category.

Finally there are those plants usually epiphytic which are very rare on the limestone, having been collected only once or twice; and if they are recorded from the limestone only as growing on rocks and roots at ground level, then, of course, they have been included under lead No. 6.

**INTRODUCTORY KEY**

1. Plant with a single leaf or leaflets ........................................ 2  
   *Corybas, Taeniophyllum*

1. Plant different

2. Plant terrestrial or on rocks; not with a climbing stem

3. Lip with a large pouch ...................................................... 6  
   *Paphiopedilum nivenum*

3. Lip not so

4. Plant with a prominent tuber and erect leafy stem ...................... 8  
   *Habenaria*

4. No tuber; pseudobulbs may be present

5. Pseudobulbs absent; growth not regularly sympodial ................... 12  
   *Eria vestita, Vandopsis gigantea, Thunia alba, Goodyera hispida, Corymborchis, Malaxis*

5. Pseudobulbs present or not; growth sympodial

6. One leaf on each shoot of the sympodium ................................ 23  

6. Two or more leaves on each shoots of the sympodium

7. Shoots forming long leafy stems ........................................ 26  
   *Tropidia curculigoides, Dendrobium salaccense*

7. Shoots not forming long leafy stems

8. Leaves about 1 cm wide .................................................... 28  
   *Eulophia keithii, Cymbidium dayanum*

8. Leaves more than 1 cm wide ............................................... 29  
   *Calanthe, Coelogyne, Spathoglottis hardingiana, Geodorum citrinum, Cymbidium finlaysonianum*

2. Plant epiphytic or with a climbing stem

9. Plant monopodial

10. Leaves closely 2-ranked with overlapping bases ....................... 39  
    *Dipodium pictum*

10. Plant different

11. Stem short, leaves close, laterally flattened .......................... 41  
    *Microsaccus*

11. Plant different

12. Flowers lasting 1 day; producing one or a few at a time ............. 44  
    *Pteroceras, Thrixspermum, Ascochilopsis myosurus*
12. Flowers lasting longer; usually many opening together

13. Leaves terete ................................................................. 50
   Sarcanthus

13. Leaves not terete

14. Upper sepal more than 2 cm long ................................. 52
   Arachnis flos-aeris, Staurochilus fasciatus

14. Upper sepal 2 cm long or less

15. Flowers with lip at the top; on erect inflorescences ............ 54
   Acampe longifolia, Camarotis apiculata, Pomatocalpa

15. Flowers with lip at the bottom if inflorescence erect

16. Inflorescence producing 1-4 flowers .............................. 61
   Adenoncos, Uncifera tenuicaulis, Trichoglottis

16. Inflorescence producing more than 4 flowers ................... 67
   Aerides odoratum, Renanthera, Phalaenopsis, Sarcanthus, Schoenorchis micrantha, Abdominea minimiflora, Pomatocalpa spicatum, Malleola

9. Plant sympodial

17. Pseudobulbs or stems with 1 leaf

18. Inflorescence from the top of pseudobulbs ........................ 82
   Ceratostylis pendula, Dendrobium, Pholidota pallida, Liparis

18. Inflorescence from the side or base of pseudobulbs or from the rhizome ........ 87
   Thecostele alata, Bulbophyllum, Thelasis

17. Pseudobulbs with 2 or more leaves

19. Pseudobulbs with 2 leaves

20. Flowers solitary from the pseudobulbs, or opening singly, or 2-3 from an inflorescence ................................. 98

20. Flowers more than 3 opening together .......................... 102

19. Pseudobulbs with more than 2 leaves

21. Stem and leaves laterally flattened .............................. 104
   Hippeophyllum scortechinii, Oberonia, Dendrobium

21. Stem and leaves not laterally flattened.

22. Leaves terete ............................................................. 117
   Dendrobium setifolium

22. Leaves not terete

23. Stems with a swollen base of 2 internodes, the rest slender ........ 118
   Dendrobium planibulbe

23. Stems not so

24. Stems with leaves at apex only, lower part long and bare ....... 120

24. Stems not so

25. Stems over 5 cm long

26. Inflorescence a terminal dense head ............................ 123
   Agrostophyllum majus

26. Inflorescence different
27. Lip with 1-2 appendages near its base  
    
    *Podochilus, Appendicula, Dendrobium*

27. Lip with no appendages

28. Inflorescence terminal or subterminal  
    
    *Eria citrina, Agrostophyllum*

28. Inflorescence lateral  
    
    *Poaephyllum pauciflorum, Eria*

25. Stems under 5 cm long  
    
    *Paphiopedilum lowii, Polystachya flavescens, Phreatia secunda, Thelastis*

**ORCHIDACEAE – MAIN KEY**

1. Plants with a single leaf or without leaves  
   Plants with more than one leaf

2. Leaf present, single, heart-shaped to 2 cm long  
   *Corybas mucronatus*

   Leaves absent, or reduced to tiny brown scales; stem very short, roots, green, long and spreading. Epiphytes

3. Bracts in 2 ranks  
   Bracts not in 2 ranks, facing all ways, scape to 3 cm long  
   *Taeniophyllum culiciferum*

4. Anther with a short beak; lip not lobed  
   Anther with a long beak; lip slightly lobed  
   *Taeniophyllum obtusum, Taeniophyllum filiforme*

5. Plants terrestrial or on rocks, not with a climbing stem  
   Plants epiphytic or with a climbing stem, sometimes terrestrial

6. Lip with a large pouch, lateral sepals united. From the extreme north. A slipper orchid  
   Not so  
   *Paphiopedilum niveum*

7. Plant with a prominent root-tuber, erect leafy stem and terminal inflorescence  
   No tuber; but may have a prominent pseudobulb (stem structure, with scale leaves or their scars)

8. Spur of lip shorter than sepals and petals. Only from Langkawi  
   *Habenaria goodyeroides*

   Spur of lip longer than sepals and petals

9. Side lobes of lip nearly as broad as long. Only from Langkawi  
   *Habenaria carnea*

   Side lobes of lip very narrow

10. Upper edge of lateral sepals 6 mm wide. Only from Perak  
    Upper edge of lateral sepals 8-10 mm wide  
    *Habenaria kingii, Habenaria reflexa*

11. Pseudobulbs absent; growth not regularly sympodial  
    Pseudobulbs present, growth sympodial, or plant with underground rhizome bearing a succession of leaves and inflorescences

12. Plant to 200 cm tall; covered by red brown hairs, upper sepal over 2 cm long  
    *Eria vestita*

   (Other *Eria* spp. are chiefly collected as epiphytes)

13. Stems very fleshy, leaves strap-shaped or stems close together, to 60 cm tall, with many thin leaves 20 by 5 cm  
    Stems not fleshy, if fleshy not tall and erect, not with many thin leaves

14. Leaves very fleshy, 35 by 6 cm. Stem very stout, erect, short or to 30 cm; sepals and petals 2.5-3 cm, fleshy. On rocks from Langkawi  
    *Vandopsis gigantea*

   Leaves thin 20 by 5 cm, stem fleshy, erect to 60 cm tall; flowers at the end of stems. Only from Setul, and peninsular Thailand  
    *Thunia alba*
15. Flowers with lip at the bottom ................................................. 16
Flowers with lip at the top ......................................................... 19
16. Herbaceous, less than 20 cm tall. Leaves small, flushed with pink ........ Goodyera hispida
Woody; more than 50 cm tall. Leaves larger, green ................................ 17
17. Plants to 60 cm tall; column about 8 mm long. Very rare, endemic .......... Corymborchis brevistylistis
Plants more than 120 cm tall; column more than 2 cm long ..................... 18
18. Sepals and petals about 2.5 cm long; column about 2 cm long .......... Corymborchis rhytidocarpa
Sepals and petals 3-5 cm long; column about 3-4 cm long ....................... Corymborchis veratrifolia
19. Lip without auricles ......................................................... Malaxis latifolia
Lip with auricles ............................................................................. 20
20. Apex of lip not toothed. Endemic and very rare, only from Perlis ........ Malaxis reniloba
Apex of lip toothed .......................................................................... 21
21. Teeth, only 2 ............................................................................. 22
Teeth, 4-6. Once from Pahang ......................................................... Malaxis calophylla
Malaxis micrantha ........................................................................... 23
22. One leaf on each shoot of the sympodium ........................................ 24
Leaves 2 or more on each shoot of the sympodium ................................... 25
23. Bracts in 2 close opposite ranks ................................................... 26
Bracts not in 2 close opposite ranks .................................................... Liparis caespitosa
24. Leaf to 35 by 3 cm; lip 1 cm wide. Doubtfully from Kelantan ............ Liparis compressa
Leaf to 20 by 0.8 cm; lip 3.5 mm wide. Common in Pahang and Kelantan .......... Liparis gibbosa
25. Shoots forming long leafy stems ................................................... 27
Shoots not forming long leafy stems .................................................... 28
26. Inflorescence of more than 2 flowers; leaves 14-22 by 2.5-5 cm .......... Tropidia curculigoides
Inflorescence of 2 flowers; leaves narrower; plant grass-like ............... Dendrobium salaccense
27. Leaves about 1 cm wide. Only from the extreme north ................. 29
Leaves more than 1 cm wide ........................................................... 30
28. Pseudobulbs prominent, about 10 cm long, ovoid, green and shining .... Eulophia keithii
Pseudobulbs not obvious .................................................................... Cymbidium dayanum
29. Lip with a prominent spur .......................................................... 31
Lip without a prominent spur; spur sometimes not developed at all ........ 32
30. Plant flowering when leafless ...................................................... 33
Plant never leafless ............................................................................ 34
31. Flowers white, midlobe of lip as broad as the width of the side lobes .... Calanthe vestita
Flowers pink, midlobe of lip much narrower than the width of the side lobes ...................................................................................... 35
32. Spur less than 3 cm long; leaf blade to 50 cm long. The most common species of Calanthe on limestone .......... Calanthe triplicata
Spur 3-5 cm long; leaf blade about 30 cm long. On limestone, only from Pahang ........ Calanthe ceciliae
33. Leaves 2 to each pseudobulb ......................................................... 36
Leaves more than 2 to each pseudobulb ............................................... 37
34. Leaves less than 20 cm long. Once from limestone in Selangor .......... Coelogyne pallens
Leaves more than 20 cm long, usually more than 40 cm long .................. 38
35. Flowers creamy white, with brown markings. From limestone in Kelantan  
   Coelogyne asperata
   Flowers greenish with black markings  
   Coelogyne pandurata
36. Leaves to about 15 cm long, pseudobulbs, small, rounded.  
   Spathogolottis hardingiana
   Leaves larger, to 30 cm long and 7-10 cm wide, or longer and narrower  
   37
37. Leaves to 30 cm long and 7-10 cm wide; pseudobulbs rounded, subterranean. On limestone only  
   from Langkawi  
   Geodorum citrinum
   Leaves more than 50 cm long, about 4 cm wide; thick and fleshy; pseudobulbs long and completely hidden by the sheathing leaf bases  
   Cymbidium finlaysonianum
38. Plants monopodial, apical growth of stem continuing indefinitely  
   Plants sympodial, apical growth of stem not continuing indefinitely, ending in a pseudobulb with leaves or flowers or both  
   39
39. Leaves to 25 by 2 cm, closely 2-ranked, with overlapping bases, blades curved outwards; sepals and petals with crimson blotches on the outside. Once from limestone, Pahang  
   Dipodium pictum
   Plant different  
   40
40. Stem short, leaves close, fleshy and laterally flattened; flowers small, in pairs  
   Plant not so  
   41
41. Stem with leaves about 1 cm across; from Selangor and Pahang  
   Microsaccus brevifolius
   Stem with leaves 1.8 cm or more across  
   42
42. Lip much narrower than spur, petals wider than sepals; on limestone from Pahang  
   Microsaccus ampullaceus
   Lip not much narrower than spur, petals about as wide as sepals; common on Bukit Takun, Selangor  
   Microsaccus javensis
43. Flowers short-lived, lasting one day, produced one or few at a time at the end of the inflorescence  
   Flowers lasting longer, usually many opening together  
   44
44. Lip loosely hinged, movable, distinct from the column foot  
   Lip not so; immovable, not distinct from the column foot  
   45
45. Inflorescence-scape glabrous, to 10 cm. On limestone in Kelantan and Pahang  
   Pteroceras hirsutum
   Inflorescence-scape minutely prickly, 2-4 cm long  
   46
46. Sepals and petals spotted crimson, sepals prominently hairy  
   Pteroceras hirsutum
   Sepals and petals not spotted, not hairy  
   Pteroceras ciliatum
47. Bracts 2-ranked, alternating; rachis to 10 cm. On limestone only from Perlis  
   Thrisspermum amplexicaule
   Bracts not 2-ranked; rachis shorter  
   48
48. Scapes to 15 cm long, bracts 3-4 mm long, acute.  
   Thrisspermum album
   Scapes 2-5 cm long, bracts minute, on a thick rachis bearing very small flowers  
   Ascochilopsis myosurus
49. Leaves circular in transverse section  
   Leaves not circular in transverse section, not terete  
   50
50. Leaves grooved; midlobe of lip 6 mm wide at the base  
   Sarcanthus machadonis
   Leaves not grooved; midlobe of lip narrower. Only from the extreme north  
   Sarcanthus sacculatus
51. Upper sepal more than 2 cm long; plant with a long climbing stem  
   Arachnis flos-aeris
   Upper sepal 2 cm long or less  
   52
52. Lip loosely hinged, freely movable; leaves to 17 by 5 cm. The scorpion orchid  
   Lip not so movable; leaves to 12 by 2.5 cm. Only from the extreme north  
   Staurochilus fasciatus
53. Flowers with the lip at the top, on erect inflorescences
   Flowers with the lip at the bottom, if inflorescence is erect

54. Stem stout, often branching, leaves thick and stiffly ascending to 20 by 3.5 cm. Inflorescence-stout. Lip of flower not spurred. Only from Langkawi. \textit{Acampe longifolia}
   Plant different; lip deeply saccate or spurred

55. Spur with a 2-lobed callus attached below the midlobe; rostellum with a long beak; leaves to 9 by 1 cm
   \textit{Camarotis apiculata}
   Spur without calluses; back wall of spur with an erect tongue

56. Stem short, internodes under 1 cm long
   Stem long-climbing, internodes 2-3 cm long

57. Flowers pinkish, inflorescence minutely hairy \textit{Pomatocalpa kunstleri}
   Flowers yellowish, inflorescence not hairy

58. Sepals and petals with a red margin \textit{Pomatocalpa latifolium}
   Sepals and petals without a red margin. From limestone of the extreme north, in peninsular Thailand \textit{Pomatocalpa setulense}

59. Sepals and petals with a red margin; leaves usually 2.5-4 cm wide
   Sepals and petals without a red margin; leaves usually 1.5-2.5 wide

60. Inflorescence producing 1-4 flowers
   Inflorescence producing more than 4 flowers

61. Lip shallowly saccate at the base, papilllose or with a callus
   Lip deeply saccate or spurred, entrance to the spur often hairy

62. Rachis of inflorescence zigzag, to 8 mm long, bearing 3-4 flowers \textit{Adenoncos sumatrana}
   Rachis of inflorescence not so, very short, bearing 1-2 flowers

63. Leaves to 7 by 1 cm; slightly constricted near the acute tip; upper sepal to 5 mm long
   \textit{Adenoncos major}
   Leaves and flowers smaller. Only from Selangor, at Gua Batu \textit{Adenoncos parvisflora}

64. Lip, upper half of midlobe turned up, the tip with 2 small lobes \textit{Uncifera tenuicaulis}
   Lip, midlobe simple or 3 lobed; never 2-lobed

65. Midlobe of lip 3-lobed \textit{Trichogolottis winkleri}
   Midlobe of lip simple

66. Midlobe hairy, 9 mm long. Common \textit{Trichogolottis repusa}
   Midlobe not hairy, 5 mm long. Only in the very North \textit{Trichogolottis misera}

67. Spur turned up in front like a horn, flowers with purple markings, upper sepal about 1.2 cm long
   \textit{Aerides odoratum}
   Spur if present not so, usually saccate

68. Flowers red or yellow with red spot
   Flowers not so coloured

69. Column slender, curved; leaves fleshy, stiff and sharply pointed \textit{Renanthera histrionica}
   Column short; leaves bilobed at the tip. Only once from limestone, in Kedah \textit{Renanthera elongata}

70. Lip not spurred, sometimes slightly saccate, with a forked appendage
   Lip spurred or saccate, with no forked appendages

71. Flowers alternate, 2 ranked; rachis of inflorescence flattened; upper sepal 1.6-2 cm long
   \textit{Phalaenopsis cornu-cervi}
   Flowers not so, facing all ways; rachis not flattened; upper sepal 6.5-8.5 mm long
   \textit{Phalaenopsis decumbens}

72. Callus present, closing the entrance to the spur of lip
   No such callus
<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Scientific Name</th>
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<td>73</td>
<td>Stem to 30 cm or more long; leaves well spaced</td>
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<td>74</td>
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<td>Stem much shorter, leaves close together</td>
<td></td>
<td>75</td>
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<tr>
<td>74</td>
<td>Leaves to 30 by 1.5 cm, fleshy, constricted at about 2.5 cm from the tip</td>
<td><em>Sarcanthus subulatus</em></td>
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<tr>
<td></td>
<td>Leaves shorter and broader, constricted at about 1 cm from the tip</td>
<td><em>Sarcanthus scortechinii</em></td>
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<td>75</td>
<td>Inflorescence pendulous, to 25 cm long; stem to 6 cm long, stout. Only from Perak</td>
<td><em>Sarcanthus termissus</em></td>
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<tr>
<td></td>
<td>Inflorescence short to 1.5 cm long; stem to 15 cm long, slender. Only from Kelantan</td>
<td><em>Sarcanthus rugulosus</em></td>
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<tr>
<td>76</td>
<td>Inflorescence erect or horizontal</td>
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<tr>
<td></td>
<td>Inflorescence drooping or pendulous</td>
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<td>78</td>
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<td>77</td>
<td>Leaves 5 mm wide or less. Stem to 15 cm long, much branched, tufted. Only from Gu Batu</td>
<td><em>Schoenorchis micrantha</em></td>
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<td></td>
<td>Leaves more than 1 cm wide. Stem very short</td>
<td><em>Abdominea minimiflora</em></td>
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<td>78</td>
<td>Stem very short, leaves leathery to 18 by 4 cm; a tongue present on the back wall of the spur</td>
<td><em>Pomatocapla spicatum</em></td>
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<td>79</td>
<td>Stem and leaf sheaths flattened, leaves green. Only from Perak</td>
<td><em>Malleola undulata</em></td>
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<tr>
<td></td>
<td>Stem and leaf sheaths not flattened; leaves usually flushed with purple</td>
<td><em>Malleola dentifera</em></td>
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<tr>
<td>80</td>
<td>Pseudobulbs or stems with 1 leaf</td>
<td></td>
<td>81</td>
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<td>Pseudobulbs or stems with 2 leaves</td>
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<td>Pseudobulbs or stems with more than 2 leaves</td>
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<tr>
<td>81</td>
<td>Inflorescence from the top of pseudobulb</td>
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<tr>
<td></td>
<td>Inflorescence from the base or side of pseudobulb, or from the rhizome between pseudobulbs</td>
<td>87</td>
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<tr>
<td>82</td>
<td>Flowers 1-several on short individual stalks</td>
<td></td>
<td>83</td>
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<tr>
<td></td>
<td>Flowers 1-numerous on an inflorescence with a distinct peduncle</td>
<td></td>
<td>85</td>
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<tr>
<td>83</td>
<td>Stems with pseudobulbs distinctly fleshy, not entirely covered by leaf sheaths</td>
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<td>84</td>
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<tr>
<td></td>
<td>Stems slender not bulbous, covered by leaf sheaths</td>
<td><em>Ceratostylis pendula</em></td>
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<td>84</td>
<td>Blades of midlobe abruptly widened, whole lip purple-spotted</td>
<td><em>Dendrobium luxurians</em></td>
<td></td>
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<tr>
<td></td>
<td>Blade of midlobe gradually widened, side lobes and base of midlobe with purple spots</td>
<td><em>Dendrobium plicatil</em></td>
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<td>85</td>
<td>Bracts in 2 close opposite rows; inflorescence with 1-3 flowers opening together</td>
<td><em>Pholidota pallida</em></td>
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<tr>
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<td>Bracts different; inflorescence with numerous flowers opening together</td>
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<td>86</td>
<td>Leaf to 35 by 3 cm; lip 1 cm wide. Once doubtfully recorded from limestone</td>
<td><em>Liparis compressa</em></td>
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<td></td>
<td>Leaf to 20 by 0.8 cm; lip 3.5 mm wide</td>
<td><em>Liparis gibbosa</em></td>
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<td>87</td>
<td>Lip joined at its base to an outgrowth from the column to the column-foot; inflorescence pendulous with many flowers. Leaf stalk grooved.</td>
<td><em>Thecostele alata</em></td>
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<td></td>
<td>Lip not so</td>
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<tr>
<td>88</td>
<td>Flowers solitary</td>
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<td></td>
<td>Flowers at least 2 per inflorescence</td>
<td></td>
<td>91</td>
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<tr>
<td>89</td>
<td>Rhizome slender, much branched</td>
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<tr>
<td></td>
<td>Rhizome different, pseudobulbs to 2 cm apart, 1.5 cm long; leaf to 16 by 2.5 cm</td>
<td><em>Bulbophyllum pulchellum</em></td>
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<tr>
<td>90</td>
<td>Leaves very fleshy, usually 2 by 0.7 cm, pseudobulbs 3 mm long, appressed to rhizome</td>
<td><em>Bulbophyllum sessile</em></td>
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<td></td>
<td>Leaves thin, usually 3.5 by 2 cm, pseudobulbs 1 cm long</td>
<td><em>Bulbophyllum membranaceum</em></td>
<td></td>
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</tbody>
</table>
91. Pseudobulbs hardly noticeable, leaves to 23 by 3.5 cm with a 6-cm stalk .................. \textit{Bulbophyllum apodum}  
Pseudobulbs distinct, small or large .................................................. 92

92. Pseudobulbs large to 6 cm long, ovoid, fleshy; inflorescence to 15 cm long ............. \textit{Bulbophyllum lilacinum}  
Pseudobulbs smaller ................................................................................. 93

93. Leaves almost terete, to 15 cm long and 1 cm wide, rarely with a second shorter leaf .... \textit{Thelasis succosa}  
Leaves different .................................................................................. 94

94. Pseudobulbs broader than tall, oblong, with a terminal leaf .................. \textit{Thelasis triptera}  
Pseudobulbs not so ................................................................................. 95

95. Leaves small, about 4 by 1.3 cm, narrowed abruptly at the base and apex; rhizome slender and long creeping ................................................. \textit{Bulbophyllum concinnum}  
Leaves larger, over 10 cm long ............................................................. 96

96. Scape to 2.5 cm long, covered by sheaths, whole inflorescence 5-12 cm long ................. \textit{Bulbophyllum flammuliferum}  
Scape to 12 cm long, dull purple ........................................................... \textit{Bulbophyllum fenestratum}  

97. Flowers solitary, from the pseudobulbs, or opening singly on a slowly elongating inflorescence, or 2-3 on a single inflorescence .................. 98
Flowers more than 3 opening together on the same inflorescence .............. 102

98. Flowers solitary from the stem below the leaves ...................... \textit{Dendrobium spurium}  
Flowers or inflorescence from the apex of pseudobulbs .......................... 99

99. Inflorescence slowly elongating, one flower opening at a time; short hairy .... \textit{Eria pulchella}  
Inflorescence not slowly elongating ................................................. 100

100. Inflorescence with no distinct peduncle, flowers solitary ........ \textit{Dendrobium pumilum}  
Inflorescence with a distinct peduncle, woolly hairy, with 1-3 flowers .......... 101

101. Leaves fleshy, terete, slightly flat on one side; young shoots white-hairy .... \textit{Eria pannea}  
Leaves elliptic-oblong; young shoots brown-hairy ................................ \textit{Eria leiophylla}  

102. Pseudobulbs to 12 cm long, ribbed; leaves to 30 by 4.5 cm ........ \textit{Coelogyne foerstermannii}  
Pseudobulbs narrowly cylindrical, to 20 cm long, ribbed; leaves to 30 by 11 cm .......................................................... \textit{Coelogyne rochussenii}  

103. Stems and leaves laterally flattened ........................................... 104
Stems and leaves not laterally flattened; leaves sometimes circular in transverse section ... 117

104. Inflorescence elongate, of many small flowers many opening together .... 105
Inflorescence short, bearing 1-2 flowers at a time ................................ 112

105. Stems about 4 cm apart, leaves to 20 cm long and 1 cm wide ............... \textit{Hippeophyllum scortechinii}  
Stems close together, forming tufts .................................................. 106

106. Leaves jointed at the base ......................................................... 107
Leaves not jointed at the base .......................................................... 110

107. Stem very short ................................................................. 108
Stem 2.5 cm or more long ............................................................... 109

108. Leaves to 6 cm long. Only from Langkawi ................................ \textit{Oberonia calcicola}  
Leaves to 15 cm or more long ....................................................... \textit{Oberonia dissitiflora}  

109. Midlobe of lip bilobed ............................................................. \textit{Oberonia flavia}  
Midlobe of lop transversely oblong ................................................ \textit{Oberonia transversiloba}  

110. Stem 10 cm or more long ....................................................... \textit{Oberonia caudata}  
Stem 3-5 cm long; inflorescence 5 cm long ........................................ \textit{Oberonia caudata}
111. Flowers on distinct pedicels; not completely covering rachis ........ Oberonia spatulata
Flowers lying on rachis, completely covering it .................. Oberonia anceps

112. Leaves very close together, bases overlapping. Once from limestone, Perlis ................. Dendrobium excavatum
Leaves distinctly spaced; only sheathing parts overlapping .................. 113

113. Leaves at least 5 mm apart, stem thin, flexuous
Leaves arranged closer together, stems stiffer .................. 114

114. Leaves 3-5 cm long; flowers about 1.2 cm long ........ Dendrobium acerosum
Leaves under 2 cm long; flowers about 8 mm long ........ Dendrobium subulatum

115. Stem with the apical part devoid of normal leaves, floriferous .... Dendrobium aloifolium
Stem leafy throughout .......................................................... 116

116. Stem with leaves to 2 cm wide; a large bilobed callus present at the base of the lip .... Dendrobium indivisum
Stem with leaves to 3.5 cm wide; a small unlobed callus present on the lip ........ Dendrobium leonis

117. Leaves round in transverse section; stem to 40 cm long, very slender; flowers white ........ Dendrobium setifolium
Leaves not round in section .................................................. 118

118. Stem with a swollen base of 2 internodes, the rest slender ........ Dendrobium planibulbe
Stem not so .............................................................. 119

119. Stem elongate, with a few leaves near the apex only (old stems may have lost all their leaves),
basal part longer than the leafy part .................................. 120
Stem not so .............................................................. 122

120. Stem covered by red brown sheaths; flowers solitary .......... Eria nutans
Stem not so covered; flowers in inflorescences .................. 121

121. Pseudobulbs strongly 4-angled in the upper part; inflorescence drooping to 20 cm long ...
Pseudobulbs not angled; inflorescence shorter .................. 122

122. Stems over 5 cm long, with several to many leaves .................. 123
Stems under 5 cm long, with a few leaves, the bases of which often cover the stem completely 138

123. Inflorescence a terminal dense head, 2.5-3 cm in diameter, hardly stalked .................. Agrostophyllum majus
Inflorescence different .................................................. 124

124. Lip with 1-2 appendages near its base .................. 125
Lip with no appendages .................................................. 133

125. Flowers small, under 1 cm across .......................... 126
Flowers large, more than 1 cm across ................................ 132

126. Leaves less than 1.2 cm long; pollinia: 4 ................................ 127
Leaves more than 1.5 cm long; pollinia: 6 or 8 .................. 129

127. Leaves to 2 mm wide, acute .................................. 128
Leaves wider, ends rounded ........................................ 129

128. Leaves about 6 by 1 mm, at a very acute angle to the stem; lip with 2 narrow appendages
Leaves about 8 by 2 mm, spreading; lip with a simple broad appendage .......... 130

129. Floral bracts leaf like, closely overlapping, the inflorescence terminal .......... Appendicula torta
Floral bracts different .................................................. 130

130. Stem and leaf sheaths strongly flattened .......... Appendicula anceps
Stem and leaf sheaths not flattened ................................ 131
131. Inflorescence lateral, slender, the scape as long or longer than the leaves ..............................................*Appendicula undulata*
Inflorescence usually terminal, shorter than the leaves ..............................................*Appendicula cornuta*

132. Flowers numerous and densely arranged on one side of the inflorescence. Stems, 50 cm or more long ..............................................*Dendrobium secundum*
Flowers different, apparently solitary. Stems to 30 cm long. Only from Langkawi ..............................................*Dendrobium langkawiensis*

133. Inflorescence terminal or sub-terminal .............................................. 134
Inflorescence lateral .............................................. 136

134. Inflorescence short, 1-2 cm, with close 2 ranked bracts .............................................. 135
Inflorescence to 20 cm long. Only from Kelantan .............................................. *Eria citrina*

135. Leaf sheaths with slender appendages on either side, at the base of the blade ..............................................
Leaf sheaths without such appendages .............................................. *Agrostophyllum bicuspidatum*

136. Inflorescence slender, 1 cm long, with 3-4 flowers, each less than 5 mm across .............................................. *Poaephyllum pauciflorum*
Inflorescence different; flowers larger, about 1.5 cm across .............................................. 137

137. Stem erect, leaves thin, to 20 by 2 cm; inflorescence of 4-6 flowers .............................................. *Eria leptocarpa*
Stem pendulous, leaves thick, to 12 by 1 cm; inflorescence usually of 1 flower .............................................. *Eria rigida*

138. Flowers small, sepals to about 4 mm long .............................................. 139
Flowers much larger, lip pouch-shaped .............................................. *Paphiopedilum lowii*

139. Column-foot well developed .............................................. 140
Column-foot not developed .............................................. 141

140. Leaves 3-4; to 20 by 3 cm or smaller; scapes about 5 cm long or more .............................................. *Polystachya flavescens*
Leaves to 9; to 5 cm by 4 mm; scapes to 2 cm long .............................................. *Phreatia secunda*

141. Rachis of inflorescence to 15 cm long. Stem tufted bearing about 5 leaves, the lower leaves much shorter than the upper .............................................. *Thelasis carinata*
Rachis of inflorescence about 1.5 cm long; plant like the above but smaller .............................................. *Thelasis micrantha*


**Saccolabium minimiflorum** Hk.f., in Ridl., Fl. 4 (1924) 166.
A small plant, leaves to 5.5 by 1.7 cm, elliptic. Flowers reddish brown.

This us a rare plant in Malaya, which is also found in Java; it has been collected mainly from the limestone hills usually as epiphytes but also on rocks.


**Acampe penangiana** Ridl., Fl. 4 (1924) 155.


A species found in many lowland localities. It has been collected a number of times over limestone as epiphytes, and possibly once on rocks.

Recorded in Malaya from Perak and Selangor, uncommon. On limestone in Selangor and also from Telok Forest Reserve (freshwater swamp).


In Malaya, found in many localities from the lowlands up to 1300 m. It is a common epiphyte on the dry summit of Bukit Takun in Selangor.


Appendicula cornuta Bl., Bijdr. (1825) 302; Ridl., Fl. 4 (1924) 196; Holtt., Fl. Mal. (1964) 505.

Common in Malaya in the lowlands. However, it has been collected from the limestone only from Bukit Takun in Selangor, usually as epiphytes but also on rocks.

Appendicula torta Bl., Bijdr. (1825) 303; Ridl., Fl. 4 (1924) 198; Holtt., Fl. Mal. 1 (1964) 505.

Stems to 25 cm long, leaves to 1.6 by 0.5 cm; nearly at right angles to the stem, oblong-elliptic, tips rounded. Inflorescence terminal, bracts leaf-like and closely overlapping.

Distributed in Java, Sumatra and Borneo. In Malaya, chiefly found as epiphytes on limestone hills; also on Taiping Hills (not limestone).


A. moschifera Bl., in Ridl., Fl. 4 (1924) 159.

Stems long and stout, climbing; leaves to 17 by 5 cm; apex bilobed. Inflorescence large, over 100 cm long; flowers about 10 cm across; with broad dark purple brown streaks.

This scorpion orchid is distributed in Java, Sumatra and Borneo. In Malaya, it is chiefly found on the limestone, growing from organic debris and climbing over rocks and on trees stems.


Saccolobium myosurus Ridl., J. Str. Br. R. As. Soc. 39 (1903) 84; id., Fl. 4 (1924) 173.

Bulbophyllum apodum Hk.f., F.B.I. 5 (1890) 766; Ridl., Fl. 4 (1924) 73; Holtt., Fl. Mal. 1 (1964) 466.

Bulbophyllum concinnum Hk.f., F.B.I. 6 (1890) 189; Ridl., Fl. 4 (1924) 70; Holtt., Fl. Mal. 1 (1964) 454.

In Malaya, apart from the limestone field, found only in Johore and Singapore. Collected from the limestone in Selangor and Kelantan from rather dry situations. In Singapore and Johore found as epiphytes on old mangrove trees and by rivers.


B. punctatissimum Ridl., Fl. 4 (1924) 77.


Rhizome creeping, pseudobulbs to 3.5 cm long and 1.5 cm wide, 4-angled. Leaves fleshy 18 by 3 cm. Scape to 12 cm, dull purple. Sepals with purple spots.

Distributed in Java, Borneo and Sumatra. In Malaya, found mainly on the limestone as epiphytes and also on rocks.


Rhizome creeping, stout. Pseudobulbs 3-6 cm or more apart, to 4.5 cm high. Leaves about 12 by 2.8 cm, or more. Flowers yellow with orange tips.

Endemic and rare, chiefly from limestone; recorded from Kota Glanggi, Pahang, and Gua Batu and Bukit Takun, Selangor.


Rhizome creeping, pseudobulbs to 6 cm long, narrowly ovoid and slightly 4-angled. Leaves fleshy, to 27 by 3.5 cm. Flowers pale mauve or nearly white.
Distributed in peninsular Thailand and northern Malaya. In Malaya, chiefly on limestone as epiphytes and occasionally on rocks.


*Epidendrum sessile* Koen., Retz. Obs. 6 (1791) 60.

*B. clandestinum* Lind; in Ridl., Fl. 4 (1924) 69.


*Preptanthe rubens* Ridl., Fl. 4 (1924) 123.

Pseudobulbs ovoid and angled, about 8 cm long. Leaf blades to 40 by 15 cm. Scape hairy, to 50 cm long; rachis many flowered. Flowers pink with crimson.

Distributed in Thailand and northern Malaya, terrestrial and restricted to limestone.


*C. veratrifolia* R. Br. in Ridl., Fl. 4 (1924) 119.

*Orchis triplicata* Will., Usteri Ann. Bot. 6 (1796) 52.

Found in the lowlands, especially in freshwater swamp-forest, and extending on to the hills to almost 1600 m. It is also the commonest species of *Calanthe* on limestone; being frequently found in partly to completely shaded areas with deep or shallow soils, especially where there is a slight accumulation of decaying litter.


*Preptanthe vestita* Rchb.f, in Ridl., Fl. 4 (1924) 123.

Pseudobulbs large, ovoid and angled to 10 cm long; leaves to about 45 by 12 cm. Scape to 70 cm long hairy; flowers, well-spaced; bracts broad, 1.5 cm long.

Distributed in Thailand, Borneo and Celebes; in Malaya, collected only once. This specimen was growing as an epiphyte on the top of Gua Batu in Selangor (Ridley s.n. Dec. 1896).


Ceratostylis pendula Hk.f., F.B.I. 5 (1890) 826; Ridl., Fl. 4 (1924) 111; Holtt., Fl. Mal. 1 (1964) 496.

Endemic to Malaya, widely distributed in the lowlands but not very common, collected only once over limestone (UNESCO 455 from Gua Musang, Kelantan).


This species is known from Kedah Peak, Taiping Hills and one limestone locality (Bukit Takun in Selangor).


Corymborchis brevistylis (Hk.f.) Holtt., Fl. Mal. 1 (1953) 144, op. cit. (3rd ed.) (1964) 146.

Corymbis brevistylis Hk.f., F.B.I. 6 (1890) 91.

Stem to 60 cm tall. Leaves 12-15 by 5-7.5 cm. Inflorescence with few flowers, column 8 mm long.

Endemic and known from a single record made on limestone at Kuala Dipang, Perak.

Corymborchis rhytidocarpa (Hk.f.) Holtt., Fl. Mal. 1 (1953) 144, op. cit. (3rd ed.) (1964) 146.

Corymbis longiflora Hk.f., in Ridl., 4 (1924) 208.

C. rhytidocarpa Hk.f., F.B.I. 6 (1890) 92.

This is a lowland plant. It has been recorded only once from limestone, growing from rock crevices. (Molesworth-Allen 4435 from Gunong Tempurong, Perak)


C. acutum Ridl., J. Linn. Soc. 32 (1896) 334.


D. serra Lindl., in Ridl., Fl. 4 (1924) 35.


D. atropurpureum quoad Ridl., Fl. 4 (1924) 39.


Dendrobium indivisum (Bl.) Miq., Fl. Ind. Bat. 3 (1859) 630; Holtt., Fl. Mal. 1 (1964) 322.


Stem to 30 cm long; leaves about 5 by 0.6 cm. Flowers apparently solitary.

Endemic and known only from a single collection from Langkawi. A second specimen collected by Corner in 1941 from Pulau Chupak, Langkawi is doubtfully this species.


D. gemellum Lindl., in Ridl., Fl. 4 (1924) 40.

Stem slender to 100 cm long. Leaves to 13 by 1.7 cm. Inflorescence of 2 flowers at the nodes.

Distributed in Java. An epiphyte but more frequently found on rocks and roots on shaded to semi-exposed summits on limestone, fairly common, but unknown outside the limestone field.

Pedilontum secundum Bl., Bijdr. (1825) 322.


D. gracile Lindl., in Ridl., Fl. 4 (1929) 41.


Ephemerantha fimbriata (Bl.) P.F. Hunt et Summ., Taxon 10 (1916) 103.


Tylostylis rigida Bl., in Ridl., op. cit. 104.

Trichotosia vestita Krzl., in Ridl., Fl. 4 (1924) 100.


Pseudobulbs about 10 cm long, with about 5 leaves. Leaves to 30 by 1 cm, tapered at both ends. Inflorescence 30-40 cm long; flowers greenish.

According to Holttum found only in Langkawi and mainland Kedah; but apparently also found in peninsular Thailand (Ridley). Probably restricted to limestone but the records are not conclusive.


Plant to 20 cm tall, with 4-6 leaves. Leaves 2.5-7 by 1.2-2.7 cm, base rounded, apex acute, flushed pink with whitish or pinkish vein-network. Inflorescence erect, to 12 cm; flowers close together and subtended by prominent bracts.

Distributed in the southern Himalayas. In Malaya, restricted to limestone; first found on Gua Ninek, Kelantan. Subsequently also from Selangor. Grows on sheltered localities in small soil pockets amongst boulders.


Tuberos; stem erect, leaves from near the base, to 10 by 4 cm; olive green with pale spots. Inflorescence terminal; upper sepal and petal forming a hood, lip to 3 cm long, 3-lobed.

This species is restricted to limestone in Langkawi and peninsular Thailand at low elevation.


Plant 30-50 cm; leaves 4-6, near the base; blade to 16 by 5 cm. Inflorescence to 30 cm long, flowers pale green, upper sepal about 6 mm long.

Endemic and restricted to the limestone in Perak and once from Kedah.


H. kingii Hk.f., quoad Ridl., Fl. 4 (1924) 228.

Plant like H. kingii Hk.f., but inflorescence to 10 cm long; upper sepal and petal forming a hood 4 mm long.

Distributed in Java and Sumatra. In Malaya usually from limestone in Pahang, Perak and Kedah.


Malaxis compressa Bl., Bijdr. (1925) 390.

Distributed from Sumatra to the Philippines. Found in mountain forests in Malaya at 1300-1600 m. Recorded once on limestone at low elevation (UNESCO 55 from Bertam, Kelantan, growing on rocks).


Microstylis calophylla Rchb.f., in Ridl., Fl. 4 (1924) 11.

Distributed in peninsular Thailand. Recorded in Malaya from Penang Hill and on limestone at Baling, Kedah; now also known to be found on the limestone at Gua Musang, Kelantan. This Kelantan record is the southernmost location for this species.

Malaxis latifolia Sm., Rees Cycl. (1819) 22; Holtt., Fl. Mal. 1 (1964) 195.


Microstylis flavoviridis Ridl., Fl. 4 (1924) 12.

Microstylis micrantha Hk.f., in Ridl., l.c.


Restricted to limestone in Perlis and peninsular Thailand.


Saccolabium undulatum quoad Carr, J. Mal. Br. R. As. Soc. 6 (1928) 64.

*Saccolabium undulatum* Ridl., in Fl. 4 (1924) 172.

*S. sylvestre* Ridl., op. cit. 168.

Stem to 15 cm or more long. Leaves to 14 by 2 cm, apex unequal. Inflorescence pendulous to 16 cm long. Flowers many, yellow.

Endemic. Recorded only twice, from Perak, as epiphytes on limestone hills.


Distributed in Java. In Malaya, recorded from the southern half. Collected from limestone in Selangor and Kelantan. (The identification of Kelantan specimens UNESCO 300 and 472 is doubtful). This species is common on Bukit Takun, Selangor.


Stems very stout. Leaves about 6, spreading out evenly like a fan, to 5.5 by 0.9 cm. Inflorescence slender, to 10 cm long. Flowers in whorls of about 6.

Endemic. Known in Malaya from a single record (*Henderson 21398*) from the limestone at Langkawi as an epiphyte. Also from peninsular Thailand


Stem 3-5 cm long with 4-5 leaves. Leaves at 45 degrees to the stem, tips incurved, 5 by 0.4 cm. Inflorescence about 5 cm long, decurved.

Stem 3-5 cm long with 4-5 leaves. Leaves at 45 degrees to the stem, tips incurved, 5 by 0.4 cm. Inflorescence about 5 cm long, decurved.

Recorded once from Thailand. In Malaya, known from a collection made by Scortechini in Perak. More recently recorded on limestone from Kelantan (UNESCO 337, from Gua Serai).


*O. lunata* Lindl., in Ridl., Fl. 4 (1924) 14.

This very rare endemic, until 1962, was known only from a single collection from Telom, to the East of Cameron Highlands in Pahang. The second known collection (UNESCO 309) is from over limestone in Kelantan.


Stems 3-5 cm long with about 6 leaves. Leaves at a very acute angle to the stem, to 9.5 by 0.5 cm. Inflorescence erect, to 16 cm long. Flowers in whorls, yellow orange.

Endemic to limestone in Malaya. Until 1962 known from Gua Tipus in north Pahang (Henderson 19448). Now recorded from Kelantan. This species is probably more common than the records suggest.


Plant fleshy. Leaves almost horizontal, surface with pale purple mottling on a dark green background; undersurface purple. Inflorescence about 12 cm long with 1-2 large flowers which are 5-6 cm across.

Distributed in peninsular Thailand. In Malaya, only from Langkawi where it is restricted to limestone and often locally abundant in partly shaded situations; growing on soil and from rock crevices.


Aerides decumbens Griff., Notul. 3 (1851) 365.

Kingiella decumbens Rolfe., in Ridl., Fl. 4 (1924) 158.


Pseudobulbs conical, 3-6 cm long. Leaves fleshy to 30 by 6 cm; plicate. Inflorescence to 30 cm long, with numerous flowers and persistent semi-circular bracts.
Distributed in Burma and southern China and southwards to Australia. Common on the limestone in Malaya, but also found in lowland forest. This species grows in partly shaded areas but will tolerate extreme exposure.


*P. microtidis* Lindl., in Ridl., Fl. 4 (1924) 106.


*P. microtidis* Lindl., in Ridl., Fl. 4 (1924) 106.


Saccolabium hobsonii Ridl., Fl. 4 (1924) 167.

S. uteriferum Ridl., op. cit. 168.


Dendrocolla ciliata Ridl., Fl. 4 (1924) 188.


Pteroceras hirsutum (Hk.f.) Holtt., Kew Bull. 14 (1960) 270.

Ascochilus hirsutus Ridl., Fl. 4 (1924) 182.

Sarcochilus hirsutus Hk.f., F.B.I. 6 (1890) 38; Holtt., Fl. Mal. 1 (1964) 691.


Stems to 5 cm long. Leaves many, to 40 by 4 cm or usually less, with an unequally bilobed apex. Inflorescence to 13 cm long; bracts spreading. Flowers pale yellow with purple spots at the base of lateral sepals; about 3-4 cm across.

Endemic to limestone, previously known only from Kota Glanggi in Pahang. Now known from Kelantan as well, where it is not uncommon.


Renantherella histrionica Ridl., J. Linn. Soc. 32 (1896) 355; id., Fl. 4 (1924) 161.


Saccolabium machadonis Ridl., Fl. 4 (1924) 168.


Saccolabium rugulosum Ridl., Fl. 4 (1924) 168.

Stem 15 cm. Leaves spreading to 13 by 1.3 cm, slightly constricted at 0.5-1.5 cm from the apex. Inflorescence 1.5 cm long with a few flowers. Flowers yellow, spotted red.

Endemic to Malaya; formerly known only from a single collection from Kedah Peak (not limestone). Now known from two other numbers from the Kelantan limestone (UNESCO 38, 358).


Sarcanthus subulatus (Bl.) Rchb.f., Bonpl. 5 (1857) 41; Holtt., Fl. Mal. 1 (1964) 654.


Stem to 6 cm long, stout, with about 10 leaves. Leaves to 23 by 1.8 cm. Inflorescence pendulous, to 25 cm, unbranched or with a few branches. Flowers pale green; sepals and petals with dull purple-red median bands.

Distributed in Java and Sumatra. In Malaya, known only from Langkawi, and Lenggong in in Perak; the Lenggong collection is from limestone and the Langkawi ones are probably also.


Saccolabium perpusillum Hk.f., in Ridl., Fl. 4 (1924) 171.


Plant with small round pseudobulbs. Leaves to about 15 cm long; Scape to 20 cm long, rachis elongated; flowers about 2.5 cm wide; crimson to pale pinkish-purple.

Distributed in Lower Burma and Thailand. In Malaya, it is restricted to the limestone on Langkawi. This is a terrestrial species, growing from soil and rock crevices in partly shaded localities, often close to the sea.

Staurochilus fasciatus (Rchb.f.) Ridl., J. Linn. Soc. 32 (1896) 351, id., Fl. 4 (1924) 157; Seid. et Smit., Orch. Thai. (1962) 600.


S.S. 7 (1932) 80; Holtt., Fl. Mal. 1 (1964) 593; Seid et Smit., Orch. Thai. (1964) 720.

*T. macrorhizum* Ridl., Fl. 4 (1924) 176.


*T. serrula* Hk.f., in Ridl., Fl. 4 (1924) 176.


*T. zollingeri* Rchb.f., in Ridl. op. cit. 192.


Pseudobulbs lying on rhizome, about 1 cm diameter and 7 mm tall. Leaves fleshy, almost terete, to 15 cm long and 1 cm wide. Inflorescence from between pseudobulbs, scape to 15 cm long, rachis gradually elongating to about 4 cm; bracts persistent and deflexed, overlapping. Flowers whitish.

Endemic and restricted to limestone. Previously known only from Kota Glanggi in Pahang. Now also known from Gua Musang, Kelantan and Bukit Chintamani, Pahang. Epiphytic.


*Dendrocolla alba* Ridl., Fl. 4 (1924) 188.


*T. lilacinum* Rchb.f., in Ridl., Fl. 4 (1924) 184.


*Saccotabium miserum* Ridl., J. Linn. Soc. 32 (1896) 359; id., Fl. 4 (1924) 171.

Stem long-climbing. Leaves 7-12 by 1.5-2 cm; ends unequally bilobed. Inflorescence 1-flowered, 1-3 at a node. Flowers greenish yellow with red-brown spots, 2-3 cm across.

Distributed in Java, Sumatra and Borneo. In Malaya, found chiefly on limestone, in Kelantan, Pahang and Selangor.


var. minor J.J.S., Bull. Btzg (ser. 2) 26 (1918) 102; Holtt., op. cit. 642.

Stem pendulous, about 30 cm long. Leaves about 5 by 1.3 cm. Inflorescence 1-flowered, 1-3 at a node. Flowers pale yellow with brown spots and streaks.

The typical variety is distributed in Borneo and Sumatra; known in Malaya only from Port Swettenham and Cameron Highlands. Var. minor is distributed in Java and recorded from Malaya once only (Kota Glanggi, Pahang).


Saccolabium tenuicaule Hk.f., in Ridl., Fl. 4 (1924) 171.

Stem to 30 cm long, more or less pendulous. Leaves well spaced, to 12 by 0.6 cm. Inflorescence very short, from nodes, each with 1-3 flowers. Midlobe as long as the forward curving spur, with 2 small diverging curved horns at the very tip.

Distributed in peninsular Thailand. In Malaya, found chiefly on limestone in Pahang, Selangor, Perak and Langkawi.


Stauropsis gigantea Benth., in Ridl., Fl. 4 (1924) 155.

Excluded Species


According to Henderson this species is known only from Gua Tipus limestone in Pahang. I have not been able to trace this in any literature, nor have I seen any specimens.

Notes

Dendrobium tetrodon Rchb.f. ex Lind., J. Linn. Soc. 3 (1859) 10; Ridl., Fl. 4 (1924) 45; Holtt., Fl. Mal. 1 (1964) 293.
Endemic to Malaya, not uncommon in open places in the lowlands. Two numbers from limestone are doubtfully identified as this species, UNESCO 444 & 456 from Gua Musang, Kelantan.


Locally common, recorded on Gunong Blumut and G. Ledang in Johore, Penang Hill, Kedah Peak and several other isolated small hills in westcoast. Strangely not recorded on the main range.

Usually in shaded places with peaty or mossy substrate. What appears to be this species has been seen on Gunong Tempurong, Perak. (I am grateful to Mr. Lee Toh Ming for his information.)


Stem to 5 cm long. Leaves fleshy, at the end of stems, to 19 by 2.5 cm. Inflorescence to 15 cm with few branches. Flowers pale yellow, lateral sepals sometimes with reddish spots at the base.

A rare plant which according to records is restricted to limestone in peninsular Thailand and Perlis, Malaysia. The specimen thought to be from Malaya (Ridley 15226) was collected from Bukit Rajah Wang, Setul. All previous authors have implicitly or explicitly expressed Setul to be within the Malayan boundary. According to present maps, however, Setul is within Thai territory. But this plant is very likely to be found in Malaya proper.


This species has also been recorded from limestone in Setul.

### PALMAE*

| 1. Leaves palmate | .......................................................... | 2 |
| Leaves pinnate or bipinnate | .......................................................... | 6 |
| 2. Major divisions of leaf reaching the insertion on the petiole; leaflets wedge-shaped | .......................................................... | 3 |
| Major divisions of leaf not reaching the petiole | .......................................................... |
| 3. Petioles armed with stout spines; fruits 1.5-2 cm diameter, blue green | .... | Livistona saribus |
| Petioles unarmed | .......................................................... | 4 |
| 4. Leaves massive, petiole channelled, with very sharp edges; leaflets compound | .......................................................... | Borassodendron machadonis |
| Leaves small, petiole not channelled | .......................................................... | 5 |
| 5. Leaf sheaths formed of broad laminate fibres. Only from Langkawi | .... | *Maxburretia gracilis* |
| Leaf sheaths formed of fine dark fibres. Only from Selangor | .... | *Maxburretia rupicola* |

* The generous help of Dr. J. Dransfield (KEW) with this family is gratefully acknowledged.
6. Leaves simply pinnate .................................................. 7
   Leaves bipinnate .................................................. *Caryota mitis*

7. Spiny palms .............................................................. 8
   Non-spiny palms ................................................... 13

8. Massive clustering palm with crownshaft ......................... *Onchosperma horridum*
   Slender palms without crownshaft (rattans, 1 species acaulescent) ................................. 9

9. Leaflets with white indumentum below; whole leaf ending in a barbed whip (cirrus) ......................
   Leaflets concolorous; leaf without cirrus; barbed whip (flagellum) borne on leafsheath .............. 10

10. Middle leaflets 15-30 by 1.4-1.5 cm ............................... 11
    Middle leaflets much larger .................................... 12

11. Leaflets equidistant. Leafsheaths densely covered with 2-5 cm-long spines ............................
    Leaflets grouped. Leafsheaths with spines to 2 cm long ........................... *Calamus balingensis*
    ................................................................. *Calamus siamensis var malaianus*

12. Middle leaflets 30-60 by 3-3.5 cm. Fruits 0.8-1 cm long .......................... *Calamus concinnus*
    Middle leaflets 60-80 by 5-8 cm. Fruits 3-3.5 cm long .......................... *Calamus ornatus*

13. Leaflet-tips entire .................................................. *Areca triandra*
    Leaflet-tips serrate (praemorse) ................................ 14

14. Massive palms with leaves to 10 m or more long ................ 15
    Slender undergrowth palms; leaves rarely exceeding 2 m .............................................. 16

15. Stem solitary, monocarpic with basipetal inflorescence production; trunk covered with black fibres
    ................................................................. *Arenga pinnata*
    Stem clustered, polycarpic with acropetal inflorescence production; trunk eventually bare ....
    ................................................................. *Arenga westerhoutii*

16. Terminal leaflet present .......................................... *Arenga hookeriana*
    Terminal leaflet absent ......................................... 17

17. Inflorescence unbranched; fruits elongate with a pronounced hook at the tip ...........................
    Inflorescence branched (rarely unbranched); fruits curved, with no pronounced hook at the tip 
    ................................................................. *Iguanura corniculata*
    ................................................................. *Iguanura polymorpha*

*Areca triandra* Roxb., (Hort. Beng. (1814) 68, *nom. nud.*), Fl. Indica 3 (1832) 617;
Ridl., Fl. 5 (1925) 4; Henders., Mal. Br. R. As. Soc. 17 (1939) 85; Whitmore, Palms Mal. (1973) 35.

Common palm at 700-1300 m, uncommon in the lowlands. Recorded from limestone in Langkawi at near sea-level.


*Didymosperma hookerianum* Becc., Malesia 3 (1889) 186; Ridl., Fl. 5 (1925) 20;

South Thailand. In Malaya only from the east coast; not uncommon in lowland forest, recorded several times from limestone.

Recorded once from limestone in Malaya (Whitmore FRI 4267 from Gua Musang, Kelantan).

_Arena westerhoutii_ Griff., Calc. J. Nat. Hist. 5 (1845) 475; Ridl., Fl. 5 (1925) 19; Whitmore, Palms Mal. (1973) 38.

Locally gregarious in lowland forest. Not uncommon on the lower slopes and gullies of limestone hills.

_Borassodendron machadonis_ (Ridl.) Becc., Webbia 4 (1914) 361; Whitmore, Palms Mal. (1973) 39.

_Borassus machadonis_ Ridl., Fl. 5 (1925) 71; Molesworth-Allen, M.N.J. 18 (1964) 168.

Peninsular Thailand. Recorded from limestone at Gua Musang, Kelantan; conspicuous on Gunong Datok, Perak. Rare in the wild.


Solitary. Leaf-sheaths densely covered by 2-5 cm long spines. Leaves 1.6-2 m long. Male spadix slightly longer than the leaves, with about 6 branches. Female inflorescence unknown.

Endemic and known from only one collection (Furtado 33073, Gunong Baling, Kedah).


_Plectocomiopsis ferox_ Ridl., op. cit. 66.

Peninsular Thailand. Rare; in Malaya known from only three collections, one of which is from limestone (Haniff & Nur 7087, Telok Apau, Langkawi).


Endemic; in lowland forest. Recorded on limestone from Gua Musang and from the small outcrops in Johore.

(Dransfield, J. (pers. com.) does not regard _C. ornatus_ var. _horridus_ as distinct from the typical variety _C. ornatus_ var. _ornatus_)


_C. densiflorus_ Becc., in Ridl., Fl. 5 (1925) 53.

_C. siamensis_ Becc., in Ridl. op. cit. 59.

The species is described from Thailand and the variety is found only in Kedah and Perlis; once from limestone (Henderson 23028, Tebing Tinggi, Perlis).

_Caryota mitis_ Lour., Fl. Cochinch. (1790) 569; Ridl., Fl. 5 (1925) 20; Whitmore, Palms Mal. (1973) 44.
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Plant similar to I. polymorpha. Rare; known from two collections only, one from limestone (Henderson 25059, Bukit Serdam, Pahang).


Not uncommon on limestone.


L. wrayi Becc. ex Ridl., Fl. 5 (1925) 28.

Endemic, from the lowlands to 1600 m. Recorded from the limestone at Gunong Pondok, Perak.

Livistona saribus (Lour.) ex Chev., Bull. Econ. Indochine (ser 2) 22 (1919) 501; Whitmore, Palms Mal. (1973) 72.


Indochina, Java, Sumatra, Borneo and the Philippines. Widely distributed in Malaya, except in the South. Recorded once on limestone (Henderson s.n. 7th June 1930, from Gunong Pondok, Perak).

Maxburretia gracilis (Burr.) Dransfield, Gentes Herb. 11 (1978) 194.


Endemic and known only from the limestone at Dayang Bunting, Langkawi. Very likely to be found on the limestone islands of southern Thailand too.


Stem to 1m. Petiole 50-90 cm, lamina 50-60 cm across with 30-35 segments. Inflorescence to 60 cm with a strong musty-sweet fragrance. Fruits ovoid, 0.8-0.9 cm long; ripening black.

Endemic and restricted to the limestone in Selangor.

Onchosperma horridum (Griff.) Scheff., Tijdschr. Ned. Ind. 32 (1871) 191; Ridl., Fl. 5 (1925) 16; Whitmore, Palms Mal. (1973) 82.

There is a clump of this palm on the top of the Gua Batu limestone growing in a broad gully amongst tangled shrubby vegetation.

_Plectocoma griffithii_ Becc. ex Hk.f., F.B.I. 6 (1893) 478; Ridl., Fl. 5 (1925) 70; Furt., Gard. Bull. S. 13 (1951) 346; Whitmore, Palms Mal. (1973) 94.

Thailand, Peninsular Malaya. Common especially in mountain forests and coastal hills. Once from limestone (_Chin_ 1273, Gua Batu, Selangor).

**PANDANACEAE**

1. Plant of sandy or rocky shores, spines on leaves white ................ _Pandanus odoratissimus_ Inland plant, if by shores spines not white ............................................. 2

2. Leaf apex very abruptly acuminate-caudate, boat-shaped, when older, splitting and appearing bilobed .............................. _Pandanus irregularis_ Leaf apex not so .............................................................. 3

3. Leaf less than 2.5 cm wide, usually less than 150 cm long; stem slender, less than 5 cm in diameter ............................................. 4

   Leaf more than 2.5 cm wide, usually more than 4 cm wide, and often more than 200 cm long; stem stout, more than 5 cm in diameter ................... 5

4. Plant much branched; stems 1-5 m tall, thorny; older parts devoid of leaf bases; very rare on limestone, a forest species .................. _Pandanus recurvatus_ Plant seldom branched; often forming dense clumps; stems about 30 cm or more long; all covered by persistent leaf bases ........................... _Pandanus alticola_

5. Drupes all simple, one-celled. Plant large; leaves to 4 m long and 9-12 cm wide (on younger plants with stem less than 1 m tall); older plants with leaves smaller, about 3 m long; tip of apical leaves filiform and 10-15 cm long. Common on Gua Batu, Selangor ... _Pandanus calcicola_ Drupes connate, 1-4 celled. Plant large; leaves smaller, to 4-7 cm wide; tip 4-5 cm long. So far only known from the Pulai area, Perak .................. _Pandanus piniformis_


A fairly common endemic epiphyte in Malaya. Recorded from limestone; seen on Bukit Anak Takun, Bukit Takun, and Gua Batu in Selangor, and Gua Musang in Kelantan. They are always fround growing on rocks and from rock crevices, often forming large dense clumps. Common on Bukit Takun, in very exposed to partly shaded situations. Distinguished by its linear, narrow leaves and its often clump-forming habit.


Plants to 5 m tall, 2-3 times branched when old. Stem 10-20 cm in diameter at the basal part. Leaves about 3 m long and 9 m wide; often larger in young plants when stems are as yet unbranched. Fruits terminal, either a single syncarp to 20 cm by 10 cm, or with 2-3 laterals which are smaller, about 12 by 9 cm each. (Dimensions all refer to mature fresh fruits.)

Endemic to limestone in Malaya. Recently found to be common on the slopes of Gua Batu in Selangor, on rocky localities with soil pockets. Originally described from a Perlis specimen.

Erect plant, when old to 5 m tall, 2-3 times branched, lower half of stem 5-10 cm in diameter. Leaves 100-150 by 6-10 cm, tip abruptly acuminate-caudate, boat-shaped, but this is lost in older leaves which are split at the tip and apparently bilobed. Peduncle to 30 cm long, bearing 3-7 syncarps each of which globose to subglobose, about 6 cm in diameter when mature.

Endemic to limestone in Malaya. Common on some of the limestone hills around Gua Musang in Kelantan; often a conspicuous feature of the precipitous, pinnacled ridges.

**Pandanus odoratissimus** L.f., Suppl. (1781) 424; Stone, M.N.J. 21 (1968) 3.


*P. tectorius* Sol. ex Balf.f., J. Linn. Soc. 17 (1878) 63.


Plant forming clumps, stem 3-4 m tall. Leaves about 3 m long and 4-7 cm wide; glaucous beneath. Penduncle about 30 cm long, bearing up to 7 heads of syncarps, each ovoid and 6-11 cm long.

Endemic to limestone in Malaya, and so far known only from limestone in the Pulai area in Perak.


**STEMONACEAE**


*S. curtisii* Hk.f., F.B.I. 6 (1892) 298.

**TACCACEAE**


**TRIURIDACEAE**

*Sciaphila asterias* Ridl., J.F.M.S. Mus. 6 (1915) 188; id., Fl. 4 (1924) 365; Henders., J. Mal. Br. R. As. Soc. 17 (1939) 82.

Endemic to Malaya, uncommon; often on limestone but also on the mountains. Recorded from Langkawi, Gua Ninek, and Batu Bayan in Kelantan, and on Gua Tipus in Pahang.
NOTE

TYPHACEAE

Typha angustifolia L.

A very widely distributed plant found throughout the world between the arctic circle and lat. 35 degrees South; in marshy places; not uncommon in Malaya in such places. Recorded from swampy ground at the base of limestone cliffs near Ipoh, Perak.

ZINGIBERACEAE

1. Leaves spirally arranged; sheaths tubular ........................................... 2
   Leaves arranged in 2 opposite vertical rows; sheaths open on the side opposite the blade ... 3

2. Inflorescence at the apex of leafy shoots ............................................ Costus speciosus
   Inflorescence on short leafless shoots at ground level .......................... Costus globosus

3. Staminodes (infertile stamens) on either side of the lip petaloid, conspicuous; free or adnate to
   the lip ........................................... 4
   Staminodes (infertile stamens) never petaloid, usually reduced to short, linear appendages or
   small teeth at the base of the lip ........................................... 10

4. Lip and filament joined for some distance above the insertion of petals and staminodes; filament
   much longer than lip ........................................... 5
   Lip and filament not so joined, filament usually shorter than lip ............... 7

5. Anthers with 4 appendages; leaves 3-4, broadly elliptic, 19-24 by 6.5-10 cm .............................. Globa patens
   Anthers with 2 appendages; leaves usually more than 7, narrowly elliptic, 19-29 by 3-5.5 cm .... 6

6. Appendages of anther attached to the base of anther, their bases extending up along the side
   of anther ........................................... Globa fasciata
   Appendages of anther spreading from about the middle of each side of the anther; their bases
   spreading along the whole length of each side of the anther ........................................... Globa albiflora

7. Leafy stems to 2 m tall ........................................... Zingiber spectabile
   Leafy stems short, less than 15 cm ........................................... 8

8. Bracts in 2 opposite rows, alternate and overlapping .......................... Boesenbergia curtisii
   Bracts not in 2 opposite rows ........................................... 9

9. Petiole and sheath to 6 cm long, scape enclosed by leaf-sheaths; anther-crest narrow, spatulate
   ........................................... Kæmpferia pulchra
   Petiole and sheath longer, scape exerted beyond leaf-sheaths; anther-crest as wide as long, or
   nearly so ........................................... Kæmpferia elegans

10. Inflorescence terminal on a leafy stem ............................................ Catimium speciosum
    Inflorescence not terminal but on a leafless peduncle from the rhizome or from the base of a
    leafy shoot ........................................... 11

11. Inflorescence surrounded at the base or covered all over by large overlapping sterile bracts; the
    floral bracts smaller ........................................... 12
    Inflorescence different ........................................... 15

12. Inflorescence on a long erect peduncle 40-80 cm, a common forest species, very rare on limestone
    ........................................... Phaeomeria maingayi
    Inflorescence on a submerged short peduncle; inflorescence at ground level .................... 13

13. Bracts large, to 8 by 5 cm ........................................... Achasma triorygale
    Bracts smaller, usually less than 2.5 cm wide ........................................... 14
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14. Petals longer than sepals, dorsal petal about 1 cm wide \ldots \ldots \ldots Achasma macrocheilos
   Petals as long as sepals, dorsal petal about 0.5 cm wide. \ldots \ldots \ldots Achasma megalocoleilos

15. Inflorescence with only 2 to 3 flowers, short. Fairly common in forest and waste grounds but
   very rare on limestone \ldots \ldots \ldots \ldots Amomum biflorum
   Inflorescence with numerous flowers, elongate, narrowly cylindric when old, with persistent,
   buff-coloured, papery bracts. Not uncommon on northern limestone \ldots Amomum testaceum

\textit{Hornstedtia macrocheilos} Ridl., Fl. 4 (1924) 271.

A common species in lowland forest. According to Henderson I.c., recorded from
limestone in the Ipoh area, Perak.

\textit{Hornstedtia megalocoleilos} Ridl., Fl. 4 (1924) 270.

\textit{Amomum triorgyale} Bak., F.B.I. 6 (1892) 237.
\textit{Hornstedtia triorgyalis} Ridl., Fl. 4 (1924) 269.

Endemic to Malaya, not common; recorded from limestone in Perak.

\textit{Amomum biflorum} Jack, Mal. Misc. 1 (1820) 2; Bak., F.B.I. 6 (1892) 240; Holtt.
\textit{Elettariopsis pubescens} Ridl., Fl. 4 (1924) 275.

Endemic and fairly common in Malaya in lowland forest and waste grounds.
Once recorded from limestone.

\textit{Amomum testaceum} Ridl., J. Str. Br. R. As. Soc. 32 (1899) 135; id., Fl. 4 (1924)
   (1950) 205.

Leafy shoots 2-4 m tall. Leaves to 60 by 10 cm, base narrowly cuneate, sessile. In-
florescence elongating, narrow cylindrical, bracts persistent, papery, and buff-
coloured.

Distributed in Borneo; in Malaya common especially in the North, very often on
or near limestone, but not confined to it.

   13 (1950) 112.
\textit{Gastrochilus curtisii} Bak., Bot. Mag. (1894) t. 7363; Ridl., Fl. 4 (1924) 249;

Leafy stems short, to about 5 cm tall. Leaf to 40 by 12 cm, slightly asymmetric,
elliptic; base cuneate. Bracts numerous, 4-5 cm long, narrow.
Endemic to limestone in Malaya; common in the North, growing on soil and from rock crevices in part shade.


*Alpinia nutans* Andr., in Ridl., Fl. 4 (1924) 277.


*C. kingii* Bak., in Ridl., sp. cit. 257.

*C. velutinae* Ridl., op. cit. 257.


Plant to 80 cm tall. Leaves 10-16, narrow, to 24 cm by 3-3.5 cm. Inflorescence 20-30 cm long; flowers with white corolla.

Endemic and found only on Penang Hill.

var *aurea* Holtt., l.c.

This differs from the typical form by having orange flowers and the longer lip 1 cm instead of about 0.6 cm long. Recorded once from Gua Lambok limestone, Kelantan (*Henderson 29115*).

*Globba fasciata* Ridl., J. Str. Br. R. As. Soc. 57 (1910) 101; id., Fl. 4 (1924) 136;


Plant 30-50 cm tall. Leaves 5-8; 6-21 by 1.5-6 cm. Inflorescence 20-60 cm long. Flowers with orange corolla.

Endemic. Until recent collections from limestone, this species was known only from the type collection, *Ridley 14415*, from 'banks of woods by the Temengoh river'. The correct spelling of Ridley's 'Temengoh' is — Temengor'. This is in Upper Perak and as far as I know is not a limestone locality.

Recently (1970 & 1971) this species was collected from Gua Musang and Batu Neng (about 2 miles to the south west of Gua Musang), both limestone hills in Ulu Kelantan. The Gua Musang collections (*Chin 1420 & Stone 9524*) were from a small population of 6-10 scattered plants at and around the opening of the large cave half-way up the hill, on the side facing Gua Musang town. They were growing in small pockets of accumulated soil and humus and from crevices in limestone ledges in this fairly sheltered locality which is at about 100 m elevation. The Batu Neng specimen (*Chin 1543*) was solitary and growing in a similar sheltered situation in a small shallow gully on the lower half of the outcrop.

It may be interesting to note that this new locality for the species is about 50 miles to the south-east of the type locality in Upper Perak and separated from it by the
main range of mountains which are all well above 1500 m. This species is probably more common than originally thought.


Plant to 60 cm tall. Leaves 3-6, broadly elliptic, 19-24 by 6.5-10 cm. Inflorescence 15-30 cm long; flowers with orange corolla.

Distributed in Sumatra; not uncommon in lowland and mountain forest and with only one record from limestone.


Stem short, leaves 2-3, 8-4 cm, asymmetric, elliptic. Scape of inflorescence enclosed by leaf-sheaths.

Distributed in peninsular Thailand; in Malaya apparently restricted to limestone in the extreme North. Very similar to *K. elegans*, but slightly smaller in size. There is supposedly some floral differences but this is referred to with some doubt. More specimens are needed for verification.


*Amomum maingayi* Bak., F.B.I. 6 (1892) 180.


Endemic to Malaya, found throughout in lowland forest, recorded once from limestone.

**Literature Cited**


Index to Specimens

The Index to Specimens is a list of all specimens examined. Species names are arranged in the alphabetical order of the genus and then of their epithets. The order of citation is: species, collector(s)' name(s) and collection number(s), all printed in italics. A full list of collectors in this index is found in Part 1 of this paper (Gard. Bull., vol. xxx (1977) 168-170). Where a species is represented by more than one specimen and collected by different persons, the collectors' names are arranged alphabetically. Only collectors' surnames or, in their absence, their principal names are cited. A name, if followed by 'et al.', indicates that the specimen has been collected by more than two individuals. When a collecting number is absent, the date of the collection, which is printed in roman is cited instead. Months are indicated in Roman numerals; Twentieth Century years are abbreviated to, e.g. '41 (= 1941) but Nineteenth Century ones are in full. The few specimens with neither number nor date are listed as 's.n. & s.a.' (since numero & sine annum), followed (if available) by an accession number prefixed by the code of the Herbarium which houses them. KEP and FRI are herbarium codes for the Forest Research Institute, Kepong, KLU, for the University of Malaya, and SING, for Singapore.

Buccarea lanceolata (Miq.) M.A.: Henderson 23767; Balanophora fungosa Forst.: Henderson 22810.


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decurrens Stapf: Boey 267; Chin 91, 922, 1123, 1456, 1609; Corner 20 xi '41; Spare 36329; Stone 7458. G. diversifolium C.B. Clke: Henderson 29094; Holttum 15128.


Jacquemontia paniculata (Burm.f.)Hall.f.: Henderson 28941; Ridley 14900a. Jasminum adenophyllum Wall.: Kiah 35424. J. bifarium Wall.: UNESCO 661. J. cordatum Ridl.: Chin 366; Mills
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25053, 29696; Holttum 15095; Keng et al. 6223; Kiah 35309, 35380; Nur 25151, 34381; Ogata KEP 110180; Ridley 8535; Smith FRI 72558; Stone 5894, 6922, 6994, 8931; Turnau 773, UNESCO 173, 319; Whitmore FRI 12158. Vitis martinelli Kew ex Planch: Kiah 35392. Vittaria angustifolia Bl.: Corner & Henderson 22813, 23131; Henderson 29070. V. elongata Sw.: Chin 1705, 1762A.

Wikstroemia androsaemifolia Decne: Chin 146, 412, 1159; Stone 5888, 7308; Whitmore FRI 12164. W. indica (L.)C.A. Mey.: Chin 521, 1748, 1837; Corner 37837, 37856; Hashim Jaafar 238; Henderson 25093, 29055; Ridley xii 1896; Symington FMS 46733; Whitmore FRI 15063. W. polyantha Merr.: UNESCO 338. Wrightia dubia (Sims)Spreng.: Kiah 11 iv '38. W. laevis Hk.f.: Henderson 19599; Kiah 35275.

Xylocarpus granatum Koen.: Henderson 29159.

STUDIES IN MALESIAN RUTACEAE
III*. Melicope suberosa, a new species and new generic record for the Malayan flora

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Abstract

The genus Melicope, previously believed not to be represented in the flora of Peninsular Malaysia, has been found, in the form of a new species, occurring in montane rainforest on the upper slopes of Gunung Ulu Kali, Genting Highlands, Pahang, in Malaysia. The only known locality, a densely wooded gully at 1550 m alt., is in the midst of a zone rapidly being cleared by bulldozing and two of the only five trees found have been felled. The new species, M. suberosa Stone, is apparently related to Bornean species of Melicope, particularly as a yet undescribed unifoliolate species known from Mt. Kinabalu in Sabah. The addition of Melicope to the Malayan flora brings the number of Rutaceous genera known to occur in Peninsular Malaysia up to seventeen.

Introduction

The family Rutaceae as represented in Peninsular Malaysia was last revised in 1972 (Stone, 1972) with sixteen genera and 58 species known to occur in the area. Since that time, further work on the family by T.G. Hartley (1974, 1979, 1982) and myself (Stone, Lowry, Scora, and Jong 1973; Stone 1978a, 1978b) improved our understanding of the Malayan members of the family and resulted in several changes of name and descriptions of new taxa. Continuing field work in the Peninsula in recent years has widened our knowledge of the distribution of various taxa. The exploration of the summit areas of the Genting Highlands, along and just past the Selangor border in Pahang, with particular concentration on the flora of Gunung Ulu Kali, the fourth highest peak in Peninsular Malaysia (almost 1800 m) was recently summarized in a checklist of the flora (Stone, 1981). This flora was already known to include several endemic taxa (including another species, Maclurodendron magnificum Hartley, of the Rutaceae, which was only discovered a few years ago), and all indications were that further exploration would likely result in an increase in the number of species including novelties in various genera. This conclusion is demonstrated by the discovery documented here, which not only proves to be an undescribed species but, in addition, to be a representative of a genus hitherto unreported from Peninsular Malaysia. This genus, Melicope J.R. & G. Forst., has long ago been recorded from India (M. indica R. Wight), China, Taiwan, Borneo, Philippines, Okinawa, New Guinea, Australia, and various Pacific Islands.

As the genus Melicope is being revised currently by Hartley, along with the closely related genera such as Euodia, specimens of the new species described below were

sent to Canberra for his examination. He has confirmed (in litt.) that the species belongs to Melicope sensu stricto, in the original sense of the Forsters and therefore also to the more restricted diagnosis which will be using in his restructuring of the generic division of the tribe Zanthoxyleae. Dr. Hartley has also indicated some relationships of the new species particularly to Bornean plants, as detailed below.

With the addition of Melicope, the Malayan flora now is known to possess members of 17 genera of Rutaceae.

**RUTACEAE — Zanthoxyleae — Euodiinae**

*Melicope suberosa* B.C. Stone, sp. nov.  
Plate 1; Figures 1, 2.

Arbor parva etecta usque ad 10 m alta, ramis majoribus fragilibus oppositis, truncus usque ad 15 cm diametro, cortice crassiter rugososuberoso, partibus glabris floribus et innovationibus primo ephemeraliter minute sparseque puuberulentis exceptis; foliis simplicibus oppositis integris ellipticis, petiolis ad 55 mm longis, laminis vulgo 10-15 cm longis, 4-8 cm latis (maxime ad 22 × 11 cm), tenue subcoriaceis, minute glanduloso-punctatis non-aromaticis, costa infra elevato, nervis 7-12-paribus; inflorescentiis axillaris, 15-30 mm longis, pedunculo 10-20 mm longo, cymulis 3-4 congestibus trilfloweris; floribus pallide albo-viridibus, tetrameris; sepals c. 1.3 mm longis deltoideis scariso-marginatis, extus minute puuberulentis; petals imbricatis galndulosis, 4.3 mm longis, anguste ovatis, apice cussiculo, extus subglabris vel minute sparseque puuberulentis; staminibus 8 (in specimen viso infortibile) inaequalibus albis glabris, filamentis 1-1.5 mm longis, antheris 0.75 mm longis connectivo dorso minute glanduloso, apice apiculato; disco albo, 1 mm alto; ovario 4-lobato, viridi, 1.4 mm lato, minute puuberulo; stylo 1.25 mm longo, in parte dimidio inferiori minute puuberulo; stigmatse obscure 4-lobato- capitato; fructibus 4-lobati, stellato-radiatis, ad 20 mm latis, folliculis ad 9 mm longis, 8 mm latis, 9 mm alitis, uniseminatis, dehiscentibus; endocarpio cartilagineo glabro; seminibus ovoideis c. 7 mm longis, nitide nigris, endospermi albo.

Type: Stone & Lowry 15338 (KLU, holo: isotypes A, BISH, BO, K, L, SING, etc.), from Ulu Kali, Pahang, Malaysia.

A small glabrous tree up to 10 m tall, the trunk straight, to c. 15 cm diameter, branched laxly above with opposite, elongated branches; innovations at first very minutely sparsely puuberulent (hairs simple, clear, 0.15-0.1 mm long, densest on leaf margins) but quickly glabrate; bark of trunk and older branches becoming thickly rugose-corky, 2-8 mm thick (or move), spongy, light brown; bark of youngest branchlets 0.5 mm thick, pale tan, sparsely and coarsely fissured; inner bark green; only the youngest 1 or 2 internodes green and as yet not corky; wood white, very brittle; leafy branchlets mostly 3-9 mm diameter. Leaves opposite, simple, elliptic, the petioles to 5.5 cm long, but usually 1.5-3.5 cm long, 3.5 mm diameter, thickened at base and apex and there later becoming pale corky-barked, the rest remaining green, subterete, distally shallow-channelled above, not articulated, abscissing at the base; blade to about 22 × 11 cm but commonly smaller, usually 10-15 × 4-8 cm, acute or obtuse at apex and at base, thin and rather delicately coriaceous, rather rapidly wilting; margins entire to somewhat sinuous or shallowly irregularly crenate distally; upper surfaces medium-dark glossy green, lower surfaces paler apple-green, somewhat duller; glands pellucid or green but minute, numerous but not evident without a lens; midrib slightly raised or flat above, well raised beneath; main secondary nerves about 7 to 12 pairs, looped well within (3-5 mm) the margin; tertiary
Fig. 1. *Melicope suberosa* B.C. Stone, sp. nov. Details of holotype — *a:* flowering branch; *b:* older branch showing rugose corky bark; *c:* functionally pistillate flower, side view; *d:* the same, with petals removed, stamens sterile; *e:* capsule in top view; *f:* capsule in side view; *g:* capsule in top view, enlarged; *h:* one ripe carpel with extruded seed. (From Stone 15338; *b,e,f* to same scale as *a.*)
nerves and reticulations rather obscure in life, fine but evident in sicco; fresh blades very slightly scented on bruising.

Inflorescences axillary, pedunculate, up to 15-30 mm long, the peduncle somewhat compressed, 10-20 mm long, to 2.5 mm wide when fresh, channelled and somewhat shrunken when dry, subglabrous, but at first with minute and rather scattered conical 1-celled whitish hairs c. 0.1 mm long; bracts and bracteoles early caducous, c. 1 mm long, deltoid, scurfy; cymes congested, usually 3-flowered, or up to 3 or 4 partial cymes crowded near apex of inflorescence, with very short pedicels c. 1 mm long. Flowers greenish-white, the calyx about 2 mm high, the 4 deltoid lobes c. 1.3 mm long, green with pale or white scarious margins, minutely puberulent externally; petals 4, imbricate, folded, white tinged green, glandular, c. 4.3 mm long, narrowly ovate, the margins pale, the apex cucullate, glabrous within and subglabrous to minutely sparsely puberulent externally; staminodes in pistillate flower 8, glabrous, white, small, thin, with 4 slightly longer, anthers devoid of pollen, filaments 1-1.5 mm long, tapered, anthers 0.75 mm long, the connective dorsally with several small pale glands, the apex minutely apiculate; disk white, 1 mm high, slightly wider than the ovary; ovary 4-lobed, green, to 1.4 mm wide, minutely puberulent; style 1.25 mm long, pale green, puberulent in lower half; stigma pale, capitulate but 4-lobed, minutely papillose, glabrous. Pedicels in fruit pale, corky, 3-4 mm long, 2.5 mm diameter. Fruits 4-lobed, or by abortion 3- to 1-lobed, dark green, radiate, dehiscent and turning brown, to 20 mm wide, each lobe ovoid, to 9 mm long, 8 mm wide, 9 mm tall, glabrate, glandular, 1-seeded. Endocarp thin, horny, glabrous, detaching. Seed ovoid, c. 7 mm long, testa thin, glossy black; endosperm white.
MALAYSIA: Pahang: Genting Highlands, Gunung Ulu Kali, 1550 m alt., below hotel complex in remnant patch of montane forest; small tree to 10 m tall, trunk and all branches with thick, rugose, softly corky bark and brittle wood; leaves all simple, opposite, as are the branches; flowering and fruiting simultaneously; 17 November 1982, B.C. Stone & J.B. Lowry 15338 (KLUC and to be distributed).

A very characteristic species. The most remarkable features are the thick, deeply corrugated but soft and corky bark, which is a light or medium brown and covers all the trunk and main branches and even twigs, except the youngest; and the uniformly simple, non-articulate leaves, which are very slightly undulate-subcrenate toward the tips, glossy on both sides, somewhat paler below, with rather conspicuous nerves. The leaves when crushed are only very slightly scented, and the fruit pericarp is also but faintly odorous. The capsular follicles dehisce, the seed is extruded but remains attached on its placenta, and the pericarp quickly withers and turns brown. Fruits with 1-4 ripening lobes are found, but the lobes seem to be uniformly 1-seeded. Only pistillate flowers were seen, and the number of staminodes was uniformly 8, with no fertile anthers even in the youngest buds examined. The minute hairs on the ovary are rather ephemeral and the fruits appear quite glabrous when ripe.

Ecology: Five or six apparently full-grown individuals were found, all close together in a moist, originally well-shaped gully with dense vegetation and granite boulders, at 1550 m altitude on the uppermost slopes of G. Ulu Kali (the location is about 50 m higher than the Sri Genting Villa, and is on the SE. side of the road leading up to the Genting Hotels complex). The gully is rich in bryophytes but lacks Sphagnum. Currently it is being cut, the upper end opened and the understorey now largely exposed to much more insolation than originally must have been the case. So far, this species has not been found elsewhere; this small gully population is clearly threatened. (Seeds, seedlings and cuttings have been taken for cultivation, and it is hoped to distribute this species widely). Fruiting was rather abundant in the population and ripe seeds were visible on most of the trees at the time of collection (November). In addition, there were numerous seedlings underneath, especially on the rich organic matter.

All the individuals found were pistillate; the flowers, though possessing stamens, do not produce pollen, the anthers being somewhat rudimentary. It seems possible that the seeds found, and perhaps the seedlings as well, are the result of a non-sexual process of reproduction. Further exploration is required in the hope of finding additional individuals and particularly to find staminate (or perhaps bisexual) individuals.

The canopy trees in the area include Eugenia, Garcinia, Symingtonia, Lithocarpus, Litsea, and various other genera (see Stone, 1981), forming a canopy about 18-26 m tall, i.e. about twice as tall as the Melicope trunks. It is clear that this species is essentially an understorey species of the primary montane forest, and seems not to be a pioneer or colonizer species like the Euodias. The very brittle, easily broken wood, and quick wilting character of the Melicope is very noticeable and somewhat unusual in this forest. Other members of the substorey stage which reach about the same dimensions as the Melicope are Polysoma parviflora King, Prunus arborea (Bl.) Kalkm., Casearia capitellata Bl., and somewhat smaller shrubs include
Chasalia minor Ridl., Pinanga polymorpha Becc., and Arthrophyllum stonei Lim.

Relationships: The most similar species is one found on Mt. Kinabalu in Sabah, represented by J. & M.S. Clemens 51077, 51184, G. Mikil SAN 46579, Chew, Corner & Stainton 197, and RSNB 4547 and 4558. This species, as yet undescribed, has unifoliolate leaves. It differs from M. suberosa in having smaller flowers (with petals about 2.5 mm long), a glabrous perianth, and a glabrous gynoeicum. There are also on Mt. Kinabalu plants which are very similar, grading to a taxon with trifoliolate leaves (e.g. J. & M.S. Clemens 29810, 31048, 32562, 51052, Carr 27490, and Stone 11398). The latter taxon with trifoliolate leaves (represented by J. & M.S. Clemens 29477, 33623, Carr 27663, and Ding Hou 232) is in turn highly similar and may grade into a Sarawak taxon also with trifoliolate leaves (represented by Sibak ak Luang S. 22129 and Banying ak Nyudong S. 19031), which has smaller leaves, more delicate and longer inflorescences, and smaller fruits.

Amongst the already described species of Melicope, there do not appear to be any strikingly close to the new species. Some, such as M. mindanaensis Elmer, have unifoliolate leaves, but differ in important floral features. M. indica Wight differs in its more oboval leaves, pubescent stigma, and blunt anthers. M. monophylla Merr. differs in its hirsutulous branches, villous ovary, very short style and rugose coci. M. curranii Merr. differs in its smaller flowers, oblong-ovate to oblong-lanceolate leaves, and very long petioles. M. unifoliolata Merr. and M. helferi Hook. fil., of Borneo and Burma respectively, are not true Melicopes and have been reduced to Maclurodendron by Hartley (1982). The others mostly have trifoliolate leaves, or differ in other important respects.

In Engler’s treatment (1931) Melicope was subdivided into four sections, of which nowadays the last, Tetractomia, is best regarded as a well-defined genus of its own, as J.D. Hooker had originally ranked it. The other three are Entoganum (Banks ex Gaertn.) Engl., to which most of the species pertain; Astorganthus (Endl.) Engl., including only M. simplex A. Cunn. of New Zealand; and Brombya (F.v.Muell.) Engl. with only M. platynema (F.v.Muell.) Engl. of Queensland. The latter two are remote from the present new species.

Thus the relationships of M. suberosa appear so far to be with a complex of taxa, mostly undescribed, which occur in Borneo, especially on Mt. Kinabalu.

Seedlings: The seedlings of Melicope suberosa are noteworthy in that they occasionally produce some trifoliolate, or intermediate (bifoliolate) leaves. These seem always to be among the first four or five true leaves produced by the seedling. Later stages appear to have only simple leaves. These, as in the adult plants, are not articulated and can scarcely be called unifoliolate. Details of these seedling leaves are shown (Fig. 2).
Plate 1. *Melicope suberosa* B.C. Stone, sp. nov. a: leafy shoot with fruits. b: older stem, showing corky rugose bark. c: leafy stem with inflorescences; flowers at anthesis. d: ripe capsules. (All from the holotype; photographs by the author).
Acknowledgements

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References


CONTRIBUTIONS TO THE FLORA OF THE SOLOMON ISLANDS
II. Five new combinations in Araliaceae

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Abstract

Five species of Boerlagiodendron (Araliaceae), including four from the Solomon Islands and one from the New Hebrides, are transferred, according to nomenclatural necessity, to Osmoxylon.

Some years ago I revised briefly the East Melanesian species of Boerlagiodendron Harms, describing two new species and demonstrating that four species could be found in the Solomon Islands and another in the New Hebrides. Since then it has been shown that the generic name Osmoxylon Miq. must be used for this very distinctive group of plants. As the Araliaceae, apart from Schefflera, has now been published in the Flora Malesiana (Philipson, 1979), it is appropriate to prepare a correct nomenclatural list of the East Melanesian species to supplement my original paper (Stone, 1962). This list follows.

Osmoxylon Miq.


1. Osmoxylon puniceopolleniferum (Stone) Stone comb. nov.

2. Osmoxylon tetrandrum (C.T. White) Stone comb. nov.
   SOLOMON ISLANDS: San Cristoal, Walker BSIP 260 (K).

3. Osmoxylon orientale (Guill.) Stone comb. nov.
4. *Osmoxylon reburrum* (Stone) Stone **comb. nov.**

5. *Osmoxylon russellense* (Philipson) Stone **comb. nov.**

**References**


Annotated List of Seed Plants of Singapore (VIII)*

HSUAN KENG
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II. Angiospermae–Dicotyledons (cont’d)

111. Ericaceae

Rhododendron indicum Sweet

A densely branched shrub; leaves narrowly lanceolate to oblanceolate, 1.8-3.5 cm long, red-brown hairy. Flowers rose-red to scarlet, with round lobes, borne in short clusters at branch-tips. A pot plant introduced from Japan, has never set fruit here.

Rhod. longiflorum Lindl.

An epiphytic shrub with bright red flowers, formerly collected from lofty Hopea trees near the top of Bukit Timah, Ridley 2030 in 1891, now extinct.

112. Epacridaceae

Styphelia malayana Spr. (= Leucopogon malayanus Jack)

A shrub; leaves narrow and stiff with a sharp-pointed tip. Flowers white, in axillary clusters. Fruit red, baccate, Formerly found on the sea-shore near Changi, Tanah Merah, Ridley 1832, now extinct.

113. Sapotaceae

Key to the genera

1. Sepals 4, in two whorls .................................................. Ganua, Madhuca, Payena
1. Sepals 5, 6 or 8, in one or two whorls

2. Sepals 5, in one whorl
3. Staminodes 5 ........................................ Planchonella, Pouteria
3. Staminodes absent ........................................ Chrysophyllum

2. Sepals 6 or 8, in two whorls
4. Sepals 6
5. Stamens 6 ................................................. Manilkara
5. Stamens about 12 ........................................... Palaquium
4. Sepals 8 ....................................................... Mimusops

Chrysophyllum cainito L.
A tree with elliptic, drooping leaves. Leaf-blades coppery-silvery beneath. Corolla purplish white. Fruit large, broadly ellipsoid to spherical, 5-7 cm across, white or purple, with a star-like core in transverse section (hence Star-apple). Native of tropical America, occasionally planted.

Chrys. lanceolatum DC. (= C. roxburghii G. Don)
Tree; leaves dark green, with numerous pairs (12-35) of parallel secondary veins. Corolla yellow, 5-merous; staminodes absent. Fruit globose, 5-lobed. Tanglin, Bukit Timah (Sinclair SF 40200).

Ganua kingiana (Brace) v.d. Assem (= Madhura kingiana (Brace) Lam)
Large tree; leaves closely clustered. Flowers white, 1-6 per cluster, above the leaf scars. Bukit Timah, Ridley 6294, type of Bassia kingiana.

Ganua motleyana Pierre ex Dubard
Tree; leaves spiral, glabrous. In freshwater and peat swamps, Seletar, Jurong, Kranji, Bukit Mandai, Changi (Ridley 5645).

Ganua sessilis (K. & G.) Lam (= Payena sessilis K. & G.)
Leaves obovate, the base gradually tapered downward, hence appearing sessile. Tuas, Goodenough 5076, type.

Madhuca malaccensis (Clarke) Lam
Small or medium tree; leaves loosely clustered. Flowers white or yellow, many in axillary clusters. Gardens' Jungle, Ridley 6521.

Madh. sericea (Miq.) Lam
Medium tree; leaves yellowish brown to silvery, velvety below. MacRitchie Reservoir, Sinclair SF 39656.

Manilkara zapota (L.) van Royen (= Achras zapota L.)
Small tree; leaves glabrous, dark green below. Fruit roundish ovoid, up to 9×7 cm, the rind thin, brown; flesh pinkish, juicy, in which are embedded about 10 black seeds. The milky latex tapped from the trunk is known as Chicle or Chicle gum, the main ingredient of chewing gum. A native of tropical America, locally grown for its edible fruit, Chicku.

Mimusops elengi L.
Small or medium tree; leaves alternate or laxly spirally arranged, margin wavy and curled; flowers white, with 8 flat and hairy staminodes. Native to India and Thailand, often cultivated as an ornamental and roadside tree.
Palaquium gutta (Hook. f.) Baill.
Medium-sized tree, buttressed; leaves obovate to oblong-elliptic, spirally arranged, golden brown velvety below. Flowers pale green, in small axillary clusters. Fruit ovoid, 2.5 cm across. This species furnishes the top grade of Gutta Percha which was an important commodity for insulation material during the last century. Probably introduced from the Malay Peninsula, formerly widely planted; a small patch can still be found at the foot of Bukit Timah Nature Reserve.

Pal. hexandrum (Griff.) Baill.
Large tree; leaves obovate or oblong-elliptic, to 20 cm long; petioles glabrous, narrowly grooved above. Bukit Timah, Ridley 11373.

Pal. microphyllum K. & G.
Large tree; leaf-blades spatulate, less than 11 cm long; petioles finely hairy. Bukit Timah, Sinclair SF 38245.

Pal. obovatum (Griff.) Engl.
Medium-sized or large tree; leaf-blades obovate, leathery, to 35 cm long; flowers green, crowded along the twigs behind the leaves. Tanglin, Changi, Pulau Senang (Burkill & Kiah HMB 503). Vern. Nyatoth.

Pal. oxleyanum Pierre
Small to medium-sized tree; leaf-blades obovate, to 28 cm long; petioles strongly grooved above; very similar to P. gutta. Pulau Dammar Darat, Goodenough in 1892.

Pal. ridleyi K. & G.
Large tree; leaf-blades obovate to elliptic, to 12 cm long. In swamps; Kranji, Ridley 4796.

Pal. rostratum (Miq.) Burck (= P. bancanum Burck)
Large tree; leaf-blades obovate to spatulate, to 80 cm long. Gardens' Jungle, Bukit Timah (Mat 6134).

Pal. xanthochymum Pierre
Large tree; leaves obovate to spatulate, to 15 cm long. In freshwater swamps, Changi, Ridley 3639a.

Payena lucida (G. Don) DC.
Small or medium tree; leaves oblong, to 25 cm long; flowers in small axillary clusters; sepals 4, in two pairs; corolla white, mostly 8-lobed; stamens 16; fruit ovoid to ellipsoid, 2 cm across. Seletar, Ridley 5644, type.

Pay. maingayi Clarke
Medium-sized or large tree; leaves oblong, to 30 cm long, velvety beneath. Flowers white or pale yellow. Chua Chu Kang, Ridley 6696, Mandai Road.

Pay. obscura Burck (= P. havilandii K. & G.)
Leaves elliptic, to 15 cm long, glabrous beneath. Bukit Timah, Ngadiman SF 35800.
Planchonella maingayi (Clarke) Van Royen (= Sideroxylon maingayi Clarke)
Tree; leaves obovate. Like the next species, but leaves glabrous below, tertiary veins transverse. Less common; Gardens' Jungle, Bukit Timah (Liew 36465).

Planch. obovata (R.Br.) Pierre (= Sideroxylon ferrugineum Hook. & Arn.)
Small or medium-sized tree; leaves obovate, usually velvety below, tertiary veins reticulate; flowers small, 5-merous; staminodes tongue-shaped, alternate with corolla-lobes; fruit obovoid, small. In mangroves and on the sea-coast; Pulau Dammar Darat, Goodenough 2763.

Pouteria malaccensis (Clarke) Baehn. (= Lucuma malaccensis Dubard)
Large or medium-sized tree; flowers small, in leaf-axils, 5-merous; staminodes 5, alternate with corolla-lobes. Seletar, Mat 6499.

114. Ebenaceae

Diospyros argentea Griff.
Small tree with dense golden-yellow hairs on various parts; leaves oblong, 15-32 cm long; flowers 4-5 merous, in axillary cymes, usually dioecious; fruit round, about 5 cm across, covered with red hairs. In dense jungle, Bukit Timah, Changi (Hullett 410), Chua Chu Kang.

Diosp. buxifolia (Bl.) Hiern. (= D. microphylla Bedd.)
Tree; leaves small, ovate, 1.2-5 cm long. Fruit ellipsoid, 1.1 cm across, 1-seeded. Producing black heartwood, the Malacca Ebony. Bukit Timah, MacRitchie (Sinclair SF 39482).

Diosp. clavigera Clarke
Large tree; leaves obovate, 5-13 cm long. Fruit round, 1.2 cm across. Sungei Morai, Bukit Timah (Ngadiman SF 36396).

Diosp. diepenhorstii Miq. (= D. pyrifera Ridl.)
Leaves oblong, 15-30 cm long. Fruit obovoid or oblong, 8 cm across. Bukit Timah, Ridley 8101.

Diosp. discolor Willd.
Small, densely crowned tree; leaves lanceolate or oblong-elliptic, 8-30 cm long, densely hairy below; fruit depressed globose, 5-12 cm across, densely hairy. Native to the Philippines, occasionally planted for the edible fruits (Buah Mentega).

Diosp. ferrea (Willd.) Bakh. (= Maba buxifolia Pers.)
Leaves small, elliptic or obovate, 1.6-6 cm long. Fruit globose, 0.8 cm across. Often near the sea, Tempinis, Kranji (Ridley 6703).

Diosp. kaki Thunb.
Fresh fruits of the Chinese persimmon (¥t) are imported from China, Japan and Java usually during the end of the year. Compressed dried ones are sold in stores almost throughout the year.
Diosp. lanceifolia Roxb. (= D. lucida Wall.)

Leaves lanceolate to oblong-elliptic, 4.5-15 cm long. Fruit globose, about 2 cm across, beaked. In the forest, sometimes near the sea, Bukit Timah, Changi, Loyang, Tempinis.

Diosp. maingayi (Hiern.) Bakh. (= D. bilocularis Oliv.)

Leaves elliptic, 6-17 cm long. Fruit oblong, 3.5 cm across. Gardens’ Jungle, Changi (Goodenough s.n. in 1890).

Diosp. pilosauthera Blanco var oblonga (Wal. ex G. Don) Ng

Leaves oblong, 15-33 cm long. Fruit ovoid, 2.5 cm across, Bukit Timah, Tanjong Gul, Gardens’ Jungle (Abu Kassim 267).

Diosp. styraciformis K. & G.

Leaves lanceolate to oblong, 5-13.5 cm long. Fruit globose, to 2.5 cm across, pointed. MacRitchie, Samsuri 1463.

Diosp. venosa Wall. ex A. DC. (= Maba venosa (Wall.) K. & G.

Leaves lanceolate to elliptic. Fruit globose to oblong, 1.3-1.7 cm across. Changi, Ridley 4667.

115. Styracaceae

Styrax benzoin Dryand

Medium-sized tree; buttressed. Leaves ovate to elliptic, 6-20 cm long, glaucous beneath; corolla white, fragrant; fruit depressed-globose to globose, 2-3.8 cm across. Gum benzoin is a fragrant resin, tapped from deep incisions into the bark. It is used as incense and in medicine. Bukit Timah, Seletar (Ridley 2650), Chua Chu Kang, Gardens’ Jungle. Vern. Kemenyan.

Styr. crotonoides Clarke

Leaves elliptic to broadly ovate, 8.5-20 cm long, densely rust-hairy below; fruit ovoid to round, to 3 cm across. Recorded in Singapore by a single collection, Wallich 7848.

116. Symplocaceae

Symplocos adenophylla Wall, ex D. Don

Shrub or small tree; young twigs and undersurface of leaves covered with red brown hairs. Leaves ovate-lanceolate, 4-14 cm long; flowers white; fruits ellipsoid, to 0.8 cm long. The fruits of Symplocos are drupes, usually bluish when ripe, crowned with a persistent calyx, and have a ribbed stone. Seletar (Ridley 2752b), Tuas.

Syml. barringtoniifolia Brand (= S. rigida Clarke)

Small tree; leaves oblong or elliptic, 26-31 cm long; flowers white; fruit oblong, pointed, to 3 cm long. Changi, Ridley 5960.
Sympl. celastrifolia Griff. ex Clarke
Leaves elliptic to ovate, 5.5-12 cm long; fruit ovoid, to 1 cm long. Jurong,
Ridley 8423.

Sympl. fasciculata Zoll.
Leaves oblong-lanceolate, 5-11 cm long; fruit ovoid, with a short beak, blue,
6 mm long. In the forest and belukar, Bukit Timah, Chua Chu Kang, Tanglin,
Bukit Mandai (Ridley 3626a).

Sympl. odoratissima (Bl.) Choisy ex Zoll.
Leaves narrowly elliptic to obovate, 7.5-17 cm long; fruit ovoid, 0.8-1.5 cm
long. Bukit Timah, Ridley 4428.

Sympl. rubiginosa Wall, ex DC.
Leaves narrowly elliptic to obovate, 15-35 cm long; fruit ellipsoid, 0.8-1 cm
long. Chua Chu Kang, Bukit Timah (Ngadiman SF 36363).

117. Myrsinaceae

Key to the genera

1. Woody climbers
2. Ovary and fruit superior, seed solitary, globose ........................................... Embelia
2. Ovary and fruit half-inferior, seeds numerous, angular ................................... Maesa
1. Erect subshrubs, shrubs or small trees; fruit 1-seeded
3. Herbaceous subshrubs, rhizomatous; flowers in small fascicles along the rachis of a racemose in-
florescence ................................................................. Labisia
3. Shrubs or small trees, not rhizomatous; flowers in umbellate or other inflorescences, but not as
above
4. Fruit cylindric, curved, acute; pericarp dry, leathery ........................................ Aegiceras
4. Fruit globose, pericarp fleshy
5. Corolla-lobes contorted in bud, flowers perfect, style and stigma tapering to a point .......
................................................................. Ardisia
5. Corolla-lobes imbricate or valvate, stigma tongue-shaped ................................... Rafania

Aegiceras corniculatum (L.) Blanco
Shrub; leaves thick-leathery, obovate, 4-8 cm long; flowers pale pinkish, 10-20
in terminal and axillary umbels. Fruit cylindric, acute, curved, pericarp
leathery. In mangroves, Tuas, Changi (Ridley s. n. in 1890), Lim Chu Kang,
Pulau Ubin.

Ardisia corolata Roxb. (= Ard. stylosa Miq.)
Shrub or small tree; leaves papery, oblong-lanceolate, 12-25 cm long, variable,
reddish-brown beneath. Bukit Timah, Gardens’ Jungle, Changi Road, Jurong
Road (Ridley 11342).

Ard. crassa Clarke
Shrub or small tree; leaves leathery, narrowly oblong; panicles rusty pubescent,
flowers pink. Rare, Seletar, Chua Chu Kang (Ridley 3844).
**Ard. crispa** DC. (= *A. crenata* Roxb.)
Glabrous shrub; leaves thinly leathery, lanceolate, with a crenate margin, 5-10 cm long; flowers pink, in short umbellate racemes. In open places, Alexandra Road, Changi, Sentosa Island (*Samsuri 1347*).

**Ard. lanceolata** Roxb.
Shrub or small tree; leaves leathery, lanceolate or elliptic-oblong, 15-28 cm long, petioles winged; panicles terminal. Seletar, Bukit Timah (*Ridley 6436*).

**Ard. littoralis** Andr. (= *A. elliptica*)
Large shrub; leaves leathery, obovate, 8-12 cm long, nerves nearly invisible; flowers rose pink, 6-8 in an umbel, corolla gland-dotted. Drupe flattened, globose, red then black. In tidal swamps and muddy river banks. Changi, *Ridley 20115*.

**Ard. ridleyi** K. & G.
Slender spreading shrub; leaves membranous, oblong-lanceolate, 10-20 cm long. Sole record in Singapore: Ang Mo Kio. No specimens available.

**Ard. singaporensis** Ridl.
Small tree, young parts densely red-scurfy; leaves thinly leathery, elliptic-lanceolate, gland-dotted, 10-18 cm long. Rare, Pulau Ubin (*Ridley 2816, type*), and Changi Road; probably extinct.

**Ard. teysmanniana** Scheff. (= *Pimelandra wallichii* DC.)
Shrub or small tree; branches rusty tomentose; leaves papery, oblong or oblanceolate, 30-45 cm long, margin entire; flowers in branched short racemes. Gardens' Jungle, Bukit Timah (*Corner s.n. in 1940*), Changi, Nee Soon.

**Ard. tuberculata** Wall.
Glabrous shrub; leaves leathery, elliptic, 8-15 cm long, coppery scaly beneath; flowers pink, in a lax terminal panicle. In forests, Bukit Timah, Seletar (*Ridley 432*), Jurong, Gardens' Jungle.

**Ard. villosa** Roxb.
Small shrub; leaves papery thin, oblong-lanceolate, villose beneath, 10-20 cm long. In dense forests, Pulau Ubin (*Ridley 2809*).

**Embelia amentacea** Clarke
Slender climber, branches brown velvety; leaves papery, oblong, 3-8 cm long, pubescent beneath; flowers small, in panicles of slender hanging racemes. In secondary forests and their edge; Bukit Timah Road, Changi Road.

**Embelia canescens** Jack (= *E. garcinifolia*)
Slender woody climber; inflorescences terminal, red-hairy; fruit small, black. Catchment forests (*Goodenough 1822*), Changi (*Ridley 5927*).

**Embelia coriacea** DC.
Large liana; leaves stiff, coriaceous, oblong, 16-25 cm long; panicles very large, pendent, corolla white; fruit black. In secondary forests, Seletar, Bukit Mandai, Chua Chu Kang (*Ridley 2812*).
Emb. lampani Scheff.

Woody climber; leaves oblong, 4-8 cm long. In forest edge, Changi, Bukit Timah, Gardens' Jungle, Catchment forests (Ridley s.n. in 1906).

Emb. ribes Burm.

Slender woody climber; in forest edge, Changi, Bukit Timah (Ridley s.n. in 1889), Gardens' Jungle.

Emb. ridleyi K. & G.

Large climber; leaves thinly papery, oblong-acute, 10-18 cm long; panicles axillary. Forest edge; Chua Chu Kang, Bukit Mandai. Probably extinct.

Labisia pumila (Bl.) Benth. & Hook. f. (= L. pothoina Lindl.)

A shrublet; leaves variable, usually lanceolate-elliptic, crenulate, petioles short or long, sometimes winged (var. alata). Corolla pink, flowers in small clusters on a spike-like inflorescence; fruit globose, bright red, 3-4 mm across. In dense forests; Sungei Bajau, Bukit Timah, Kranji (Ridley 1799a), Changi. Vern. Akar Fatimah.

Maesa ramentacea Wall.

Scandent shrub or small tree; branches often bearing masses of abortive branchlets; leaves membranous, ovate-lanceolate, 8-20 cm long; flowers with a white corolla, very small, in axillary panicles. In secondary forests, Catchment forests, Bukit Timah (Ridley 2064).

Rafania avensis (Bl.) Mez (= Myrsine avensis DC.)

Small tree; leaves oblong-lanceolate, 3-6 cm long, nerves obscure; flowers in compact, few-flowered umbels. Drupe globose, 3-4 mm across. In mangrove forests, Bajau, Tanjong Gul (Sinclair SFN 39637).

Raf. umbellulata (Wall.) Mez (Myrs. umbellulata A. DC.)

Shrub or small tree; leaves oblanceolate, 4-8 cm long, nerves visible; flowers 3 or more in an umbel; drupe globose, 7-8 mm across. Near the sea, Changi, Chua Chu Kang (Ridley 6827).

118. Plumbaginaceae

Plumbago auriculata Lamk. (= P. capensis Thunb.)

A dwarf shrub, much branched; flowers in umbel-like clusters, corolla tubular, light blue. Native of S. Africa, planted as an ornamental or hedge. 萼雪花。

Plumb. indica Linn. (= P. rosea L.)

Corolla rose-pink or red. Native of India.

Plumb. zeylanica Linn.

Corolla white. Native of tropical Asia; cultivated or as garden escape on roadside, waste ground or near villages.
119. Plantaginaceae

Plantago major L. (or as P. asiatica Michx)
A herb with thin or thick rhizomes; leaves lanceolate to ovate, in a radical rosette; flowers small, white, in a spike-like inflorescence. A cosmopolitan weed, used in herbal medicine.

120. Loganiaceae

Key to the genera

1. Leaves with one main vein from the base; tendrils often present ......................... Strychnos
2. Leaves with 3-5 basal veins; no tendrils
   2. Corolla-lobes imbricate or contorted; fruit baccate ................................. Fagraea
   2. Corolla-lobes valvate in bud; capsules 2-valved ................................. Norrisia

Fagraea auriculata Jack
Epiphytic or climbing shrub; leaves stalked, with auricles present at the base of stalk; corolla tubular, large, to 30 cm long. Pulau Pawai (Sinclair SF 38900).

Fagr. crenulata Maingay ex Clarke
Large tree, trunk and branches often thorny; leaves obovate, 18-35 cm long, sessile, like those of the cabbage plant (hence Cabbage Tree). Native to the swamp-forests in S. Malaya, cultivated in large gardens or along roadsides. Superficially it resembles the Ketapang tree (Terminalia catappa), but the leaves are green and larger. Vern. Birah.

Fagr. fragrans Roxb.
Medium-sized tree; leaves elliptic, 5-13 cm long; flowers cream-white, becoming yellow, fragrant, 2 cm across; berry orange, round, 8 mm across. Usually found in open places and belukar, also widely planted. A form with a wavy leaf-margin and reddish brown bark, found in the primary forest, is sometimes considered as a separate species, namely Fagr. gigantea Ridl. Vern. Tembusu.

Fagr. racemosa Jack ex Wall.
Shrub or small tree, rarely climbing; leaves elliptic, 15-30 cm long, without distinct auricles, but stipules united around the twig into a short ocrea. In secondary forests, Changi (Goodenough 2783), Kranji.

Fagr. ridleyi K. & G.
Climbing or straggling shrub or small tree; leaves obovate, 15-25 cm long, secondary veins prominent below. Very rare, Bukit Timah (Ridley 11363), Sungei Karang.

Norrisia major Solered. (= N. malaccensis Gardn.)
Small tree; leaves oblong to elliptic, 6-10 cm long; flowers cream-yellow, in terminal corymbs, branched; capsules opening by parting of 2 valves. Mandai Road (Corner s.n. in 1937).
Strychnos axillaris Colebr. (= S. malaccensis Benth. & S. pubescens Clarke)

A liana, sometimes a shrub or small tree; twigs pubescent; leaves lanceolate to suborbicular, 9-12 cm long, 3-5 nerved from the base; flowers less than 0.5 cm long, corolla-tube nearly as long the limb; fruit ovoid, oblique, 1-1.5 cm across. Bukit Timah (Ridley 6317), Gardens' Jungle.

Strychn. ignatii Berg. (= S. ovalifolia Wall, ex G. Don)

Large liana; leaves ovate to elliptic, 8-12 cm long; flowers in axillary cymes, salver-shaped, 1-1.5 cm long, the corolla-tube longer than the limb; fruit globose, 5-8 cm across, on thickened branches. The seeds contain strychnine (Saint Ignatius' Bean); the roots are used for poison arrows and as fish poison. Changi, Gardens' Jungle, MacRitchie (Whitmore 68).

Strychn. ridleyi K. & G.

Climbing shrub; leaves oblong, 8-10 cm long; flowers 0.5 cm long, corolla-tube longer than the limb. Rare, once collected at Tuas, Ridley 6313 (type).

121. Gentianaceae

Nymphoides indica (L.) O. Kuntze (= Limnanthemum indicum Griseb).

Aquatic plant; leaves broadly ellipsoid or rounded, solitary at the top of stem or branches, floating; lowermost leaves submerged; flowers in fascicles, at the top of the petiole-like stem; corolla white, the lobes densely covered with long, white hairs. In shallow stagnant water at the margin of the Catchment Area, Haviland & Lim 5741.

122. Apocynaceae

Synoptic key to the genera

1. Herbs; leaves opposite (introduced and naturalised) .......................... Catharanthus
2. Trees, shrubs or woody climbers
   3. Leaves alternate and spiral
      4. Native plants, both wild and planted ............................ Cerbera
      4. Introduced plants ............................................. Thevetia, Plumeria, Adenium
   3. Leaves opposite or in whorls
      5. Leaves opposite
         6. Native plants .............................................. Kibatalia, Kopsia, Tabernaemontana
         6. Introduced and cultivated plants ......................... Carissa, Tabernaemontana
      5. Leaves usually in whorls of 3-8
         7. Native plants, small to larger trees ........................ Alstonia, Dyera
         7. Introduced cultivated plants, small trees or shrubs ... Nerium, Ochrosia, Strophanthus
   2. Climbers or scramblers,
      8. Leaves opposite
         9. Native plants Anodendron, Leuconotis, Melodium, Parameria, Strophanthus, Wilughbeia
         9. Introduced cultivated plants ....... Allamanda, Beaumontia, Chonemorpha, Odontadenia
      8. Leaves in whorls of 3-4
   10. Native plants .................................................. Alyxia
   10. Introduced cultivated plants .................................. Allamanda
Adenium obesum Balf. (= A. coetaneum Stapf)
A bushy shrub; 1-1.5 m tall; stem and branches thick, succulent; leaves ovate, 5-10 cm long, spirally arranged in tufts. Flowers purple or pink, funnel-shaped, 4-5 cm long, in small clusters. Native to E. Africa. A pot plant.

Allamanda cathartica L.
Climbing shrub; leaves opposite or in whorls of 3-4, oval-shaped, tapering at both ends, 10-15 cm long. Flowers broad-tubular, 4-5 cm long and across, in small clusters at branch-tips. A large flowered form, sometimes called A. hendersoni Rafill., native to Brazil, is often planted in gardens.

Allamanda violacea G. & E.
A climbing shrub also from Brazil. Differs from the above species in having flowers 5-7 cm across and a reddish-purple corolla. Less commonly planted.

Alstonia angustifolia Wall, ex A. DC.
Small tree, to 10 cm tall; leaves in whorls of 3, oblanceolate, 6-14 cm long. Fruit of 2 long, slender, woody follicles. Seeds small, numerous, flat, with a tuft of silky hairs at both ends. In the forest, Gardens’ Jungle, Bukit Timah, Jurong (Corner s.n. in 1933), Pasir Panjang.

Alst. angustiloba Miq.
Big tree, buttressed; branches in distinct whorls; leaves in whorls of 5-8, obovate-elliptic, 8-16 cm long. In the forest; Gardens’ Jungle (Ridley s.n in 1890), Sentosa Island. Vern. Pulai.

Alst. scholaris (L.) R. Br.
Small or big tree; leaves in whorls of 5-8, elliptic, 7-17 cm long. Native to the Malay Peninsula, sometimes planted.

Alst. spathulata Bl.
Small to big tree; leaves in whorls of 4-6, obovate, 7-10 cm long. In wet forests or swamps; Cluny road, Bukit Mandai, Changi (Sinclair SF 40541).

Alyxia reinwardti Bl. var. lucida (Wall.) Markgr. (= A. lucida Wall.)
Woody twiner; leaves thin-leathery, elliptic or obovate, 4-8 cm long, in whorls of 3-4. Flowers white, with an orange throat, fragrant. Drupe ellipsoid, pulpy, black. On the sea-coast; Kranji, Sungei Morai (Ridley 4427).

Anodendron candolleanum Wight
Big climber; leaves opposite, leathery, elliptic or obovate, 12-20 cm long. Flowers cylindric, yellow, very small, in panicles. Follicles dagger-shaped, 15-18 cm long. In swampy forests. No specimens available.

Beaumontia multiflora T. & B.
Woody climber, leaves opposite, oblong, 10-25 cm long, wavy-margined. Flowers funnel-shaped, 5-7 cm long and 8-10 cm across, white, fragrant, clustered at the end of branches. Native to SE. Asia; cultivated.
Carissa carandas L.

A much branched shrub; small branches zigzag and with opposite, sharp, bifid spines to 3 cm long. Leaves opposite, oblong, 3-7 cm long. Flowers in terminal cymes, solitary, salver-shaped, white, 3-4 cm across. Fruit a black berry. Native to S. Asia, sometimes grown as a hedge plant or for its edible fruit.

Catharanthus roseus G. Don (= Lochnera rosea Rchb. ex Steud.)

A perennial herb, 30-60 cm tall, ever blooming; leaves opposite, oblong, 3-8 cm across, rose-purple or white (var. albus Sweet) with a slender tube 2-3 cm long. Native to tropical America; cultivated as an ornamental, often wild.

Cerbera manghas L.

Small tree; leaves spirally arranged, obovate, 12-30 cm long. Flowers large, fragrant, white, with a pink eye in the throat of the corolla tube (2.5-4 cm long). Drupes solitary or in pairs, oblong, slightly compressed, 5-7 cm long. Rare, at Pasir Panjang and Katong. Vern. Pong Pong. Pink-eyed Cerbera.

Cerb. odollam Gaertn.

Like the above species but the corolla-tube is shorter (1.5-2 cm long), the eye yellow, and the drupe is roundish, 5-10 cm across. Common on sea-shores and mangroves, and planted along roadsides. Vern. Pong Pong. Yellow-eyed Cerbera.

Chonemorpha fragrans Alst. (= Ch. macrophylla G. Don)

Large liana with milky sap; leaves opposite, elliptic with a heart-shaped base, pubescent, 10-15 cm long. Flowers in cymes, bell-shaped, white, fragrant, 3-4 cm long. Native to the Malay Islands, sometimes found in gardens.

Dyera costulata (Miq.) Hook.f.

Huge tree, to 60 m tall, the bark dark grey, not buttressed; branches in whorls; leaves in whorls of 6-8, ovate-oblong, 7-18 cm long. Flowers in branched cymes. Fruit a pair of massive woody follicles, 20-30 cm long, a commercial timber tree, the latex used to be tapped for chewing gum. Vern. Jelutong.

Kibatalia maingayi (Hook.f.) Woodson (= Vallaris maingayi Hook.f.)

Medium tree, to 20 m tall; leaves decussate, elliptic, 7-10 cm long; flowers white, in axillary cymes or fascicles. Follicles oblong, slender, to 15 cm long. Seeds plumed. In the forest, Tanglin, Gardens' Jungle (Hassan SF 36262).

Kopsia fruticosa (Ker) DC.

Shrub or small tree; leaves oblong-lanceolate, 16-23 x 5-9 cm; flowers pink with a dark eye, grouped in a much-branched sessile cyme. Native to Burma, sometimes planted.

Kops. singaporensis Ridl.

Shrub or small tree; leaves oblong-ovate, 14-26 x 7-11 cm; flowers in large terminal dense cymes; corolla white, with a crimson eye. In forests, Chua Chu Kang, Seletar (Md Noor 17).
Leuconotis griffithii Hook.f.
Climber; leaves leathery, elliptic-oblong, 8-10 cm long; corolla yellow, 0.75 cm long; calyx thin, dry. In the forest, Serangoon Road (Ridley 9166), Seletar, Bukit Mandai, Jurong.

Leuc. maingayi Dyer
Leaves leathery, often in whorls of 3; corolla smaller and shorter (0.5 cm long) than the above species, calyx fleshy. In forest edge, Bukit Timah, Changi, Jurong (Ridley 3868).

Melodinus micranthus Hook.f.
Climber; leaves leathery, oblong-lanceolate, with 10-15 slender parallel nerves; flowers in axillary cymose panicles; corolla-tube slender, with bifid scales in the mouth. In the forest, Jalan Bray, Mat 5999.

Nerium indicum Mill.
Erect shrub; leaves leathery, narrowly lanceolate, 10-30 cm long, usually 3 in a whorl; flowers red, pink or white (often double), fragrant, 4-5.5 cm across. This is a native to South Asia, easily differentiated from the European Oleander (N. oleander L.) by its scented flowers.

Ochrosia borbonica Gmel. (= Calpicarpum oppositifolium Boireau)
Small tree with stout branches; leaves fleshy, 3-4 in a whorl, obovate, 10-25 cm long; flowers white, in short cymes; drupe ovoid, oblique. Serimbum, Ridley s.n. in 1894.

Odontadenia macrantha Markgr. (= O. speciosa Benth.)
A woody climber; leaves opposite, oblong, 10-25 cm long; flowers yellow or orange, many in terminal or upper axillary cymes; corolla salver-shaped, 6-10 across, the tube 3-4.5 cm long, 5-lobed. Native to tropical America.

Parameria glandulifera Benth.
Large climber; leaves opposite or 3 in a whorl, elliptic to obovate, 8-12 cm long; flowers white, bell-shaped, fragrant, very small (0.3 cm long), in terminal corymbose panicles, glabrous; follicles slender, 25-30 cm long. Locality unstated in Cantley's collection.

Param. polyneura Hook.f.
Like the above, but flowers pink, and, follicles much longer, 50-60 cm. Garden's Jungle, Changi. No specimens available.

Parsonia helicandra Hook. & Arn. (= P. spiralis Wall.)
Slender twiner, glabrous; leaves membranaceous, ovate-oblong, 7-15 cm long; flowers pinkish yellow, with a pink eye, very small. Follicles cylindric, linear-lanceolate, 8-15 cm long. Climbing up bushes, usually near the sea. Seletar, Tuas, Pulau Brani, Tempinis (Ridley s.n. in 1891).

Plumeria acuminata Ait.f. (= P. acutifolia Poir.)
A broad-crowned tree; branches thick, succulent; leaves oblong, pointed, 20-40 cm long, alternate and spiral, congested at branch ends; flowers funnel-shaped,
4-5 cm across, waxy, white with a yellow centre. The Frangipani is a native of tropical America.

*Plum. alba* L.

Like the above, but the leaf-tips blunt, and the white flowers much longer (the spread corolla 8-15 cm across). Other species and hybrids are also planted, one of them, *P. rubra* or the Red Frangipani with leaves having a pointed tip and flowers pink to red, also from tropical America.

*Strophanthus brevicaudatus* Wight (*= ? S. singaporianus* Gilg)

Erect shrub; leaves opposite, membranaceous, oblong-elliptic, 5-10 cm long; flowers small, purple, corolla-lobes not tailed; terminal cymes much branched; follicles cylindric, to 20 cm long. In damp, open places; Holland Road, Jurong, Balestier Plain (*Ridley 9149*), probably extinct.

*Stroph. dichotomus* DC. (*= ? S. caudatus* Kurz)

Stout shrub with long, slender trailing shoots; leaves obovate-oblong, 7-12 cm long; flowers white, corolla-lobes ovate, with long, slender tails, 7-10 cm long, purple; the follicles cylindric, twinned, stout, divaricate, each 20 cm long and 5 cm across. In open places and edge of forests; Changi (*Ridley s.n.* in 1890) Seletar. Vern. *Sembrong, Seram.*

*Tabernaemontana corymbosa* Roxb. (*= Ervatamia corymbosa* K. & G.)

Shrub or small tree; leaves leathery, elliptic, 15-40 cm long; petiole-base enlarged, clasping stem; corymb in upper axils, much branched; follicles often twinned, ovoid, curved, beaked, 3.5-4 cm long. Mandai Road, *Corner 30668*.

*Tabern. divaricata* Roxb. (*= T. coronaria* Willd., *Ervatamia divaricata* Burke)

Cultivated shrub, less than 60 cm tall; corolla white, often in double form; flowers 2-3 in a cyme. Probably native to N. India.


Slender shrub; leaves membranaceous, lanceolate, 4-10 cm long; cymes terminal and axillary; corolla white with a yellow throat; follicles oblong, falcate, beaked, orange, 2.5-3 cm long. Gardens’ Jungle (*Hullet 521*), Changi.

*Thevetia peruviana* K. Schum. (*= T. neriifolia* Juss.)

Much branched shrub; leaves leathery, alternate and spirally arranged, narrowly lanceolate, 8-14 cm long; flowers, many together in cymes, 1-2 blossoming at a time; corolla bright yellow, 6-7 cm long; drupe compressed-globose, 4-5.5 cm across. Native of Central America. Yellow oleander.

*Urceola brachysepalu* Hook.f.

Large climber; leaves papery, elliptic, 10-14 cm long; panicles terminal and axillary; flowers white, small, corolla globose, short; follicles cylindric, slender, 15-18 cm long. Jurong, Bukit Timah (*Ridley 8397*), Bukit Mandai.

*Urc. lucida* Benth.

Stout liana; leaves papery, elliptic, 7-12 cm long; follicles dagger-shaped below, recurved. Jurong, Changi, P. Ubin (*Ridley s.n.* in 1894).
Urc. maingayi Hook.f.
Large climber; leaves leathery, elliptic, 6-8 cm long; follicles terete, 15 cm long, the tip hooked. In the forest, Kranji, Goodenough 2717.

Urc. malaccensis Hook.f.
Climbing shrub; leaves leathery, ovate, 5-12 cm long; follicles terete, recurved, 20 cm long. Gardens' Jungle, Changi (Hullet 398), Bukit Timah, Bedok.

Urc. torulosa Hook.f.
Climber; leaves leathery, oblong-lanceolate, 10-17 cm long; follicles very slender, constricted at intervals. Gardens' Jungle, Tempinis (Ridley 3602a), Seletar, Nee Soon.

Willughbeia apiculata Miq. (= W. flavescens Dyer)
Differs from W. coriacea in the flowers being in slender-peduncled, lax cymes and in the smaller, spherical fruit (2-5 cm across). Chua Chu Kang (Ridley 6143), Changi.

Will. coriacea Wall. (= W. firma Bl.)
Large woody climber with tendrils (modified peduncles); leaves leathery, opposite, distichous, oblong-elliptic, 8-14 cm long; cymes sessile, axillary; flowers white; berry pear-shaped, orange to dull red, to 10 cm across. In the forest, common; Bukit Timah, Gardens' Jungle, P. Ubin, Tanjong Gul (Ridley 3594a).

Will. tenuiflora Dyer
Like W. coriacea, but leaves thin, leathery, oblong, 10-12 cm long; fruit larger, to 14 cm across. In the forest; Bukit Timah, Catchment Reserve forest (Corner s.n. in 1937).

Wrightia religiosa (T. & B.) Hook.f.
Shrub, less than 1 m tall, with many short and slender branchlets; leaves opposite, oblong-lanceolate, 2-5 cm long; flowers in terminal cymes; corolla white, salver-shaped, less than 0.5 cm long and 2 cm across. native to Thailand, a popular bush planted for training as bonsai or miniature plant. 永株。

123. Asclepiadaceae

Synoptic key to the genera

1. Erect herbs, shrubs or small trees
   2. Erect herbs ................................................................. Stapelia, Asclepias
   2. Shrubs or small trees .................................................. Calotropis

1. Climbers
   2. Corolla-tube very short or almost none, or corolla wheel-shaped ... Cynanchum, Finlaysonia, Genianthus, Hoya, Sarcolobus, Tylophora

2. Corolla with a distinct tube
   3. Corolla urn-shaped .......................................................... Dischidia
   3. Corolla bell-shaped ....................................................... Physostelma, Telosma
   3. Corolla salver-shaped or funnel-shaped ......................... Ceropegia, Stephanotis, Toxocarpus
Asclepias curassavica L.

Perennial herb, 50-60 cm tall; leaves opposite, narrowly oblong, both ends pointed, 5-12 cm long; flowers umbellate; corolla red; corona orange, protruding; fruit a pair of follicles, erect; seeds with a tuft of silky hairs. The milkweed is a native to tropical America, occasionally planted as an ornamental.

Calotropis gigantea (Willd.) Dryand ex Ait.f.

Bushy shrub or sometimes a small tree, to 5 m tall; young parts woolly-greyish; leaves elliptic, 10-35 cm long, fleshy; flowers in umbellate clusters; corolla white to pale lilac, 2.5-3.5 cm across; corona prominent. Native to India and the Malay Islands.

Ceropegia woodii Schlecht.

Slender tuberous vine; leaves heart-shaped, mottled with dark green; flowers 2-3 together, pinkish; corolla tube 1.5-2 cm long, with swollen base. Native to S. Africa, occasionally planted in hanging baskets.

Cynanchium ovalifolium Wight

A slender twiner; leaves thin, oval or oblong, 6-10 (-15) cm long, tip pointed; flowers 5-15 in a bundle; corolla 5-6 mm across, yellowish, tipped red; follicles narrow oval, 8-10 cm long, pointed. Cluny Road, Balestier Plain, Bukit Timah Road, Holland Road (Ridley 11456).

Dischidia albiflora Griff. (= D. collyris Wall.)

Slender creeper, epiphytic; leaves rounded or kidney-shaped, buff-yellow above, purple beneath, lying flat on the trees; flowers white. Ants often nesting between the leaves of the epiphyte and the branches of the host tree. Tanglin, Chua Chu Kang (Ridley 2928), Bukit Timah, Kranji.

Disch. bengalensis Colebr.

Large creeping epiphyte; stem glaucous green, long and nearly leafless, or with a few narrow oblong leaves, 2-3 cm long; flowers creamy white. In the forest near the sea; Bajau, Kranji, Ridley 2729.

Disch. cochleata Bl. (= D. coccinea Griff.)

Stem slender; leaves fleshy, rounded (1.5-2 cm across), crowded together, the edges pressed close to the bark of the host tree, harbouring ants and roots; flowers scarlet, tipped blue. Usually on lofty trees; Bukit Timah, (Ridley s.n. in 1896), Seletar, Chua Chu Kang.

Disch. hirsuta Decne

Stem slender; leaves small (1-2.5 cm long), purple green, hairy; flowers red. In the forest; Seletar, Chua Chu Kang (Goodenough s.n. in 1889), Kranji.

Disch. major Merr. (= D. rafflesiana Wall.)

Epiphytic twiner; leaves opposite, of two forms: the smaller ones rounded (2-2.5 cm across), the pitcher leaves oblong, pouch-like (7-12 cm long), outside yellowish green, inside purple, with holes at the base for ants and aerial roots. Flowers golden yellow, in small umbels. Common on trees all over the Island especially near the sea. Berlayer (J.H. Burkill 239).
Disch. nummularia R. Br. (= D. gaudichaudii Decne)
Creeping epiphyte; stem very slender; leaves small (5-6 mm long), thick and fleshy; flowers pale yellow or white, 2-3 in leaf-axils. In open places often in masses closely covering the tree trunk and limbs and causing damages to the host trees, throughout the Island. Tyersall Road Ridley 5746.

Disch. singaporensis Ridl.
Leaves ovate, flat, 1.5-2.5 cm long. Collected only once at Changi by Ridley (Ridley s.n. in 1908, type).

Finlaysonia obovata Wall. (= F. maritima Backer)
Woody climber; leaves fleshy, green, broadly obovate, 5-10 cm long; flowers in branched axillary cymes; corolla 1 cm across, yellowish green, purplish in the centre; follicles pear-shaped, oblique, 3-4 ribbed, 8-10 cm long. In mangroves and on tidal river banks, Kranji, Geylang (Ridley s.n. in 1893).

Genianthus maingayi Hook.f.
Slender climber, with a purply pubescence; leaves leathery, oblanceolate to obovate, 6-9 cm long; flowers reddish white, very small (2-3 mm long), in long spikes. Bukit Timah, Cantley s.n. (not seen).

Hoya coriacea Bl.
Epiphytic climber; leaves thin, ovate-lanceolate, 12-15 cm long; flowers yellowish white, tipped purplish. Collected once at Tempinis (D'Almeida s.n. in 1893).

Hoya coronaria Bl.
Densely hirsute; stem stout; leaves coriaceous, elliptic, 8-10 cm long. Flowers waxy, 2-3.5 cm across, the largest of all the species; when opened, white, with a yellow tint, then becoming pink. Common near the sea, Serangoon, Changi, Kranji, P. Tekong, Ulu Berih (I.H. Burkill 4336).

Hoya diversifolia Bl.
Leaves fleshy, elliptic-obovate with narrowed base, 10-13 cm long; umbels 1-20 flowers; flowers pink. Often densely covering trees; Jurong, Chua Chu Kang, Kranji, Serangoon (Ridley 2733).

Hoya finlaysonii Wight
Leaves coriaceous, ovate-oblong. Collected once from Singapore (Wallich 2724).

Hoya lacunosa Bl.
Creeping epiphyte; leaves thick-fleshy, lanceolate to ovate, 2-4 cm long; corolla white. On trees; Tanglin, Seletar, Bukit Mandai, Chua Chu Kang, Bukit Timah (Ridley s.n. in 1892).

Hoya latifolia G. Don
Stem deep red young; leaves fleshy, ovate with a heart-shaped base, up to 25 cm long; flowers small, pink. On trees in dense jungles; Kranji, Seletar, Pong-gol, Changi, P. Tekong, Changi (I.H. Burkill 10013).
Hoya obtusifolia Wight
Stout climber; leaves oblong thick, 12-15 cm long; umbels 1-20 flowers; flowers yellow, with a pinkish centre. Serangoon (Ridley 8932), Changi, Bukit Timah.

Hoya parasitica Wall (= H. ridleyi K. & G.)
Leaves fleshy, elliptic with cuneate bases, 8-10 cm long; umbels 1-40 flowered; flowers pink or white. Often near the sea, Changi, Chua Chu Kang, Tuas, Kranji, Pulau Tekong (Ridley 1796).

Physostelma wallichii Wight
Slender climber; leaves oblong to elliptic, abruptly pointed, 5-12 cm long; umbels 1-40 flowered; flowers large, in axillary bundles; corolla bell-shaped, 2-2.5 cm across, thin, cream-white, with a purple centre; fruits long and narrowly cylindric, 15-20 cm long. Tempinis River (Ridley s.n. in 1894), Kranji, Tuas.

Sarcolobus globosus Wall.
Small twiner; leaves fleshy, oblong, pointed, 7-10 cm long; flowers small in umbels, light purple with brown streaks; follicles nearly globose, ridged on one side, greyish brown; seeds not plumed. On edges of mangroves and river banks. Changi, Seletar, Serangoon (Ridley 11640). Pulau Ayer Chawan.

Stapelia nobilis N.E. Br.
Small leafless herb; stem cactus-like, succulent, bluntly 4-angled, 5-20 cm long, with soft spines; flowers star-shaped, dark purple, 3-5 cm across, hairy. Native to Africa, sometimes planted.

Stephanotis floribunda Brongn.
Climber; leaves oval, leathery, shiny, 5-10 cm long; flowers in axillary clusters, tubular, waxy, white, 2.5-5 cm long, fragrant. Native to Malagasy (Madagascar).

Steph. maingayi Hook.f.
Climber; flowers white, bigger than the above species. Once collected at Changi (Hullett 147).

Telosma cordatum Merr. (= Pergularia minor Andr.)
Slender vine; branches downy; leaves cordate, 4-11 cm long, pubescent below; flowers yellowish green, bell-shaped, about 1 cm long, in axillary clusters. Probably a native to E. Asia, occasionally cultivated.

Toxocarpus griffithii Decne
Slender twiner; leaves papery, elliptic-oblong, 5-10 cm long; flowers in small clusters; corolla-lobes pinkish-crimson outside, yellow inside; follicles cylindric, 25-30 cm long. Jurong, Corner s.n. in 1933.

Tylophora asthmatica W. & A.
Slender twiner; leaves oblong or ovate-lanceolate, 4-10 cm long; flowers small in compound umbels, yellow or pink; follicles narrowly lanceolate, 8-10 cm long. In sandy places by the river or sea; Changi, Ridley s.n. in 1891.
Tyl. squarrosa Ridl.
Slender twiner; leaves ovate, 5-8 cm long; flowers in racemes. Tanah Merah (Ridley 2737). Probably synonymous with T. wallichii.

Tyl. tenuis Bl.
Slender climber; leaves small, lanceolate, tip pointed, 2-6 cm long; flowers small, purple, in axillary, spreading inflorescence. In open places or on banks of tidal rivers; Alexandra Road. (Ridley 5746), Sentosa, Tanjong Rhu.

124. Oleaceae

Key to the genera

1. Scrambling, scadent or climbing shrubs ........................................ Jasminum
   1. Erect shrubs or trees
      2. Flowers 4-merous
         3. Trees; corolla-lobes nearly free to the base ............................ Linociera
         3. Shrubs; corolla-lobes connate below .................................... Olea
      2. Flowers 5-merous; cultivated shrubs .................................. Nyctanthes

Jasminum bifarium Wall.
Scrambling or climbing shrub; leaves simple, opposite, ovate-lanceolate, 4-8 cm long; flowers 3-5 in axillary clusters higher up; calyx 5-7 lobed; corolla-tube 1.5-2.5 cm long, 5-7 lobed, the pointed; drupe black. In open country and hedges; Tanglin, Balestier Plain, Mandai Road (Sinclair SF 40007), Changi, Vern. Melor Hutan.

Jasm. griffithii Clarke
Scandent or climbing shrub; hairy; leaves ovate or elliptic, 10-15 cm long; cymes densely hairy; corolla-tube 1.5-2 cm long, drupe white. In forests, Gardens’ Jungle, Chua Chu Kang (Goodenough s.n. in 1893).

Jasm. longipetalum K. & G.
Slender climber; leaves elliptic to lanceolate, 5-15 cm long, 3-nerved from the base; flowers in short cymes; corolla-tube 2 cm long, 9-lobed, the lobes linear-oblong, acute, 2-2.5 cm long; fruit glabrous, black. In forests, Mandai, Ridley 10937.

Jasm. rex Dunn
Climbing shrub, glabrous; leaves simple, 3-5 nerved at the base; flowers white, often tinted violet, odourless; corolla-tube 2.5-3 cm long, 5-11 lobes, the lobes oblong-obovate. The Royal Jasmine is native to Thailand, often cultivated.

Jasm. sambac Ait.
Scandent or climbing shrub; leaves oval or rounded, 2.5-5 cm long; flowers white, often violet outside, fragrant; corolla-tube 0.7-1.5 cm long, 8- or more lobed, the lobes oblong to oval, blunt, or often the corolla double. Native to India, often planted in gardens. 苹莉花.
Linociera ramiflora (Roxb.) Wall (= L. pauciflora Clarke)
Small tree; leaves coriaceous, elliptic-oblong, 10-20 cm long; flowers in panicles; petals oblong. In wet forests, Jurong, Bukit Timah, Bukit Mandai (Goodenough 5079), Seletar.

Nyctanthes arbor-tristis L.
Shrub, much-branched, the branches 4-angled, hairy; leaves ovate, 4-11 cm long, flowers in cymose panicles; corolla tube orange, 1-2 cm long, the lobes white; capsule dark brown, 2-seeded. Night blooming, strongly fragrant; native to India, one of the sacred plants of that country; occasionally cultivated. (The genus Nyctanthes is sometimes classified under Verbenaceae). Vern. Seri Gading.

Olea brachiata Merr. (= O. maritima Wall.)
Much-branched shrub; young parts pubescent; leaves leathery, elliptic or ovate-lanceolate, 7-10 cm long; flowers in cymose panicles; corolla globose or campanulate, yellow, very small; drupe pear-shaped, 7-8 mm long, black. In open places near the sea, Changi (Sinclair SF 40017), P. Ubin.

ADDENDA, CORRIGENDA ET EMENDANDA

A) MALPIGHIACEAE

Through an oversight the family Malpighiaceae was left out in the previous treatment. The following is to be read after 85. Erythroxylaceae and before 86. Oxalidaceae on page 341, in Gdns’ Bull. Sing. 33(1980).

1. Erect shrubs; fruit smooth, neither winged nor horned
   2. Leaves membranous, entire, with 2 glands at the base .......................... Galphimia
   2. Leaves leathery, usually with spiny teeth, glandless .......................... Malpighia
1. Scandent or twining shrubs; fruits winged or horned
   3. Petals yellow
      4. Flowers in racemes; petals ± equal, keeled ................................. Tristellateia
      4. Flowers in umbellate clusters; petals unequal, not keeled .................. Stigmaphyllum
   3. Petals white or pink
      5. The central mericarp surrounded by a large oblong wing, and the 2 lateral by smaller and narrow wings ................................................. Hiptage
      5. Mericarps surrounded by broad, oblong to orbicular wings ................ Aspidoptreys

Aspidoptreys concava (Wall.) Juss.
Liana to 20 m tall; young parts dark-red hairy; leaves ovate-elliptic, opposite; panicles axillary, flowers white, ovary glabrous, with 3 winged sides; samara of 3 membranous, ovate to orbicular, winged mericarps. In forests, Bukit Mandai, Seletar, Chua Chu Kang, Bukit Timah (Ridley 3583a), Nee Soon.
Galphimia glauca Bartl.

Shrub, to 2 m high; young parts reddish hairy, older twigs brown, glabrous; leaves oblong, 2.5-5 cm long, with 2 small glands at the base of the blade; flowers yellow, in terminal racemes. Native to Central America, cultivated in gardens.

Hiptage sericea Hook.f.

Climber; young twigs densely brown hairy; leaves oblong, 4-6 cm long; flowers pink and white, in axillary racemes; samara 3-winged, the central wing 3-4 cm long, and 2 lateral wings 1.5-2 cm long. In open places, Changi (Ridley 3989), Bukit Mandai.

Malpighia coccigera L.

Small shrubs, 1-2 m high; leaves leathery, elliptic, 1-2 cm long, entire or with a few spiny teeth; flowers axillary, single or in pairs; petals pinkish, fringed, abruptly narrowed at the base. From the West Indies, planted as hedges or in pots as a miniature plant or bonsai.

Stigmaphyllon cilia (Lam.) Juss.

A slender woody vine; leaves heart-shaped, 2.5-6 cm long, with hairy edge; flowers 3-7 in a cluster; petals pinkish, fringed, abruptly narrowed at the base. From the West Indies to Brazil, occasionally planted.

Tristellateia australasiae A. Rich.

Liana to 10 m tall; twigs purple, lenticellate; leaves oblong-ovate, 7-12 cm long; petioles with 2 small stipules at the base; racemes terminal; flowers bright yellow; samara of 3 mericarps, the lateral wings of the mericarp 4-10 lobed or horned, expanding in one plane, star-shaped. In mangroves, tidal swamps or in forests; often cultivated in gardens. Jurong, Ridley s.n. in 1894.

B) VITACEAE (Gdns’ Bull. Sing. 35: 86-88, 1982)

Dr. Abdul Latiff Mohamed of Universiti Kebangsaan Malaysia, in a letter dated 19th January 1983, kindly informed that the following 8 species should be included in this family.

1. Pterisanthes cissoides Bl.
   Nee Soon, Enoch s.n. in 1955.

2. Pter. eriopoda (Miq.) Planch.
   Chua Chu Kang, Ridley 425.

3. Ampelocissus ascendiflora Latiff
   Catchment Reserves, Bukit Timah (Ridley 5846).

4. Ampel. polystachya (Wall.) Planch.
   Bukit Timah, Sinclair SF 39649.

5. Ampel. thrysiflora (Bl.) Planch.
   Changi, Ridley s.n. in 1893.
6. **Tetrastigma lanceolarium** (Roxb.) Planch.
   Bukit Timah, *Ridley s.n.* in 1894.

7. **Tet. curtisii** (Ridl.) Suesseng.
   Bukit Timah, *Ridley s.n.* in 1894.

8. **Cissus quadrangularis** L. (alt. names: *Vitis quadrangularis* Wall.)
   Native to Bengal, India; sometimes cultivated as a hedge plant, also used in local herbal medicine

   Dr. Latiff also mentioned that he has elevated *Vitis macrostachya* Miq. or *Ampelocissus spicifera* Planch. to a generic status, namely *Nothocissus*, recently published in *Mus. J. (N.S.)*, 27, 1983.
The Genus *Trisetum* (Gramineae) In Malesia And Taiwan

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**EFFECTIVE-PUBLICATION DATE: 14TH OCT. 1983**

**Summary**

In Malesia and Taiwan there are three taxa of *Trisetum* Pers. (Gramineae): *T. bifidum* (Thunb.) Ohwi in Taiwan and New Guinea, *T. spicatum* (Linné) Richt. ssp. *kinabaluense* Chrtek in Sabah and the ssp. *formosanum* (Honda) Veldk., *comb. nov.*, in Taiwan. *Trisetum flavescens* (Linné) Beauv. must be the conserved type of the generic name. Some subspecific epithets proposed by Hultén (1959) under *T. spicatum* are validated.

**Introduction**

The genus *Trisetum* Pers. belongs to the Aveneae and is characterised by the lemma, which is awned in the distal half and has a bifid to bisetose apex. It is very close to *Koeleria* Pers., in which the lemma has a (sub-) apical awn and an entire apex. Some species are intermediary in these characters, as could be expected, but since they are annuals, the life-cycle has been used to place them conveniently in separate satellite genera. Thus we have *Parvotrisetum* Chrtek and *Trisetaria* Forssk. next to *Trisetum* and what is generally called *Lophochloa* Reichenb. next to *Koeleria*. Life form seems a very weak character, especially when it is the only one to base genera on, and it is then not surprising that some authors, e.g. Paunero (1950), Jacques-Félix (1962) have united *Trisetum* with *Trisetaria*, the latter name being the oldest. Jonsell (1978, 1980) has kept them separate, but retained some annuals in *Trisetum*. Unfortunately he has not yet explained the exact reasons for doing so. As we intended to study only the Malesian and Taiwanese taxa, we did not want to get involved in the problems of generic delimitation and have here used the more usual generic name *Trisetum*.

There is yet another problem about the application of the name *Trisetum*, however. The generally accepted lectotype of this is *T. pratense* Pers., a superfluous name for *T. flavescens* (Linné) Beauv. (cf. Hitchcock, 1920; Kergüelen, 1975); the Index Nominum Genericorum erroneously followed Britton & Brown’s (1913) arbitrary typification, which must be rejected. They appointed *T. striatum* (Lamk.) Pers., but that is a taxonomic synonym of *Helictotrichon sempervirens* (Vill.) Pilg., the lectotype of *Helictotrichon* Besser! (See Sevenster & Veldkamp, 1983). It has not been realised, however, that as early as 1827, Besser (between July and December) and Link (in October or November) restricted *Trisetum* to the *annual* species, and by retaining *T. parviflorum* (Desf.) Pers. as the only species in it, Link made that the obligatory type! Jonsell has kept that species in *Trisetum* but Holub (1974) has included it in *Rostraria* Trin., which he claimed is the correct name for *Lophochloa*, but which then rightfully would be the ‘true’ *Trisetum*. What everyone else has called *Trisetum* must then be named *Acrospelion* under which name Besser placed the perennial species including *T. flavescens*. This is of course most undesirable and
therefore Veldkamp (1983) has proposed to make T. flavescens the conserved type of both Trisetum and Acrospelion, whereby the latter name becomes superfluous.

Various attempts have been made to distinguish infra-generic entities in Trisetum. For America, Louis-Marie (1928) has proposed a system which was based on morphological characters; for Europe, Chrtek (1965) made another using the anatomy of the leaves and roots. The two systems are incompatible: Louis-Marie’s subgenus Heterolytrum (= Trisetum) includes all of Chrtek’s subgenera, while sections of the latter were not recognised by Louis-Marie at all.

The species under study here belong to the subgenus Trisetum, with T. bifidum in the sect. Sibirica Chrt. (1968), reduced to a subsection of sect. Trisetum by Probatova (1978), and T. spicatum in sect. Trisetaera Aschers. & Graebn.

Ridley (1916) described T. latifolium from New Guinea and mentioned the presence of T. spicatum [as T. subspicatum (Linné) Beauv.] there. The type of the first name belongs to Arundinella furvata Chase, the material of the second to Anthoxanthum angustum (Hitchc.) Ohwi.

Some 18th century collections labeled “Timor” represent T. antarcticum (Forst. f.) Trin. This locality is no doubt erroneous, for this species is otherwise only known from New Zealand and some Antarctic islands. If it really occurred in Timor, it could only have been found in the mountains, but the collectors at that time had not yet penetrated so far inland. This species is certainly not the same as T. spicatum spp. australiense Hultén, although the name is cited in the latter’s synonymy by Hultén (1959). It is a ‘good’ Trisetum and certainly not a Hierochloë as stated by the International Code of Botanical Nomenclature (1975)! Here its basionym, Aira antarctica, is cited as the basionym of Disarrenum antarcticum Labill., the type of Disarrenum Labill. a name rejected against Hierochloë. De Labillardière in fact did mention Forster’s name as possibly belonging to what he described and depicted, but his doubts were soon validated when Forster’s material turned out to belong to Trisetum and its own, to what now is known as Anthoxanthum redolens (Vahl) Royen. The reference to Forster must therefore be deleted from his protologue and the Code emended. If it is maintained that Aira antarctica must nevertheless be regarded as the basionym, the whole entry of Disarrenum must be deleted, as that name then be regarded as a later, heterotypic synonym of Trisetum!

Acknowledgements

This study was initiated by the second author during a course in advanced Angiosperm taxonomy at the Rijksherbarium and finished by the first author. The descriptions are mainly based on material present in L., specimens of the T. spicatum-complex seen by Hultén were kindly sent on loan from S by Dr. K. Bremer, making possible the validation of some of Hultén’s combinations, while Veldkamp was able to annotate specimens in BO and SING during a visit to these Institutes. The latter also made the drawings, which were carefully inked by Mr. J. van Os, Leiden.
Literature


Trisetum


Trichaeta Beauv., Agrost. (1812) 86, 179, t. 17, f. 8. — Type: Trichaeta ovata (Pers) Beauv. [= Trisetum ovatum Pers.; the basionym of this is Bromus ovatus Cav., 1801, non Gaertn., 1770, so Persoon is the validating author].

Rupestrina Provancher, Fl. Canad. (1862) 689. — Type: Rupestrina pubescens Provancher, non. superfl. [= Trisetum spicatum (Linné) Richt.].

Perennials. Innovations folded or involute. Ligule membranous. Panicle lax to densely contracted. Spikelets laterally compressed, (1–) several-flowered, disarticulating above the glumes and between the lemmas (rarely below the glumes in some N. Am. spp.), all florets bisexual except for the variously reduced uppermost one(s). Glumes in situ shorter to longer than the lemmas, of ± the same consistency or thinner, unawned, keeled; lower glume usually 1-nerved; upper glume usually 3-nerved, equal to or longer and wider than the lower one. Rachilla prolonged, nodes puberulous to pubescent. Lemmas usually awned above the middle, apex usually bifid and bi-aristate, 3–5-nerved; callus usually shortly hairy. Palea 2-nerved, not enclosed by the lemma in fruit. Lodicules 2, membranous, bilobed, margin puberulous to glabrous. Anthers 3. Ovary apically glabrous or with only a few hairs; styles free at base, protruding laterally. Caryopsis fusiform, ± terete, not furrowed; hilum subbasal, punctiform to elliptic, inconspicuous; embryo small; endosperm ± liquid.

Distribution. Temperate regions, in the tropics in the high mountains. Depending on the classification, 50–75 species, 2 in Malesia and Taiwan.

Key

1. Peduncle densely pubescent below the contracted panicle. Axis densely pubescent. Lower glume 0.6–1 times as long as the first lemma, Apical teeth of the first lemma 0.4–0.7 mm long . . . 2
1. Peduncle and axis glabrous, panicle lax, nodding. Lower glume 0.5–0.6 times as long as the first lemma. Apical teeth of the first lemma 1.5–2 mm long.—Lower glume 2–5 mm long. Upper glume 4.5–6.5 mm long. First lemma 5–7.5 mm long. Anthers 0.9–1.3 mm long. Taiwan, New Guinea ................................................................. 1. T. bifidum
2. Lower glume 3.5–5 mm long, 0.6–0.8 times as long as the first lemma. Upper glume 5–7 mm long. First lemma 4.5–6 mm long, apical teeth ± 0.4 mm long. Taiwan ................................................................. 2a. T. spicatum spp. formosanum
2. Lower glume 6–7 mm long, ± as long as the first lemma. Upper glume ± 8 mm long. First lemma 6–6.5 mm long, apical teeth ± 0.7 mm long. Sabah . . 2b. T. spicatum spp. kinabaluense
1. Trisetum bifidum (Thunb.) Ohwi


Bromus avenaeformis Steud., Syn. 1 (1854) 326. — Lectotype: Burger s.n. (L, holo, 908.98-239, here proposed), Japan.


Trisetum bifidum (Thunb.) Ohwi var. oshimense Honda, Bot Mag. Tokyo 49 (1935) 697. — Type: Jotani s.n. (TI, holo, n.v.), Japan, Prov. Izu, Oshima, Sashikijji, 1933.

Tussocky perennial, up to 90 cm high, with a shortly creeping rhizome. Culms densely pubescent at base, becoming glabrous upwards. Ligules collar-shaped, 0.5-2 mm long, margin usually glabrous. Blades flat, up to 20 cm by 5 mm, ± appressed pubescent to glabrous above, glabrous beneath. Peduncle glabrous. Panicle ± lax, nodding, 10-20 by 2-5 cm across, axis glabrous, lower branches 2 or 3 together, longest one up to 5.5 cm long with 20-25 spikelets, scabrous. Spikelets 5-9 mm long, 2-4 flowered, at least the lower two florets bisexual. Glumes acuminate, scabrid on the nerves; lower glume 2-5 mm long, 0.5-0.6 times as long as the first lemma, 1-nerved; upper glume 4.5-6.5 mm long, 0.6-0.75 times as long as the second lemma, 3-5-nerved. Rachilla nodes 1.5-2 mm long, process 2-2.7 mm long, hairs 0.2-0.5 mm long. First lemma lanceolate, 5-7.5 mm long, scabrid-punctate, somewhat shiny at base, 3-nerved, callus hairs ± 0.3 mm long, apical teeth 1.5-2 mm long; awn L-shaped, inserted in the apical quarter, usually horizontally patent, column 2-4 mm long, arista 5-7 mm long. First palea 3-5 mm long, keels ciliate, apex bifid, brown-suffused. Lodicules 0.8-1 mm long, oblong, bidentate. Anthers 0.9-1.3 mm long. Caryopsis fusiform, ± 2.75 mm long.

Distribution. China (E. of Szechuan–Kwantung), Korea, Japan, Taiwan, Malesia: New Guinea (Snow Mts., Lake Habbema, Brass 9118; W. Sepik, Star Mts., Tel Besin, Veldkamp 6248; Central, Iswan Swamp, Van Royen 10867).

Ecology. Banks of rivulets, well-drained slopes, on limestone, old native camps, 2660-3225 m in New Guinea, at around 2000 m in Taiwan (Hsu, 1978).

Collectors' notes. Tussocks to 30 cm across, culms divergent, to 60 cm long. Leaves bright green. Inflorescence pendulous, spikelets green to silvery purple, awns divergent in fruit. Anthers and stigmas white.

Chromosome numbers. 2n = 28 (Lee, 1966; Hsu, 1971; Tateoka, 1978), 42 (Hsu, 1972).

Notes. This species is not as closely related to Trisetum flavescens as is sometimes thought. In Probatova's system it belongs to subsection Sibirica (Chrtek) Probatova, while the other species, being the generic type, belongs to subsect. Trisetum. As the latter is a good forage grass, it has been introduced in many parts of the world, and may perhaps sometime appear in Malesia and Taiwan also. It differs from T. bifidum by having at most only a slightly scabridulous lemma with an S-shaped awn, white to silvery paleas, and anthers 1.5-3 mm long (for the connoisseurs: x = 6, not 7).

Thunberg's specimen is filed under Avena antarctica in UPS. It is annotated Bromus bifidus and Aira antarctica and under that latter name there is a collection by Forster f. marked Bromus bifidus, but with the 'bifidus' partly crossed out. Schweickerdt (Bothalia 3, 1937, 198) who personally studied these specimens noted that the last one matches another in K, which, we may add, is Trisetum antarcticum (Forst. f.) Trin. In L there is a specimen given by Thunberg to D. van Royen, which we assume is an isotype of Bromus bifidus.

The Code errs where it cites, under the nomen conservandum 206 Hierochloë,
Aira antarctica Forst. f. as the basionym of Disarrenum antarcticum Labill. De Labillardière only doubtfully included the reference to Forster's plant, which is Trisetum antarcticum (Forst. f.) Trin., while his own is Anthoxanthum redolens (Vahl) Royen. (See introduction here and R. Brown, Prodr., 1810, 209).

This species has a very curious distribution, 'jumping' from Continental Asia and Taiwan to New Guinea, while it is not found anywhere else in Malesia. Comparable patterns are known for only a few other species: Carex bilateralis Hayata, C. brachyathera Ohwi, C. curta Gooden., C. duriuscula C. A. Mey., C. finitima Boott (also in Sumatra), C. michauxiana Boeck, Eleocharis attenuata (Franch. & Sav.) Palla, Fimbristylis dictyocolea S. T. Blake (Cyperaceae), Drosera rotundifolia Linné ssp. bracteata Kern & Steen. (Droseraceae), Germainia capitata Balansa & Poitrasson, Hemarthria pratensis (Balansa) Clayton (Gramineae), Myriophyllum propinquum Cunn. or M. verticillatum Linné (Haloragaceae) to which a sterile collection from the Wissel Lakes is thought to belong; Hypericum gramineum Forst. (Hypericaceae), Utricularia minor (Lentibulariaceae). It is remarkable that, but for the savannah grasses, all these species are montane to subalpine and rare to very rare (Germainia ranges from 0-2000 m). The cause of this phenomenon can only be speculated on. Some also occur in Australia.

2. Trisetum spicatum (Linné) Richt.


For further synonymy see Hultén (1959) and Kergüelen (1975).

This species has one of the widest natural distributions of flowering plants known (Hultén, 1959): Eurasia, North and South America, New Zealand and Australia. It is no wonder that it is very variable and so Hultén thought he could distinguish at least 14 subspecies in it. Chrtek (1968, 1970) added two more and Petrovsky (1979) another. Unfortunately Hultén gave no key, while his diagnoses are often incompatible and vaguely worded; several of his names are moreover invalid as he did not indicate types. Opinions on the acceptance of these subspecies differ widely. Hitchcock et al. (1969) remark that at least for their area 'well marked geographical races are not delimitable ... (and) serve(s) no useful purpose', while Bor (1960) remarked that for the taxa in the Himalaya 'it is by no means possible to make any clear-cut division ... (It) is a polyploid complex which cannot be worked out by the examination of even a large number of dried specimens.' Chrtek (1970), however, 'is inclined to accept' them. Undoubtedly the best guide for identification at present
is provided by the provenance, but at least the plants from Sabah and Taiwan appeared to be really distinct from each other and from material identified by Hultén as ssp. *alaskanum* in S, although that does not seem to be homogenous and can possibly be split up further. Therefore, although a much clearer account of the complex is necessary to clear up the difficulties, we have decided to follow Hultén and Chrtěk. The plants from Taiwan must therefore be regarded as a subspecies to avoid the suggestion that they might represent a taxon subjugated to one of Hultén’s, e.g. ssp. *alaskanum*.

2a. *Ssp. formosanum* (Honda) Veldk., *comb. & stat. nov.* — Fig. 1b.


Tussocky perennial, up to 50 cm high. Culms glabrous at base, becoming pubescent upwards to villous under the panicle. Ligules lingular, 1.5–3 mm long, margin sometimes erose, glabrous. Blades flat, up to 15 cm by 5 mm, glabrous, scabridulous. Peduncle villous. Panicle contracted, erect, 8–15 by 0.5–1.5 cm across, axis villous. Spikelets 5–7 mm long, 3-flowered, the uppermost florets sometimes variously reduced. Glumes acute, scabrid on the nerves, greenish, rarely purple; lower glume 3.5–5 mm long, 0.6–0.9 times as long as the first lemma, 1-nerved; upper glume 5–7 mm long, ± 0.9–1 (or more) time as long as the second lemma, 3-nerved. Rachilla nodes ± 1.2 mm long, process ± 1.5 mm long, hairs 0.8–1.1 mm long. First lemma 4.5–6 mm long, scabridulous, 3–5-nerved, callus hairs 0.2–0.5 mm long, apical teeth ± 0.4 mm long; awn nearly straight to S-shaped, inserted in the upper 3/10–4/10 th, column 1–2 mm long, arista ± 4 mm long. First palea 3–5 mm long, keels scabridulous, apex bidentate. Lodicules ± 0.5 mm long, bidentate. Anthers ± 1.75 mm long. Caryopsis not seen.

*Distribution.* Endemic to Taiwan [Van Steenis 20698, 20937 (L), Tamura et al. 20823, 22135 (S)]

*Ecology.* Subalpine grasslands, roadsides in Pinus forest, 3000–3950 m.

*Chromosome number.* N = 14 (Chen & Hsu, 1962).

*Note.* The ecological data have been taken from the numbers cited above as other records are scanty, at most stating ‘alpine grass’.
Fig. 1. Spikelets of *Trisetum spicatum* (Linnê) Richt. — a. subsp. *kinabaluense* Chrtek, *J.M.B. Smith* 512; b. subsp. *formosanum* (Honda) Veldk., *Tamura et al.* 20823; all × 6.

2b. Ssp. *kinabaluense* Chrtek — Fig. 1a.


Tussocky perennial, up to 40 cm high. Culms pubescent at base, becoming villous upwards. Ligules lingular, 2–3 mm long, margin sometimes incised, ciliolate. Blades flat, up to 15 cm by 5 mm, slightly to moderately pubescent. Peduncle villous. Panicle contracted, 8–10 by 1–2.5 cm across, axis villous. Spikelets 6–9 mm long, 3-flowered, the uppermost floret variously reduced. Glumes acute, slightly scabrid, with distinct brown, green and purple areas, sometimes green all over; lower glumes 6–7 mm long, about as long as the first lemma, 1(–3)-nerved; upper glume ± 8 mm long, ± 0.8 times as long as the second lemma, 3-nerved. Rachilla nodes 1.5–2 mm long, process ± 1.2 mm long, hairs ± 0.7 mm long. First lemma 6–6.5 mm long, scabridulous, 5-nerved, callus hairs 0.1–0.3 mm long, apical teeth ± 0.7 mm long; awn L-shaped, horizontally patent, inserted in upper \( \frac{1}{10} \) th, column 2–3 mm long, arista ± 4 mm long. First palea ± 5 mm long, keels scabridulous, apex bidentate. Lodicules ± 0.3 mm long, bifid. Anthers ± 1.5 mm long, yellow. Caryopsis not seen.

Ecology. Seepage fens, disturbed places, sometimes weedy, 2650-3760 m alt.

Excluded Taxa

1. *Trisetum antarcticum* (Forst. f.) Trin. var. densum Ridl. in Forb., A naturalist’s wanderings (1885) 522, nomen. — Lectotype: Wiles & Smith s.n. (BM, holo; L), Timor, Kupang, October 1792.

Although this combination was not validly published, it represents the purported occurrence of the species for Malesia. The plants on which it was based belong to a form of *T. antarcticum*. At BM there are two collections from Timor, one by Nelson, who accompanied Capt. Bligh on the expedition of the Bounty, and one by Wiles & Smith, who joined the Captain on his voyage with the Providence. *Trisetum antarcticum*, however, occurs only in New Zealand and some Antarctic Islands. It is, moreover, doubtful whether Nelson collected any plants in Timor, as Bligh (Voyage to the South Sea, 1792, 240, *fide* Britton, J. Bot. 54, 1916, 352) reported that he was too ill to move around. If the species indeed did occur in Timor (it has not been collected since), it could only have grown in the mountains, where none of these collectors could have gone. It is obvious that mislabeling must have taken place.


Ridley’s original specimens (*Kloss s.n.*, Mt. Carstensz, camps xiii–xiv) were seen at BM. Van Royen equated it with *Anthoxanthum horsfieldii*, but that is an endemic Javanese species. Henty, who had no access to the specimens, merely corrected the name used by Ridley.

Appendix
(by J. F. Veldkamp)

Hultén did not validly publish all his new taxa because he forgot to indicate their types. Now that we have seen some of his specimens in S which were mentioned by him and sometimes even depicted, these names can be validated:


*Trisetum spicatum* (Linnê) Richt. ssp. *ovatipaniculatum* Hultén was validated by Jonsell, Svensk Bot. Tidskr. 69 (1975) 132 with its lectotype represented by *Hoppe s.n.* (S, holo, n.v.: L), Austria, Karinthia, summit of Mt. Glockner, mistakenly cited by Hultén (f. 2b) ‘Tirol, Treffer’. Jonsell suggested that Hultén had indicated types on the sheets, but the ones seen by us were not so designated. Some had remnants of a red label which had been torn up.
A Revision of *Heteropholis* and *Thaumastochloa* (Gramineae)

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**EFFECTIVE-PUBLICATION DATE: 14TH OCT. 1983.**

**ABSTRACT**

*Heteropholis* C. E. Hubb. (Gramineae, Rottboelliiinae) has 4 allopatric species in Central Africa, Madagascar, Sri Lanka and from India to central Malesia. For Taiwan *H. cochinchinensis* (Lour.) Clayton var. *chenii* (Hsu) Sosef & Koning is here distinguished. The related genus *Thaumastochloa* C. E. Hubb. has 7 species mainly in Australia of which 3 are newly described here: *T. monilifera* Sosef & Koning, *T. rubra* Sosef & Koning, *T. striata* Sosef & Koning. *T. major* S. T. Blake also occurs in the Aru Islands off the south-west of New Guinea, and *T. rariflora* (F. M. Bailey) C. E. Hubb. in Papua New Guinea. A suspected hybrid between *T. major* and *T. pubescens* (Benth.) C. E. Hubb. is reported. A cladistic study indicates that the two genera may be paraphyletic.

**INTRODUCTION**

**HISTORICAL BACKGROUND**

When C. E. Hubbard (1936) described *Thaumastochloa* (Gramineae, Rottboelliiinae) he included *T. cochinchinensis* (Lour.) C. E. Hubb. from SE. Asia and for Australia *T. brassii* C. E. Hubb., *T. pubescens* (Benth.) C. E. Hubb., *T. rariflora* (F. M. Bailey) C. E. Hubb. and an unnamed, insufficiently known species. Ohwi & Odashima (1937) included *T. shimadana* (Ohwi & Odashima) Ohwi & Odashima from Taiwan, which was soon reduced to a form of *T. cochinchinensis* by Ohwi (1942). In 1941 S. T. Blake added *T. major* S. T. Blake and *T. constricta* S. T. Blake from Australia, while Hsu (1971) proposed *T. chenii* Hsu for Taiwan.

*Heteropholis* as described by C. E. Hubbard (1956) originally included the African *H. sulcata* (Stapf) C. E. Hubb., the Ceylonese *H. nigrescens* (Thw.) C. E. Hubb. and an unnamed species from Madagascar, which he gracefully left to Miss Camus to describe. She described it in 1956 as *H. benoistii*.

Clayton (1981) transferred *T. cochinchinensis* to *Heteropholis* and remarked that as a result *Thaumastochloa* would be restricted to Austraalia. This aroused our curiosity as Jansen in his unpublished treatment of the grasses of Malesia, Chase (1939), Reeder (1948), Henty (1969), and Lazarides (1980) had recorded at least two other species for Malesia. As the identification of these collections had turned out to be difficult, a full survey of all material became necessary, and as we were not quite satisfied about the generic delimitation of the two genera, *Heteropholis* was also completely revised.

**RELATIONSHIPS OF THE GENERA**

Both genera can be placed without any problem in the *Rottboelliastra* sensu Clayton (1973), but the generic delimitation within this group and its distinction
from related genera is far from clear, as was also indicated by Clayton. The use of fused versus free stipes of the pedicelled spikelets to distinguish the *Rottboelliastrae* from the *Coelorachidastrea*, respectively, makes the species with partly fused ones difficult to place, e.g. *Rottboellia coelorachis* Forst.f., *Robynsiochloa purpurascens* (Robyns) J.-Fél. of the *Rottboelliastrae* and *Coelorachis striata* (Steud.) Camus, occasionally of the *Coelorachidastrea*.

The presence of two sessile and one pedicelled spikelet per joint is supposed to be the character that distinguishes *Mnesithea* Kunth from *Coelorachis* Brongn. The expression of this feature, however, is variable even within a single inflorescence of *M. laevis* (Retz.) Kunth, the type, while on account of the presence of stipes that are at least apically fused to the rachis, the species should not have been included in the *Coelorachidastreae*. Other species sometimes regarded as belonging to *Mnesithea* often have only a few triads at the base of the inflorescence and with their free stipes are better accommodated in *Coelorachis* (Heidweiller & Van der Klaauw, MS). One collection of *T. major* (q.v.) also had such triads and fused stipes.

Several species of *Heteropholis* and *Thaumastochloa* have been included in *Ophiuros* Gaertn., which differs mainly by having the sessile spikelets in two opposing rows while the lower floret of the sessile spikelet is usually paleate and male, but may also become epaleate and sterile or paleate and female or bisexual with lodicules present whenever the sexual organs are developed (Avé, MS). In other *Rottboellinae* the pedicelled spikelets alternate from the right hand side to the left, joint for joint, throughout the raceme.

Close to *Heteropholis* seems to be *Robynsiochloa purpurascens* of which we have seen no material. Here the lower floret of the sessile spikelet is paleate and male, while the pedicelled spikelet is well-developed, 1- or 2-flowered with the lower floret male and the upper male or sterile (apparently without lodicules). Although this species resembles especially *H. sulcata*, it is an annual and thus does not fit the transformation series thought to be represented in *Heteropholis*.

The distinction between *Heteropholis* and *Thaumastochloa* is at first rather obvious: *Heteropholis* comprises perennial plants with a persistent peduncle and completely fragmenting spikes or racemes, the species allopatrically distributed in the Afro-asian tropics, while *Thaumastochloa* contains annual plants in which the peduncle breaks off at its base and remains attached to the lowermost joint of the fragmenting spike (of course not fragmenting when only one joint is developed), the species being found more or less sympatrically in tropical Australia.

On the other hand there appears to be a gradual transition in the reduction of the various parts from West to East and we have tried to test the hypothesis that the present situation would be the result of a West-East migration with an ultimate centre of speciation in Australia from an ancestor which had become annual and had evolved this peculiar diaspare.
Differeniating Characters for Genera

When looking at the differentiating characters singly they seem not to be too impressive at the generic level.

Life form has occasionally been used to distinguish between genera, e.g. in European literature, but even for Europe this is not very satisfactory: *Avena* L. would include annual species only, but Baum (1977) grudgingly had to include one perennial, which renders a distinction against Helictotrichon Besser and *Avenula* (Dum.) Dum. very vague (see also Sevenster & Veldkamp, 1983). A similar situation where life form is apparently the single distinctive and thus an unsatisfactory feature is present in *Trisetum* Pers., Koeleria Pers. (perennials), and *Rostraria* Trin., and *Trisetaria* Forstt. (annuals) (see Veldkamp & Van der Have, 1983). On the other hand many genera are generally accepted to contain both annual and perennial species, a distinction which in the humid tropics becomes difficult to maintain anyhow. The species of *Thaumastochloa* are apparently annual, but a few collections of *T. major* have been annotated 'biennial' and 'short-lived perennial', so whatever the latter may be, doubt creeps in whether under favourable situations an extended longevity would not be possible in at least that species.

Is mode of dispersal a 'dependable' generic character? Apart from the fact that in taxonomy no a priori value can be given to any feature, although some act as if it were otherwise, and that evaluation depends on the situation and the careful consideration of the revisor, it is frequently employed in this alliance, Clayton (1981), for instance, distinguished Manisuris L. from *Glyphochloa* Clayton on the mode of disarticulation of the raceme. In many cases, however, the form of the diaspare depends more on the degree of modifications of structures already present in the related taxa than on the presence of really different ones. In *Heterophilis* the lowest point of breakage in the inflorescence is below the lowest joint of the rachis, and in *Thaumastochloa* this is at the base of the peduncle, but it seems illogical to confer a separate generic status to *T. rariflora* where the articulation often takes place at the one but last vegetative node, so that the diaspare is composed of the uppermost internode and its leaf, the peduncle and the single or double joints of the rachis.

It should be obvious that distribution by itself cannot be considered as a generic character, and even its employment at the infra-specific level may not be absolute. Theoretically, disjunctions and isolation may cause distinct forms to evolve into distinct species and in the end, perhaps, genera, but in the present case the 'unit' *Thaumastochloa* fits in very well with the allopatric pattern shown by the species of *Heterophilis*. If there was but one species in Australia, how great would then be the inclination to distinguish it at generic level? The fact that there are several instead should not be an inducement to do so, tempting as it may be. Distribution should be correlated with other characters and can then at most be regarded as a confirmation of a conclusion already reached.

The correlation between life form, diaspare and distribution shown by the present two genera is of course interesting, but do three rather weak characters constitute proof when found together? At most they are very suggestive, but the alternative possibility that only a single genus with radiate speciation in Australia is involved could not be overlooked.
Fig. 1. Alternative models of phylogenetic relations in *Heteropholis* and *Thaumastochloa*. — • o o: different apomorphous character-states. — p: parallel apomorphous states. — 1-10: character-states according to Table 1. — H1-4, T1-7: species of *Heteropholis* and *Thaumastochloa*. For further explanation see text.

Table 1. Survey of characters

<table>
<thead>
<tr>
<th>Character</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plants perennial</td>
<td>yes / no</td>
</tr>
<tr>
<td>2. Sheaths longer than 0.5 times</td>
<td>yes / no</td>
</tr>
<tr>
<td>the internodes</td>
<td></td>
</tr>
<tr>
<td>3. Peduncle falling of with the</td>
<td>no / yes</td>
</tr>
<tr>
<td>uppermost internode and its leaf</td>
<td></td>
</tr>
<tr>
<td>4. Peduncle articulating at base</td>
<td>no / yes</td>
</tr>
<tr>
<td>5. Peduncle adnate to the lower-</td>
<td>no / yes</td>
</tr>
<tr>
<td>most joint of the spike</td>
<td></td>
</tr>
<tr>
<td>6. Peduncle smooth</td>
<td>yes / no</td>
</tr>
<tr>
<td>7. Number of spikelets per spike</td>
<td>11—more / 4--10 / 1--3</td>
</tr>
<tr>
<td>8. Spikes homomorphous</td>
<td>yes / no</td>
</tr>
<tr>
<td>9. Articulation of joints straight</td>
<td>yes / no</td>
</tr>
<tr>
<td>10. Lower glume distinctly winged</td>
<td>yes / narrowly / no</td>
</tr>
<tr>
<td>11. Margin of lower glume</td>
<td>yes / no</td>
</tr>
<tr>
<td>12. Nerves of lower glume</td>
<td>7 / 9 / 11</td>
</tr>
<tr>
<td>13. Anthers (length in mm)</td>
<td>2--more / 1--2 / up to 1</td>
</tr>
<tr>
<td>14. Pedicelled spikelet</td>
<td>male / 2 glumes only / 1 glume / 0</td>
</tr>
</tbody>
</table>

It is presumed that the character state on the left hand side is plesiomorphous, except for 2, 12 and 13, where the sequence is arbitrary.
We disagree with the views of Roberty (1960), who regarded all species of *Thaumastochloa* as subvarieties of *Rottboellia corymbosa* L.f. (now *Ophiuros exaltatus* (L.) O. Ktze) and those of *Heteropholis* as varieties of *Rottboellia myuros* (L.) Benth. (now *Manisuris myuros* L.).

**A CLADISTICAL APPROACH**

The use of cladistics causes one to look very carefully at the characters employed in a taxonomic study and may reveal certain erroneous preconceptions. We have employed this method in an attempt to shed some light on the present situation.

After extensive descriptions of all the taxa were made, at least fourteen characters seemed to be of some significance (Table 1) from which two alternative models could be deduced, having as few parallel apomorphies as possible (Fig. 1). In order to estimate the probable polarity of a character-state, the account of Clayton (1973) was used where numerical taxonomy was applied to the awnless genera of the *Andropogoneae*. The *Rottboelliastrae* as distinguished by him, excluding our genera, has been used as the out-group.

Characters 4, 5 and 6 should be regarded as belonging to the complex that makes an effective pseudo-awn possible and are probably best considered as a single character; they have therefore been enclosed by a broken line.

To characters 12 and 13 no polarity could be attributed, but the arbitrary choice made here does not seem to have much effect on the models.

For *T. major*, character 7 has been placed between brackets in the lower part of fig. 1 (summation of features) because of the heteromorphous spikes. Characters 3 and 8 might have been omitted because of their uniqueness for which reason the creeping habit of *H. nigrescens* was not mentioned, although these features set the various species apart.

In model A one can decide that a single genus is represented, if no generic value is accredited to the set of characters offered by 1, 4, 5, 6, 10 and 14. These divide the taxa into two groups which correspond with the two original genera. When, however, the correlation of these, perhaps minor characters is considered as evidence for a generic status, the old situation is maintained.

In model B a single genus can also be accepted, the extent of which remains uncertain; it is more easy here to envisage further steps 'upwards', whereby more taxa would be included. No infra-generic groups can formally be distinguished, however, because of the paraphyly involved, although the *Thaumastochloa*-alliance remains distinct. To do so would require the creation of three or four distinct taxa, which seems highly unsatisfactory. Nevertheless, because of one lesser partial parallelism between *Heteropholis* and *Thaumastochloa*, this model has a slight advantage. This model corresponds with a clinal variation coupled with the reduction of the pedicelled spikelet terminating in a secondary radiative speciation in Australia, which was the alternative explanation outlined above before the cladistics were done. It should
be noted that in neither model there is a complete correlation with the geography: the pedicelled spikelet is more reduced in *H. benoistii* from Madagascar than in *H. nigrescens* from Sri Lanka.

To make an educated guess as to which model should have preference, the out-group must be known in more detail. Only then a good insight can be obtained of the evolutionary tendencies within it. At present it seems therefore irresponsible to choose in favour of either model with any certainty. Hence, for the present, matters are better left as they were, and so we have kept the genera distinct.

**ACKNOWLEDGEMENTS**

This survey was started during a course in advanced Angiosperm taxonomy by the first two authors based on the material present in L. Subsequently other material was kindly sent on loan from A, BM, BO, BRI, K, KYO, P, PERTH, SING, TAI, TI, and W, to the Keepers of which we are very grateful. The last author guided the process, edited and translated the final report. The Director and Staff of the Rijksherbarium are much thanked for the opportunity and assistance, especially Mr. J. H. van Os who prepared the fine drawings and advised on the graphical presentation. Advice rendered by Dr. M. Zandee, Laboratory of Experimental Plant Systematics, Leiden, and Dr. R. van der Meijden (L) on the intricacies of cladistics are much appreciated. Finally, the authors wish to thank Mr. Wong Khoon Meng, Forest Botanist, Forest Research Institute in Kepong, for his critical comments on the original manuscript.

**LITERATURE CITED**


**KEY TO THE GENERA**

1. Perennials. Peduncle smooth, not articulating at base. All joints of the spike articulating in fruit. Central Africa to Micronesia, not in New Guinea. ......................... *Heteropholis*

1. Annuals. Peduncle scabrous, articulating at base or with the uppermost internode and its leaf. Lowermost (or the only) joint of the spike persistent in fruit. Australia, New Guinea. ....

................................................................. *Thaumastochloa*

**HETEROPHOLIS**


Perennials, branching intra-and/or extra-vaginally at base. Ligules collar-shaped, membranous, margin ciliolate. Peduncle glabrous, smooth, not articulating at base. Spikes ± terete, dehiscing transversally into swollen joints, which bear a sessile spikelet and a more or less reduced pedicelled one, with a ‘knob’ at base (remnants of the vasculature). Spikelets unilaterally in 1 or 2 slightly alternating rows, unawned. Sessile spikelets sunken into the joints, with 2 florets, the lower one reduced to a lemma, the upper one bisexual. Callus short, glabrous. Lower glume slightly convex, indurated, 5–11-nerved, smooth or with longitudinal rows of small pits between the nerved or rugose, 2-keeled, glabrous or margins at base puberulous, margins narrow, stiff, infolded, apex more or less winged, acutish. Upper glume boat-shaped, slightly keeled, 3–7-nerved, scarios to membranous. Lemmas and paleas obtuse, scarios to slightly membranous. First lemma 2-nerved. Second lemma 0–3-nerved. First palea absent, second palea present, 0- or 2-nerved. Lodices pre-
Fig. 2. Sessile spikelets of Heteropholis. — a. H. sulcata (Quarré 137); b. H. benoistii (Bosser 15241); c. H. nigrescens (Davidse & Sumithraarachchi 7961). × 15.

Map 1. Solid stars: Heteropholis sulcata; diamond: H. benoistii; open star: H. nigrescens; circles: H. cochinichinensis, s.l.; triangles: Thaumastochloa spp.
sent in the upper floret, broad- to oblong-cuneate, truncate, glabrous. Anthers 3, purple. Styles 2, free; stigmas purple. Caryopsis ovoid to broadly ellipsoid, dorsally flattened; hilum (sub)-basal, punctiform; embryo 0.5-0.8 times as long as the caryopsis. Stipe of the pedicelled spikelet partly to entirely adnate to the joint. Pedicelled spikelet much reduced to absent, 1-flowered, male or neuter. Glumes, when well-developed, herbaceous to indurated, the lower one keeled, 5–9-nerved, not sculptured, the upper one boat-shaped, sometimes with an infolded margin, 3–5-nerved. Lemma and palea much reduced. Lodicules present or not. Anthers 0 or 3.

**Distribution.** Four species allopatric in E. Africa, Madagascar, Sri Lanka, or from SE. Asia to S. China, E. Malesia and Micronesia.

**Ecology.** Savannahs, dry grasslands, forest edges, up to 1800 m alt.

**Chromosome numbers.** N = 18 [*H. cochinchinensis* (Lour.) Clayton var. *cochinchinensis*, *H. nigrescens* (Thw.) C. E. Hubb.]

**Note.** Hubbard described the sessile spikelets as 2-flowered with the lower floret being male or sterile and with a palea equal to the lemma or shorter to absent. Hsu (1971) also described and depicted a first palea for *H. cochinchinensis* (Lour.) Clayton (*q.v.*). However, in all specimens seen by us this floret was always reduced to an empty lemma.

**KEY**

1. Pedicelled spikelets absent. SE. Asia. .......................................................... 2
2. Pedicelled spikelets more or less developed. Africa, Madagascar, Sri Lanka. .............. 3
3. Sessile spikelets 2.7–4 mm long. Lower glume narrowly winged. Anthers 1.5–1.7 mm long.  .......................................................... 4a. *H. cochinchinensis* var. *cochinchinensis*
4. Sessile spikelets 4–4.5 mm long. Lower glume distinctly winged at the apex. Anthers ± 2.8 mm long. Taiwan. .......................................................... 4b. *H. cochinchinensis* var. *chenii*
5. Blades 4–10 mm wide, at least the margins pubescent. Pedicelled spikelets 4–5 mm long. .. 4
6. Blades 1.5–2 mm wide, glabrous. Pedicelled spikelets 2–3 mm long. Madagascar. ............. 2. *H. benoistii*

1. **Heteropholis sulcata** (Stapf) C. E. Hubb. — Map 1, fig. 2a

Culms 60–150 cm high. Nodes 3–5, glabrous, rarely hairy. Sheaths 8–12 cm long,
0.4–0.75 times as long as the internodes, subglabrous to hirsute. Blades linear, flat
to involute, up to 60 cm by 4–10 mm, subglabrous to hirsute. Peduncle 12–25 cm
long. Joints 20–30. Sessile spikelets slightly alternating, 3.5–5 mm long. Lower glume
5–9-nerved, areolate because of longitudinal and transverse ribs, margins
puberulous at base, apex winged, acuminate. Anthers 2.4–2.5 mm long. Pedicelled
spikelet more or less well-developed; stipe adnate in the lower half to completely so
with the joint and approximately as long as the joint; spikelet 4–5 mm long, male,
lodicules present.

Distribution. Zaire (Katanga: Bianos, Kalule, Kienge, Kivilolo, Kundelungu
Plateau, Lubumbashi, Manika Plateau, Musoka-Tanda, Tumbwe), Zambia (Aber-
corn, Chishinga, Lundazi, Ndola, Solwezi), Malawi (Mzimba, Mzuzi), Tanzania
(Songea).

Ecology. Open woodland dominated by Brachystegia (e.g. B. boehmii, B.
floribunda, B. microphylla) and with Andropogon schirenzis, Isoberlinia sp.,
900–1830 m alt.

Collector's notes. Loosely tufted, to 1.5 m high. Rhizome creeping, roots brown,
wiry. Lower sheaths reddish purple. Culms bright green. Leaves erect, apex ± pen-
dulous. Sessile spikelets yellowish green. Pedicelled spikelets pale green with dark
green nerves. Anthers, stigmas dark purple. Entire plant turning black. (Mainly after
Milne-Redhead & Taylor 9058, BR).

Vernacular name. Kipolo (Katanga: Kibemba).

Note. The plants are nigrescent with a greyish hue when dried, as was also noticed
in the field.

2. Heteropholis benoistii Camus — Map 1, fig. 2b

Heteropholis benoistii Camus, Bull. Soc. Bot., France 103 (1956) 476. — Type:
Benoist 1639 (P, holo), Madagascar, Domaine Central, Manjakatampono,
Ankaratra, 1700 m alt., 20 December 1951.

Culms 35–50 cm high. Nodes 6–more, glabrous. Sheaths up to 7 cm long, shorter
than the internodes, margins distally pilose, otherwise glabrous. Blades linear, flat
to involute, up to 25 cm by 1.5–2 mm. Peduncle up to 13 cm long. Joints 12–more.
Sessile spikelets slightly alternating, 3–4.35 mm long. Lower glume 5–7-nerved, with
rows of small pits, margins glabrous at base, apex minutely winged, acuminate.
Anthers ± 2.1 mm long. Pedicelled spikelets reduced, to the lower glume; stipe adnate
with and ± 0.8 times as long as the joint; spikelet 2–3 mm long.

Distribution. Madagascar (Domaine Central).

Ecology. Savannahs, up to 1700 m alt.

Note. Only two collections seen (Benoist 1639, Bosser 15241, P).
3. Heteropholis nigrescens (Thw.) C. E. Hubb. — Map 1, fig. 2c


Culms up to 60 cm high. Nodes 10–15, glabrous. Sheaths 3–6 cm long, 0.45–0.75 times as long as the internodes, pilose along the margins, otherwise subglabrous. Blades linear, flat, up to 12 cm by 6–11 mm, margins hairy at base, otherwise glabrous. Peduncle up to 5 cm long. Joints 6–10. Sessile spikelets ± in 1 row, ± 4.5 mm long. Lower glume 11-nerved, with rows of small pits, margins puberulous at base, apex narrowly winged, acute. Anthers ± 2 mm long. Pedicelled spikelet reduced to the glumes; stipe entirely adnate to and ± 0.67 times as long as the joint; spikelet up to 4 mm long.

_Distribution._ Sri Lanka: Central and Trincomalee Prov.

_Ecology._ Cracks of cliffs, forest edges, 1200–1560 m alt.

_Chromosome number._ 2n = 36 (Gould & Soderstrom, 1974; ‘60’ _sphalm._ p. 1088).

_Collector’s notes._ Plants scendent, base long-decumbent, rooting at the nodes.

_Note._ Plants nigrescent.

4. Heteropholis cochinchinensis (Lour.) Clayton — Map 1.

a. _var._ _cochinchinensis._ — Fig. 3a


Thaumastochloa chenii auct. non Hsu: Hsu, Taiwania 16 (1971) 335, pro Chen 123.


Culms up to 60 cm high. Nodes 3–4, glabrous. Sheaths 3–6 cm long, 0.25–0.75 time the length of the internodes, margins at the top with the long hairs, otherwise glabrous. Blades linear, flat to involute, up to 45 cm by 2–5 mm, margins at base with long hairs, otherwise (sub-)glabrous. Peduncle up to 10 cm long. Joints 12–more. Sessile spikelets ± in 1 row, 2.7–4(–4.5) mm long. Lower glume 7-nerved, smooth to minutely pitted in longitudinal rows, margins glabrous at base, apex narrowly winged, obtuse to acute. Anthers 1.5–1.75 mm long. Pedicelled spikelet reduced to a small scale; stipe entirely adnate to and ± as long as the joint.

Distribution. India (e.g. Uttar Pradesh, Bihar, no doubt elsewhere), Thailand (Northern: Sukhotaï, Nakhon Sawan; Southwestern: Ratchaburi), Vietnam (Tu Phap, Huê, Hanoi, Phocam), China (Canton, Hainan, Hong Kong, Putien), Taiwan, Ryu Kyu Isl. (Iriomote, Okinawa), Malešia: Java (Banjumas), Lesser Sunda Isl. (Bali, fide Jansen MS), Philippines (Luzon, Mindanao), Moluccas (Buru), Carolines (Palau, Yap), Marianes (fide C. E. Hubbard).

Ecology. Savannas, disturbed places, e.g. roadsides, bunds of rice fields, in rice fields, grass fields, up to 600 m alt.

Collectors’ notes. Very few: caespitose.

Chromosome numbers. N = 18 (Chen & Hsu, 1962, at least pro Chen 123, TAI).

Notes. The only record for Java (not mentioned in the Flora of Java!, Kievits 1543, L) probably constitutes an introduction. It has relatively large lower glumes and anthers. Jansen (MS) mentioned an unnamed collection present in BO, purported from Bali but Veldkamp could not find any trace of it there. The record for the
Marianas could not be verified with the loan from K.

Although the types of 'cochinchinensis', 'monostachyus' and 'shimadanus' have not been seen, there is enough evidence from the descriptions, later remarks and subsequent material for the authors to be certain of their identities. The last epithet was employed by several authors for specimens with pitted lower glumes, but some collections (e.g. Balansa 503, L; Chuang 1560, Hsu & Kuoh 13658A, Suzuki s.n., Tanaka & Shimada, TAI, etc.) were seen to have both pitted and smooth lower glumes even within the same inflorescence, from which we conclude that this character has no great taxonomic significance. However, specimens with both pitted lower glumes and distinctly larger spikelets and anthers have been tentatively kept distinct by us as the next variety.

Hsu (1971) described, compared and even depicted lower paleas for both varieties, but in all the material seen by us, also that from TAI, we have not even encountered a trace of them.

b. var. chenii (Hsu) Sosef & de Koning, stat. & comb. nov. — Fig. 3b

Thaumastochloa chenii Hsu, Taiwania 16 (1971) 216, 335, f. 2; Taiwan Gr. (1975) 777, f. 284; Fl. Taiwan 5 (1978) 700. — Type: Hsu 511 (TAI, holo; TI), Taiwan, Pingtung Co., O-luan-pi, ± at sea level, 21 September 1959.

Differs from var. cochinchinensis by the lower glumes of sessile spikelets being (3.5–)4–4.5 mm long, apex somewhat more broadly winged, always with pits in longitudinal rows, and especially by the ± 2.8-mm long anthers.
Distribution. Taiwan (Pingtung Co.).

Ecology. Littoral grasslands.

Chromosome number. Chen 123 on which a count of n = 18 was based and which was included in this taxon, has ± 3.8-mm long sessile spikelets and ± 1.7 mm-long anthers and obviously belongs to the typical variety (q.v.).

THAUMASTOCHLOA — Map 1


Annuals (or short-living perennials?), branching intra-vaginally at base. Ligules collar-shaped, membranous, margin ciliolate. Peduncles scaberulous, articulating at base or breaking off with the uppermost internode and its leaf, gradually narrowing to base, at least in the lower third. Spikes ± terete, the lower joint (or the only one) ± persistently adnate to the peduncle, the others (if any) dehiscing transversely to obliquely into swollen to inflated joints which bear a sessile spikelet and the remnant of a pedicelled one, with a ‘knob’ at base (remnants of the vascularity). Spikelets unilaterally in 1 or 2 somewhat alternating rows, awnless. Sessile spikelets sunken into the joints, with 2 florets, the lower one reduced to a lemma, the upper one bisexual. Callus short, glabrous. Lower glume convex to slightly concave, indurated, 7-9-nerved, smooth or variously longitudinally and/or transversely sculptured, 2-keeled, margins at base puberulous, otherwise usually glabrous, margins narrow, stiff infolded, apex somewhat acute, unwinged. Upper glume convex, slightly keeled, 3-5-nerved, scarious to slightly indurated. Lemmas and paleas obtuse, scarious. First lemma 2-keeled, second one 0-3-keeled. First palea absent, second one present, 0-keeled. Lodicules present in the upper floret, cuneate, truncate, glabrous. Anthers 3, purple. Styles 2, free; stigmas purple. Caryopsis broadly ovoid, dorsally flattened; hilum sub-basal, punctiform; embryo 0.5–0.67 times as long as the caryopsis. Stipe of the pedicelled spikelet adnate to the joint; spikelet absent or reduced to a miniscule scale.

Distribution. Seven species (and a possible hybrid) more or less sympatric in Northern Australia (W. Australia, N. Territory, Queensland) and Malesia (Aru Isls, New Guinea, each with 1 sp.).

Ecology. Savannahs, sandy places, up to 1000 m alt.

Notes. The spikes of most species are homomorphous, but in T. major S. T. Blake two different types may be present even on the same plant: long ones with 4–10 relatively broad joints, and short ones with 1–3(–4) relatively narrow joints.

As these plants grow in often nearly inaccessible places and may not be evident because of their annual life cycle, a wider distribution, certainly in Malesia, may be expected with increase of the variability as more material is acquired, while
undescribed species may well turn up. Compare for instance the supposedly monotypic genus *Microira* F.v.M., which now has at least 8 species (Lazarides, *Brunonia* 2, 1979, 67-84!)

**KEY**

1. At least some spikes with 4–more joints ........................................... 2
2. All spikes with 1–3 joints ................................................................. 5
3. All joints 1–1.8 mm across — Lower glumes areolate to weakly rugulose, at least in some spikes ......................... 3
4. At least some joints 2–3.5 mm across — Lower glumes usually smooth to at most weakly rugulose ......................... 4
5. Spikes homomorphous, joints 4–9. Lower glumes all weakly rugulose to areolate, but the basal sometimes smooth. Anthers 0.75–1 mm long .................................. 1. *T. pubescens*
6. Spikes heteromorphous, some 4–9-jointed and lower glumes areolate, others 1–3-jointed and lower glumes smooth. Anthers ± 1.1 mm long ........................................... ? *T. major* × *pubescens*
7. Culms up to 70 cm high. Spikes homomorphous. Joints inflated. Anthers 0.5–1 mm long .... 2. *T. montifera*
8. Culms up to 35 cm long. Spikes homo- or heteromorphous. Joints cylindric. Anthers 1.4–1.7 mm long ............................................................... 3. *T. major*
9. Lower glume smooth .......................................................... 6
10. Lower glume longitudinally grooved or transversely rugose ............................. 7
11. Well-developed sheaths 0.17–0.33 time length of internode. Peduncle 0.5–3 cm long, usually falling off with the uppermost internode. Joints 2.5–3 mm long ................ 7. *T. rariflora*
12. Well-developed sheaths 0.5–>length of internodes. Peduncle 1.5–18 cm long, articulating at base. Joints 3–6 mm long ............................................................... 3. *T. major*
13. Culm-nodes 4–8. Lower glume longitudinally grooved. Anthers 1.1–1.7 mm long ........ 8
14. Culm-nodes 10–15. Lower glume transversely rugose. Anthers 0.6–0.7 mm long 6. *T. brasii*
15. Well-developed sheaths 0.17–0.33 time length of internode. Peduncle 0.5–2 cm long, glabrous ................................................................. 5. *T. rubra*
16. Well-developed sheaths 0.5–same length as internode. Peduncle 4–18 cm long, with rows of minute hairs (20x!) in the upper third .......................... 4. *T. striata*

1. *Thaumastochloa pubescens* (Benth.) C. E. Hubb. — Map 2, fig. 4


Ophiuros corymbosus auct. non Gaertn.: R. Br., Prodr. (1810) 207.

Culms 12-30 cm high, rarely more. Nodes 5-9. Sheaths 1-3 cm long, 0.5–same length as internode, pilose. Blades linear, flat, 2–9 cm by 1.5–4 mm, pilose. Peduncle erect, ± straight, gradually narrowed towards the base where it articulates, up to 10 cm long, glabrous. Spikes homomorphous, cylindric to constricted, 1.5–3.5 cm by 1–1.8 mm across. Joints 4–9, articulation straight to oblique, 3–4 mm long, glabrous, rarely puberulous. Spikelets somewhat alternatingly in 2 rows, 2–3 mm long. Lower glume ovate-oblong, flat to convex, the lowermost usually smooth, the others weakly transversely rugulose to areolate by longitudinal and transverse ribs, 7–9-nerved. Upper lemma 2-nerved. Anthers 0.75–1 mm long.

Fig. 4. Sessile spikelets of Thaumastochloa — T. pubescens (McKee 9183). × 15.

**Distribution.** **Malesia:** New Guinea (Western Distr.: Arufi, Rouku); Australia: W. Australia (N. of Broome, Karunjie St., Kimberley Res. St.), N. Territory (Hooker’s Cr., Katherine, Mittibah St.), Queensland (Atherton, Batavia, Burra, Campaspe R., Cheltenham, Conjuboy St., Cooktown, Croydon, Doomagee, Endeavour R., W. of Ingham, Jericho, Lizard Isl., Mungana, Mareeba, Normaton, Pentland, Poison Cr., Port Douglas, Torrens Cr., Townsville, Yarramieere).

**Ecology.** Low lying, damp sandy places, gullies, exposed coastal sand dunes, weedy in fields and disturbed places, open savannah forests with e.g. Acacia cowa-leana, Erythrrophloeum sp., Eucalyptus calleni, E. dichromophloia, E. miniata, E. polycarpa, Grevillea glauca, Petalostigma sp., Spinifex sp., Triodia pungens, up to 840 m alt.

**Collector’s notes.** Tufted, culms prostrate to erect, up to 30 cm high or radiating to 1.5 m in diam., subglauous, dull green, brown, or reddish. Racemes green, spikelets paler to purplish.

**Notes.** Although Hubbard and many others cited Domin as the author of the basionym, it should be Bentham. The presence of a question mark does not invalidate the latter’s publication (Art. 34.2).

Roberty included Mnesithea pubescens Ridl. in his synonymy, but that species has little to do with the present genus; the correct name for it is Coelorachis mollicoma (Hance) Bor (Heidweiler & Van der Klaauw, MS).

S. T. Blake distinguished *T. constricta* because of its puberulous and constricted joints. As several intermediate collections were available these distinctions could not be upheld.

Four collections (S. T. Blake 13604, 13738, Clarkson 3146, Symon 4883 from Queensland, BRI) possess heteromorphic spikes, with one type similar to those of *T. pubescens* and the other to the small form found in *T. major*. The anthers are 1.1 mm long. These collections may be of hybrid origin (*T. major x T. pubescens*), or represent an infraspecific taxon (but of which species?), or belong to a distinct species altogether (see Map 2). At present we cannot offer a satisfactory solution.

On the other hand there are mixed collections of both species, which may confuse those unaware of the heteromorphy of the spikes of *T. major*, e.g. Bailey s.n. (K) from Thursday Isl., which led Hubbard to observe that it might represent ‘probably a new species related to *T. pubescens*.’

2. **Thaumastochloa monilifera** Sosef & Koning, sp. nov. — Map 4, fig. 5a


Culmi ad 70 cm alti. Spicae homomorphicae, articulis 4-8 inflatis 2-3.5 mm in diam. Glumae inferiores modice rugulosae. Antherae 0.5-1 mm longae. — **Type:** Brass 19712 (L, holo; A), Australia, Queensland, Cook Distr., Wenlock R., 12° 11' S, 141° 53' E, 150 m alt., 27 July 1948.
Fig. 5. Sessile spikelets of *Thaumastochloa* cont. — a. *T. monilifera* (Latz 1509); b. *T. major* (Collins 377). × 15.

Culms up to 70 cm high. Nodes 5-9. Sheaths 2.5-4 cm long, 0.33-0.68 times as long as the internodes, pilose. Blades linear, flat, 4-11 cm by 2-5 mm, pilose. Peduncle ± erect, straight, gradually narrowed towards the base, where it articulates, 1-8 cm long, glabrous. Spikes homomorphous, moniliform, 1-1.5 cm by 2-3.5 mm across. Joints 4-8, articulation oblique, 1.7-5 mm long, glabrous. Spikelets alternatingly in 2 rows, 1.6-3.5 mm long. Lower glume triangular-ovate, slightly convex, weakly rugulose, 7-nerved. Upper lemma not nervet. Anthers 0.5-1 mm long.

*Distribution.* Australia: Queensland (Batavia, Bing Bong, Koolburra, Laura, S. of N. Kennedy R., Wenlock R.).

*Ecology.* Dry sandy banks of gullies, road-sides, savannah forest with e.g. *Acacia* sp., *Eucalyptus tetrodonta*, *Melaleuca* sp., *Callitris intratropica*-heath.

*Collector’s notes.* Plants semi-prostrate, culms weak, 40-60 cm long.

*Note.* Named for the bead-like joints of the spike.

3. *Thaumastochloa major* S. T. Blake — Map 3, fig. 5b


*Thaumastochloa pubescens* auct. non C. E. Hubb. and *Th. rariflora* auct. non C. E. Hubb.: Gardn., Fl. W. Austr. 1, 1 (1952) 309, 310, f. 91 A-E.

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Map 3. *Thaumastochloa major.*

Culms up to 35 cm high. Nodes 6-10. Sheaths 1-4 cm long, (0.33-)0.5-> length of internode, pilose at least along the margins. Blades linear, flat to involute, 2-12 cm by 1.5-5.5 mm, pilose, rarely glabrous. Peduncle erect to recurved, usually gradually narrowed towards the base, where it articulates, 1.5-18 cm long, glabrous. Spikes hetero- or homomorphous: some 1.5-3 cm long, rarely with a small secondary branch at base, joints 4-10, relatively broad, 4-5.5 by 2-3.5 mm across, articulation straight to oblique, spikelets alternating in 2 very distinct rows, but still secund, others 0.35-1.6 cm long, joints 1 or 2 (or 3), relatively narrow, 3.5-10 by 1-1.5 mm across, articulation straight, spikelets ± in 1 row. Joints cylindrical, glabrous. Spikelets 2.3-4 mm long. Lower glume triangular to ovate-oblong, convex to flat, rarely concave, smooth, rarely rugulose or pustulate and with some hairs, 9-nerved. Upper lemma 2-nerved. Anthers (1.1-)1.4-1.7 mm long.

Ecology. Low-lying, damp, sandy places, coastal dunes, open woodland with e.g. *Allosyncarpia ternata*, *Aristida hygrometrica*, *Erythroploemum* sp., *Eucalyptus crebra*, *E. dichromophloia*, *E. ferruginea*, *E. latifolia*, *E. miniata*, *E. papuana*, *E. polycarpa*, *E. tetrodonta*, *Melaleuca viridiflora*, *Perotis rara*, *Petalostigma banksii*, *Plectrachne pungens*, *Sorghum* sp., locally gregarious, up to 600 m alt.

Collector’s notes. Solitary or tufted annual, biennial (!), or short-lived perennial (!), suberect to diffuse and spreading, bent over as if to bury the rigid tips into the soil, culms up to 45 cm high, tufts up to 45 cm in diam., rather pale to bright green to pale or reddish brown, but spikes green, spikelets paler to whitish.

Notes. Most remarkable for its heteromorphic spikes which, if not found on the same plant, would never have prompted the suggestion that one species was involved. It is no wonder that Gardner was led astray, thinking that *Holmes ex Black 5000.033* (PERTH) was a mixture of *T. pubescens* and *T. rariflora*.

Occasionally a secondary basal branch is present in the spike, but although we have seen the material from PERTH where Gardner worked, we have not seen this as well-developed as depicted by him. It is more likely that two spikes were placed one above the other; the heteromorphy is then evident.

As stated in the introduction, some spikes of *Brass 18880* (A, L) have some lower joints with 2 sessile spikelets and the stipe of a pedicelled one, reminiscent of the apparently single feature that characterises the genus *Mnesithea*. One of these spikelets may be regarded as a very short lateral branch as described above.

The confusion that results when a mixture is made in collecting this species with another is mentioned under *T. pubescens*.

4. *Thaumastochloa striata* Sosef & Koning, sp. nov. — Map 5, fig. 6a


Culms 15-25 cm high. Nodes 5-8. Sheaths 1.2-2.5 cm long, 0.5-1 cm wide as long as the internodes, shortly soft-hairy to nearly glabrous with densely hairy margins. Blades linear, usually somewhat involute, 2-6 cm by 1.5-3.5 mm across, hairy behind the ligule and along the margins, otherwise glabrous. Peduncle erect, straight, narrowed in the lower half towards the base, where it articulates, 4-18 cm long, upper third with rows of minute hairs (20x!). Spikes homomorphous, (0.45-) 1.1-2 cm by 0.6-1.5 mm across. Joints (1 or) 2 or 3, articulation straight, glabrous. Spikelets slightly alternating, 3-4 mm long. Lower glume triangular-oblong, slightly convex, grooved between the 7 nerves. Upper lemma 2-nerved. Anthers 1.1-1.7 mm long.
Distribution. Australia: N. Territory (Maranboy Pol. St., Elcho Isl.).

Ecology. Sandy soil in open Eucalyptus tetrodonta forest with Plectrachne pungens, alt. low.

Collector's notes. Tufted, erect annual, culms spreading from base, inflorescence erect.

Note. Named for the conspicuously striate joints and lower glumes.

5. Thaumastochloa rubra Sosef & Koning, sp. nov. — Map 5, fig. 6b

*Thaumastochloa striata* similis, sed in vaginis internodiis 0.17-0.33-plo brevioribus, pedunculis 0.5-2 cm longis glabris differt. — Type: *S. T. Blake 17636* (BRI, holo; L), Australia, N. Territory, 16° 28' S, 134° 59' E, 198 m alt., 4 May 1947.

Culms up to 45 cm high. Nodes 4-6. Sheaths 0.8-1.6 cm long, 0.17-0.33 time the length of the internode, pilose. Blades linear, flat to involute, 1.5-5 cm by 1-2 mm, pilose. Peduncle ± erect, ± straight, gradually narrowed towards the base, where it articulates, 0.5-2 cm long, glabrous. Spikes homomorphous, 0.9-2.7 by ± 0.7 mm across. Joints (1 or) 2, articulation straight, 4-5 mm long, glabrous. Spikelets (see note) 3-4 mm long. Lower glume triangular-oblong, flattened to convex, 7-nerved, grooved between the nerves. Upper lemma 2-nerved. Anthers ± 1.1 mm long.
Distribution. Only known from the type.

Ecology. On flagging sandstone ridges with *Eucalyptus dichromorphloia*, 198 m alt.

Collector’s notes. Green to reddish, ± erect tufts to 45 cm.

Notes. The exact position of the spikelets could not be ascertained, because all spikes were either 1-jointed or the second joints had dropped off; a unilateral position seems most likely. The joints are ± reddish-brown, hence the epithet.

6. *Thaumastochloa brassii* C. E. Hubb. — Map 4, fig. 7a


Culms 7-35 cm high. Nodes 10-15. Sheaths 0.5-1.5 cm long, 0.25-1 times as long as the internodes, sparsely pilose to subglabrous. Blades linear, flat to involute, 1-3 cm by ± 3 mm, sparsely pilose to subglabrous. Peduncle slightly curved, gradually narrowed towards the base, where it articulates, 0.8-6 cm long, glabrous. Spikelets erect to erecto-patent, homomorphous, 0.3-0.8 cm by 0.8-1 mm across. Joints 1(-3), articulation straight, 3-4 mm long, glabrous. Spikelets in ± 1 row, 2-2.7 mm long. Lower glume oblong, flat, transversely rugose, 7-nerved. Upper lemma 2-nerved at base. Anthers 0.6-0.7 mm long.

Fig. 7. Sessile spikelets of *Thaumastochloa* cont. — a. *T. brassii* (Craven 4103); b. *T. rariflora* (Brass 18956). × 15.

Map 4. Triangles: *Thaumastochloa brassii*; circles: *T. monilifera*.

Ecology. Wet sandy soil, *Callitris intratropica*-heath, open savannah forest with e.g. *Eucalyptus* sp., *Melaleuca viridiflora*, *Petalostigma* sp., *Pheidochloa gracilis*, road-sides, up to 300 m alt.

*Collector's notes.* Solitary or tufted, pale green, reddish, brownish, or purplish, to 35 cm diam. Culms sprawling to erect.

*Note.* Hubbard described the upper lemma as 1-nerved, we saw it consistently with 2 short nerves at the base only.

7. *Thaumastochloa rariflora* (F. M. Bailey) C. E. Hubb. — Map 5, fig. 7b


*Ophiuros pubescens auct. non* Dom.: Hitchc., Brittonia 2 (1936) 128.

Culms 10–60 cm high. Nodes (4–)8–12. Sheaths 0.8–2.2 cm long, 0.17–0.33–more than 1 in apparently juvenile plants) times as long as the internodes, pilose, rarely subglabrous. Blades linear, flat to involute, 2–10 cm by 2–4 mm, pilose, rarely subglabrous. Peduncle erect, straight to curved, gradually narrowed towards the base, usually falling off with the uppermost internode and its leaf, 0.5–3 cm long, glabrous. Spikes homomorphous, cylindric, 0.35–0.9 cm by 0.7–1 mm across. Joints 1 (or 2, then the lower one usually without a spikelet), articulation ± straight, 2.5–3 mm long, glabrous. Spikelets slightly alternating in 1 row, 2–3 mm long. Lower glume ovate-oblong, somewhat concave, smooth, 9-nerved. Upper lemma 0–3-nerved. Anthers 0.5–0.8 mm long.


*Ecology.* Sandy patches in savannah woodlands, e.g. with *Eucalyptus*, *Melaleuca cunninghamii*, *Themed* sp., clearings, sometimes gregarious, up to 1000 m alt.

*Collector's notes.* Erect to spreading, tufted or not, sometimes densely mat-forming, up to 30 cm high, green to rather dull green, culms oblique to erect, reddish. A troublesome spear-grass.

*Notes.* The type, presumed to be in BRI, was not among their material although all was sent. The specimen in K cited by Hubbard was not lent to the authors; it
may be the holotype.

**Brass 18554** (A, L) has glabrous blades and pedicelled spikelets reduced to a minute scale, otherwise it seems to belong here.

## INDEX OF COLLECTORS

Only numbered collections have been included. The ‘H-’ and ‘T-’ numbers refer to the sequence of the taxa as employed above. Specimens cited in literature but not seen have been included with their identifications *between brackets* when these seemed acceptable, otherwise they have been deleted.

**Alcorn 8160**: T7, Alston 1046: (H3), Aplin 5136: T3, Astle(?) 1354: H1.


**Edwards 25**: H1, Evrard 7027: H1.

**Fanshawe 3073**: H1, Flecker 477: (T7), Flecker Qld. Nat. Club 13189: T6, 13190: T2, Fosberg 55015: T1.


**Jackson 444**: (H1), 731: H1, Jacobsen 21: (T7).

**Kanehira & Hatusima 4425**: H4a, 4428: (H4a), 4688: (H4a), Kenneally 5969: T1, Kievits 1543: H4a, Kneucke 789 (Merrill & Robinson): H4a.


**Maconochie 2594**: T1, Malaise 17538: H1, McCallum Webster T 204: (H1), McDonald 2628: T1, McKee 9183: T1, 9505: T7, Melville et al. 3731-C: T1, Merrill 236: H4a, 9875: H4a, Merrill Philip. Pl.

NGF 38699 (Henty & Katik): T1, 49393 (Henty & Forman): T7, 49686 (Henty & Carr): T1.

Odashima 129: (H4a), 562: H4a, Oersipuny 18: H4a.


Quarré 137: H1.

Rust 33: (T1).

Salesien 832: H1, Santos 4055: H4a, 4986: H4a, Schmitz 1009: H1, Schrooten 1091: H1 (wrong label), Scribner 3: (H4a), Shantz 543: (H1), Shimada 4852: (H4a), Simon & Williamson 1872: H1, L. S. Smith 04364: T1, Specht 93: T3, 190: T3, 683: T3, 731: T3, Squires 165: H4a, Staples 010572/12: T1, Suzuki 20066: H4a, Symoens 3341: H1, 8267: H1, 12237: H1, 12285: H1, Symon 4785: T2, 4845: T3, 4883: T1x3, 4926: T6, 5022: T1, 7761: T3.

Thwaites CP 867: H3, Trapnell 1522: H1, 1706: (H1).

Vanoverbergh 2802: H4a, Vesey-Fitzgerald 1628: H1, 2975: H1.

Wang 12768: H4a, C. T. White 8674: T1, Wiehe N. 182: (H1).

Yamamoto et al. 11: H4a, Yamamoto & Suzuki 579: H4a.

Zerny 479: H1.
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The Fossil Pollen Record of the Pandanaceae

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National Museums of Canada
Ottawa, Canada

Abstract

The fossil record of pollen comparable to the family Pandanaceae and sometimes directly comparable with the extant genus *Pandanus* extends back to the latest Upper Cretaceous. The family which once had a wide geographic distribution on all continents except Australia, has, since the mid-Tertiary, become restricted to the Old World tropics and subtropics.

Introduction

The monocotyledon genus *Pandanus* Rumph. ex L. comprises about 600 species of trees, shrubs and less frequently subshrubs. Several, such as *P. epiphyticus* Martelli and *P. alticola* Holt. and St. John from Malaya and Borneo are truly epiphytic though facultatively so, also occurring on boulders of limestone or sandstone (Stone, 1978). The tree habit is the most common, and such pandans form a conspicuous part of the vegetation of many tropical shorelines. The pandans (or screw-pines) are distributed throughout the palaeotropics, with species occurring on nearly all tropical and marginally subtropical islands of the Pacific, the northern tropical regions of Australia, tropical Southeast Asia, Indonesia, the Philippines, southern India and islands of the Indian Ocean, the Malagasy Republic and East and West Africa (Stone, 1976). The genus does not occur naturally in the neotropics. Map 1 illustrates the overall distribution of the genus, as well as the known fossil pollen reports of Pandanaceae.

The pandans are dioecious, with the staminate plants, particularly of the forest species, being less frequently collected than the pistillate plants, due to the brief, ephemeral staminate anthesis. The leaves, usually long, linear, spirally arranged and congested along branch tips, the characteristic stout aerial prop roots, and the often (but not always) large pendulous female cephalia (syncarps) allow recognition of the genus even at some distance.

The pulpy fruits (drupes or polydrupes) are often a bright-coloured red, orange or yellow and are dispersed not only by birds and fruitbats, but within several sections of the genus by ocean or freshwater currents (Stone, 1976). The fruits of *Pandanus helicopus* Kurz which occur today in Bangka Island, Malaya, Borneo and Sumatra, are eaten and thus dispersed by fish and turtles (Ridley, 1930; Stone, 1976). Turtles no doubt also perform a dispersal role for *Pandanus aquaticus* F. Muell. in Australia (Stone pers. comm., 1978). The small, and very light fruits of *Pandanus basedowii* C.H. Wright, native in the Northern Territory of Australia may be distributed by wind (Stone, 1974).
Pollen Morphology

The pollen of Pandanus (29 species examined) is free, radiosymmetrical, spherical to ovoid (often irregular) monoporate (rarely pseudocolpate). The ornamentation is typically echinate but some species are psilate, finely granulate or finely rugulate (e.g. granulate in Pandanus dorystitigma Mart.; rugulate in P. matthewsii Merr.; psilate in P. jiulianettii Mart. and P. elostigma Mart.). The echinae are conical, blunt tipped or capitate, and range in length from \( <1.0 \mu \text{m} \) to 4-5 \( \mu \text{m} \). They are more or less evenly distributed over the surface of the grain. The pore (often difficult to observe) is circular and situated at one end of the long axis, with either an entire or diffuse margin, annulate or non-annulate, diameter 2-4 \( \mu \text{m} \) (rarely larger). The exine is two-layered. In some species the sexine is thicker than the nexine, while in other species the opposite is true. Wall thickness ranges from \( <1.0 \mu \text{m} \) to ca. 1.5 \( \mu \text{m} \). Dimensions for 29 species examined are 16 (22.2) 37 \( \mu \text{m} \times 13 \) (17.1) 25 \( \mu \text{m} \).

Studies on the pollen morphology of Pandanaceae include: Erdtman (1972), Huang (1970), Huynh (1980), Selling (1947), Sharma (1968), and Sowunmi (1974).

Comparisons with other extant Pollen Forms

Several angiosperm families have genera with certain pollen-morphological similarities to Pandanus. Sharma (1968) placed significance on the monocolpate condition of P. odoratissimus L.f. as providing evidence of palynological affinity of Pandanus with Hypoxis (Hypoxidaceae) and Smilax (Liliaceae). Hypoxis pollen (12 species examined) is monosulcate, often foveolate, has a rather thick exine and the grains measure about 50 \( \mu \text{m} \) in diameter. Smilax is non-aperturate, or monosulcate, but never monoporate; the exine is tenuiexinous (nexine thinner than sexine). Pandanus pollen may be quite easily differentiated from either of these two genera. Pandanus pollen is much smaller than that of Hypoxis, and is never foveolate; the presence of a pore (if discernable) will exclude Smilax, and in spinate forms of Pandanus the nexine is thicker than the sexine.

In the family Araceae, the genus Remusatia has pollen which superficially resembles that of Pandanus, but upon closer examination can be easily distinguished. Although the sculpturing elements in Remusatia are echinate, interestingly the spines are of two distinct sizes and shapes. The larger spines, as wide as they are high are interspersed with much smaller spines somewhat longer than wide. This distinctive feature, not observed in Pandanus, as well as the non-aperturate condition of Remusatia allows easy recognition of its pollen.

The generally larger diameter and extremely small scrobiculi (very small, more or less circular pits) differentiate Joinvillea (Flagellariaceae) pollen from that of Pandanus.

Although a number of palm genera (e.g. Arenga, Manicaria, Maurita, Socratia et al.) have spherical, echinate pollen, none are monoporate.

As far as is known, only three dicotyledon genera have pollen which might be confused with that of Pandanus.
The pollen of *Peumus* (monospecific genus of the Monimiaceae) much resembles that of *Pandanus*, but the grains are inaperturate, and the bases of the spines do not appear sunken below the surface, a feature common to *Pandanus* pollen. The size of *Peumus* pollen ranges 38-41 μ, somewhat larger than that of *Pandanus*.

*Hernandia* (Hernandiaceae) pollen although echinate can not be confused with that of *Pandanus*, because of its larger size (generally up to 90 μ), the equidimensional spines, and granulate surface between spines.

*Stachyanthus* (Icacinaceae) has inaperturate, spinose pollen. The characteristic, long (up to 4 μ), recurved spines however allow recognition of this pollen as distinct from *Pandanus*.

**The Fossil Occurrences**

Forty-five references to fossil pandanaceous pollen are to be found in the published literature (table 1). Thirty-five of these are Tertiary or younger occurrence, eight of which occur within the present distribution of the genus (the paper by Leopold, 1969, contains four localities, thus there are 11 fossil occurrences shown on map 1 within the present range of *Pandanus*). The combined stratigraphic ranges of fossil Pandanaceae pollen from major geographic regions of the world are illustrated in graph 1.

The stratigraphically oldest reports of pollen referable to the family of Pandanaceae, are from the Maestrichtian of the western interior of North America. Oltz (1969) reported its occurrence from the Hell Creek and Tullock Formations (Maestrichtian-Palaeocene) of central Montana; Norton and Hall (1969) described *Spinamonoporites typicus* Norton from the Maestrichtian and Palaeocene of the type Hell Creek Formation, Montana, which they compared with question to *Pandanus*, and Leffingwell (1971) recovered *Pandaniidites radicus* Leffingwell from the Lance and Fort Union Formations (Maestrichtian-Palaeocene) of Wyoming.

Within the Canadian western interior, pollen referable to the family Pandanaceae occurs in the Palaeocene of Alberta (Snead, 1969) and in the Maestrichtian of the Morgan Creek badlands of southern Saskatchewan (Jarzen, 1978). This latter occurrence is accepted as the oldest record of *Pandanus* pollen (Muller, 1981).

Archangelsky (1973; 1976) described but did not name a species of *Pandaniidites* from the Salamanca Formation (Palaeocene) in the Chubut Province of Argentina, which he compared directly to the genus *Pandanus*. The reports of Archangelsky are the only known occurrences of fossil *Pandanus* pollen from South America. Reports of pollen referable to *Pandanus* from European sediments are those of Raukopf (1959), Kedves (1963), Kedves and Endredi (1963; 1965), Martin (1976), Zaklinskaya (1967) and Simpson (1961) who described *Pandanus shiabensis* from the interbasaltic lignites of Shiaba, Island of Mull, Scotland. Simpson had earlier (Simpson, 1936) assigned this pollen form to the extant genus *Smilax* but after a re-examination, felt it more closely resembled *Pandanus*. 

---

**Note:**

The above text is an excerpt from a scientific paper discussing the fossil record of pandanaceous pollen. It highlights the characteristics of different genera within the family and their occurrences in various geological formations and regions. The text also mentions the contributions of various scientists and references to their work.
Table 1. Published reports of fossil pollen referable/comparable with the family Pandanaceae. (numbers in parenthesis refer to numbers on map 1).

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The first report of fossil pollen comparable to Pandanus (or inferred to be Pandanus by reference to the family Pandanaceae since the other members of the family, Freycinetia and Sararanga, are not usually echinate except two Freycinetia species which have echinate pollen) is that of Sedova (1956) who designated Pandanus sp. from the Oligocene of Primorsk Kray, U.S.S.R.

The geologically most recent occurrences of fossil Pandanaceae pollen are of Pliocene-Pleistocene age deposits of the U.S.S.R. (Shatilova, 1964; 1967) and from...
core material of Site 262 drilled by the Glomar Challenger in the Timor Trough near the Island of Timor (Zaklinskaya, 1978a). Zaklinskaya refers only to the family Pandanaceae, and does not illustrate the pollen thus assigned. It is probable that the pollen recovered by Zaklinskaya represents Pandanus inasmuch as the other two genera within the family usually have psilate exines and would be rather difficult to assign to the family Pandanaceae.

Of the numerous reports of pandanaceous megafossils, nearly all have subsequently been determined to be Nypa (Tralau, 1964), and in fact Stone (1976) considers the report of Pandaniites rhenanus Krausel and Weyland (1950) from the Oligocene of Germany as a true pandan. The megafossil record of Pandanaceae is thus meager and provides little information on the geologic history of the family.

**Discussion**

The fossil pollen grains illustrated in plate 1, figures 1-5, were recovered from the uppermost Cretaceous (Maestrichtian) Frenchman Formation of southwestern Saskatchewan, Canada (Jarzen, 1978). These grains were selected to illustrate several features which are diagnostic of extant Pandanaceae pollen. Figure 1 illustrates the general shape (ovoid), circular pore with entire margin and the conical isometric echinae (spines) typical of many species of Pandanus. These features are comparable with those of *P. longicaudatus* Holtt. and St. John as illustrated in figure 11.

The fossil grain in figure 2 was photographed in optical section to illustrate the nature of the spine bases which are depressed into the interior of the pollen wall (see also Erdtman, 1972, p. 308, fig. 179A). This feature of "sunken bases" is clearly seen in the phase contrast photomicrograph (fig. 7) of *Pandanus tectorius* Sol. and as faint protuberances in the electron micrograph (fig. 13) of *P. vandra* St. John.* Figure 3 also illustrates the "sunken bases" of the spines but additionally shows the less frequent annulate pore condition of some of the fossil grains. *P. odoratissimus* L.f. (fig. 8-9) also displays an annulate pore. Pandaniidites radicus Leffingwell (1971), recovered from the Maestrichtian of Wyoming, and *P. texus* Elsik (1968) are clearly annulate.

The fossil grain type illustrated in figure 4 is rarely encountered in Saskatchewan sediments. The unique elongated, clavate spines were initially considered unlike the usual conical spines of Pandanus. However, as illustrated in figure 12 the pollen of *P. mozambiqueus* St. John bears identical spines. Figure 5 and figure 10 illustrate the rather rare monocolpate condition in the fossil specimens (fig. 5) and extant Pandanus tectorius Sol. (fig. 10). Figure 14 illustrates spine shape in modern Pandanus, with a bulbous enlarged base. This feature may or may not occur at random on certain fossil specimens. Some of the spines on the fossil grain in figure 2 approach this condition.

There is little doubt as to the validity of reports of fossil pollen referable to the family Pandanaceae from the Tertiary period (see map 1) and especially so for

*P. vandra* St. John is regarded by Stone (pers. comm., 1983) as an undoubted synonym of *P. tectorius* Sol.
those occurrences within the present range of *Pandanus*. Less confidence is held for
the uppermost Cretaceous occurrences, since all of these reports occur outside the
present geographical range of the family.

Stone (1976) and Muller (1981), accept palynological reports of Maestrichtian
Pandanaceae pollen. From the descriptions and illustrations of the six published
reports of “pandanaceous” pollen from the Maestrichtian/Palaeocene interval of
the western interior of North America it appears that at least two species of the
family Pandanaceae once occurred in North America 65-63 million years ago. Since
the Cretaceous, continental movements, withdrawal of the epeiric seaways, mountain
building, and changes in climate have dramatically reduced suitable conditions for
the survival of the Pandanaceae in North America. Today no wild plants of the
family occur in North or South America, Europe, or temperate Asia where mega-
and micro- fossils have been recovered (Stone, 1976). Speculation as to the origin
of the family Pandanaceae should accept as baseline data the reports of fossil Pan-
danaceae from North and South America, which must be considered valid.

Jarzen (1978) has suggested a modern analogous environment for the fossil flora
recovered from the Maestrichtian of the Morgan Creek badlands of Saskatchewan
as being in the Southeast Asia-Indomalaysian area based on the occurrence of several

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Graph 1. Generalized stratigraphic and geographic distribution of reports of fossil Pandanaceae pollen.
diagnostic pollen taxa, including that of Pandanaceae. Other angiosperm pollen recovered from the Morgan Creek sediments could be compared with extant families including the Juglandaceae, Myrtaceae, Buxaceae, Cercidiphyllaceae, Gunneraceae, and all found together today only in Southeast Asia-Indomalaysia.

**Acknowledgements**

Appreciation is expressed to Mr. Gregory Whalen who processed the samples and assisted in photography.

Pollen material of Pandanaceae was collected from herbarium specimens at United States National Herbarium and Herbarium, Missouri Botanical Garden. The assistance and courtesy of the staff of these herbaria is gratefully acknowledged. Additional fresh pollen of *Pandanus* and *Freycinetia* was received through the courtesies of Dr. B.C. Stone (Kuala Lumpur, Malaysia), and Dr. K.-L. Huynh, (Institut de Botanique de l'Université, Neuchâtel, Suisse).

Thought provoking and useful discussion concerning the occurrence of Pandanaceae in the North American Cretaceous was provided by Drs. Arthur Cronquist, Harry Leffingwell, Gordon McPherson and Robert Tschudy.

Drs. A.K. Graham, P.H. Stauffer and B.C. Stone kindly read the manuscript and provided many useful suggestions and criticisms for its improvement.

- Special appreciation is expressed to Dr. Benjamin Stone, without whose help and encouragement this project would not have been completed.

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**Plate 1**

Morphological variation in extant and fossil Pandanaceae pollen. Fig. 1. Fossil grain illustrating the “normal” conical shaped spines (11/03 – 86.3 × 36.9). Fig. 2. Fossil grain showing, in optical section, the bases of spines sunken into the interior of the grain (11/07 – 81.3 × 37.3). Fig. 3. Fossil grain with annulate pore (07/04 – 95.4 × 36.8). Fig. 4. Fossil grain with club-like ornamentation (11/04 – 89.0 × 35.6). Fig. 5. Fossil grain in colpate condition (11/03 – 82.9 × 35.5). Fig. 6. *Pandanus tectorius* Sol., bearing the “normal” conical spines (10513 – 88.2 × 41.6). Fig. 7. *P. tectorius* Sol., photographed in phase contrast to illustrate sunken bases of spines into interior of grain (10513 – 88.2 × 41.6). Fig. 8. *P. odoratissimus* L.f., with annulate pore as observed in optical section (228 – 93.1 × 40.6). Fig. 9. *P. odoratissimus* L.f. annulate pore observed in surface view (228 – 93.2 × 39.9). Fig. 10. *P. tectorius* Sol., in colpate condition (227 – 95.3 × 31.5). Fig. 11. *P. longicaudatus* Holtt. & St. John, illustrating the conical shaped spines (7371-SEM 012/7). Fig. 12. *P. mozambicus* St. John, with club-like ornamentation similar to fossil grain in Fig. 4. (870-SEM 003/10). Fig. 13. *P. vandra* St John, split open to show sunken bases of spines into interior of grain (872-SEM 001/1). Fig. 14. *P. furcatus* Roxb. detail of surface showing spines with enlarged bases (7369-SEM 011/7). Figs. 1-10: X 1,000; Figs. 11, 12: X 2,500; Fig. 13: X 2,200; Fig. 14: X 3,400.
Plate 1

Morphological Variation in Extant and Fossil Pandanaceae Pollen
Bibliography


Fossil Pollen Record, Pandanaceae


A Guide To King’s “‘Materials for a Flora of The Malayan Peninsula’”

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\(^1\)Forest Research Institute, Kepong, Malaysia
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Abstract

The first publication on the flora of Malaya was Sir George King’s *Materials for a Flora of the Malayan Peninsula*. This appeared in 26 instalments over a period of 47 years (1889-1936). The manner of publication was somewhat complicated. This paper explains the various complications and gives the dates of issue of the various instalments.

Introduction

Although the best known Flora of the Malay Peninsula is that published by H.N. Ridley in five volumes between 1922 and 1925, it is a matter of general knowledge among Malesian botanists that much of Ridley’s work was based on an earlier work done at Calcutta by Sir George King and his various associates, entitled *Materials for a Flora of the Malayan Peninsula*, published in 25 instalments between 1889 and 1915, and with a 26th instalment in 1936. The geographical area of the *Materials* covers the Malay Peninsula, and the Andaman and Nicobar Islands. In terms of quality, the *Materials* is superior to Ridley’s *Flora* because whereas the former was based on original and careful study, the latter appears, in many places, to have been merely a hastily and inaccurately rewritten copy of the former work.

Unfortunately, the *Materials* can be quite complicated for a beginner to use, because, instead of being published in a few self-contained volumes with tables of contents, regular pagination and indices, the 26 instalments were published as separate papers in a periodical, the Journal of the Asiatic Society of Bengal, over the rather long period of 47 years. In fact it was never completed. The *Materials* in the Journal of the Asiatic Society of Bengal deal only with Dicotyledons and even so, the *Urticales* viz. *Cannabinaceae, Moraceae, Ulmaceae, Urticaceae*, and most of the *Euphorbiaceae* never appeared in print. As for *Ficus*, this is hardly a problem since King gave an extensive account of the genus in the Annals of the Royal Botanic Garden Calcutta Vol. 1, (1887–1888).

The Monocotyledons were all written up by H.N. Ridley and published independently in 3 volumes (called Parts) under the title *Materials for a Flora of the Malayan Peninsula, Monocotyledons* in 1907–1908, at Singapore.

King apparently realised that the interrupted manner of publication in the Journal would make the *Materials* difficult to use. He tried to overcome this by having extra copies of the first 21 instalments printed and assembled into 4 volumes *viz*. Vol. 1 *Thalamiflorae*, Vol. 2 *Disciflorae*, Vol. 3 *Calyciflorae*, Vol. 4 *Gamopetalaes*, each volume with continuous pagination from 1 onwards, except Vol. 2 which continued

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the pagination from Vol. 1. Instalments 22–26 were published in sequence hence the problem of repagination did not arise when they were assembled into Vol. 5, Incompletae. Botanists who use the Materials will almost certainly come across the 5-volume "reprint", found in most botanical libraries, rather than the original Journal which seems to be quite scarce.

However there are a number of complications in the use of the "reprinted" volumes. Firstly, each page of volumes 1–4 bears two page-numbers. The number series on the top of the page is the original Journal pagination, and is not continuous. The number series at the bottom is continuous. King had an index compiled for each volume, using the continuous pagination, but for purposes of citation, it is necessary to use the original Journal pagination.

Another complication is that tables of contents were not provided. This would not be a problem to anyone familiar with the system of Bentham and Hooker, which King tried to follow except for the fact that King was obliged now and again to postpone the treatment of difficult families. Consequently the family sequence is disrupted in several places.

A minor complication also arose when the Journal of the Asiatic Society fell behind schedule in publication e.g., when a number officially dated 1903 actually appeared in 1904. In such cases, both the official and actual dates of publication were given on the original Journal covers, to which it is necessary to refer whenever there is a need to establish priority. King himself cited dates of "publication" in short prefaces to the first four "reprinted" volumes but these dates sometimes refer to the dates on which the instalments were read at meetings of the Asiatic Society rather than to the dates on which they were actually published in printed form.

In the guide below, we have listed the instalments, families, dates of publication, and other details that may help users of the Materials to find their way. The dates of publication were obtained from the covers of an unbound set of numbers of the original Journal in the Singapore Botanic Gardens. For ordinary purposes of citation, we would recommend that the official year of publication be used.

Instalments 1–21 appeared in Series 2 (called "Part 2") of the Journal, (there were 3 parallel series) and we would recommend that the series be cited before the volume, for instance:


Instalments 22–26 appeared in Volume 75 of the Journal without any series number.

Ridley's account of the Monocotyledons appeared independently and should be cited as a book, e.g.,

### Volume 1. Thalamiflorae

All families by G. King

(Column A = instalment; Column B = journal pages; Column C = renumbered pages; Column D = date of publication.)

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**Volume 1 continued:**

| 10| Pittosporaceae        |      |      |     |      | 128-129 | 68-69 |
| 11| Polygaleace           |      |      |     |      | 129-144 | 69-84 |
| 12| Portulaceae           |      |      |     |      | 144-145 | 84-85 |
| 13| Hypericinaceae        |      |      |     |      | 145-147 | 85-87 |
| 14| Gutiferace            |      |      |     |      | 147-185 | 87-125 |
| 15| Ternstroemiaceae      |      |      |     |      | 185-206 | 125-146 |
| 16| (see Instalment 5)   |      |      |     |      |         |       |

**Volume 1 continued:**

| 3 | 17. Malvaceae         | II   | 60   | 1   | 1891 | 38-57   | 147-166 | 19.V.1891 |
| 18| Sterculiaceae         |      |      |     |      | 57-95   | 166-204 |
| 19| Tiliaceae             |      |      |     |      | 95-140  | 204-249 |

**Volume 2. Disciflorae

All families by G. King

| 21| Malpighiaceae         |      |      |     |      | 192-197 | 434-439 |
| 22| Geraniaceae           |      |      |     |      | 197-204 | 439-446 |
| 23| Rutaceae              |      |      |     |      | 205-226 | 447-468 |
| 24| Simarubeae            |      |      |     |      | 226-230 | 468-472 |
| 25| Ochnaceae             |      |      |     |      | 231-235 | 473-477 |
| 26| Burseraceae           |      |      |     |      | 235-262 | 477-504 |

**Volume 2 continued:**

| 7 | 27. Meliaceae         | II   | 64   | 1   | 1895 | 16-90   | 504-578 | 15.IV.1895 |
| 28| Chailletiaceae (also Instalment 8) |    |      |     |      | 90-94   | 578-582 |
| 29| Olacineae             |      |      |     |      | 94-133  | 582-621 |
| 30| Ilicineae             |      |      |     |      | 133-137 | 621-625 |
### Volume 2. Disciflorae Continued

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### Volume 3. Calyciflorae

All families by G. King except *Leguminosae* by D. Prain and *Sonerila (Melastomaceae)* by O. Stapf. *Droseraceae* was independently described twice, in Instalments 9 and 13, without explanation, and the second account made no reference to the first.

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### Volume 4. Gamopetalae

The various families were written by G. King (K.), J.S. Gamble (G.), D. Prain, C.B. Clarke (Cl.) and H.N. Ridley (Ridl.), with King as editor.

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### Volume 5. Incompletae

King died after completion of Vol. 4 and editorship of Vol. 5 passed over to J.S. Gamble. The various families were written by Gamble (G.), J.M. Macfarlane (Macf.), C. de Candolle (C. DC.), H.N. Ridley (Ridl.) and A.T. Gage. Family numbers 96 and 105 were allocated twice, the second one marked ‘bis’. The account of the Euphorbiaceae gave only a key to the genera and accounts of the first 6 genera. It was explained in a note in Vol. 75 of the Journal by the Acting Secretary General of Asiatic Society of Bengal that the complete manuscript for Euphorbiaceae was awaiting publication when Ridley’s Flora of the Malay Peninsula (1922-1925) appeared. The Society then felt that publication of the complete manuscript could not be justified.

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### Monocotyledons

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With this index, a family in the above lists can be located. The families are taken in their modern sense, and referred to their sequence number in the lists. Their spelling is the officially conserved one, as given in the International Code of Botanical Nomenclature, so our Styracaceae are referred to 73 Styraceae. Their circumscription follows the (non-official) list by Dr. C.G.G.J. van Steenis, *Nomina Generum Malesianorum* (Leiden 1972), hence our Symlocaceae are referred to that same number, 73, because King included them in his Styraceae. Monocotyledons are referred to the work by Ridley, which has a number sequence of its own, here denoted with “R”. If families were later combined, reference is made to both numbers, so our Orchidaceae which includes Apostasiaceae are referred to R2 and R3 because Ridley recognised them as separate families.

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NOTES ON THE SYSTEMATY OF MALAYAN PHANEROGAMS

XXX. Anacardiaceae

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Abstract

The purpose of these notes is to formalise several taxonomic changes in the family Anacardiaceae which has just been revised for the Tree Flora of Malaya. The changes are as follows:

Mangifera

_M. indica_ L.: reduction of _M. longipes_ to _M. indica_ and resultant range extension of _M. indica_.

_M. magnifica_ Kochummen, _sp. nov._

_M. quadrifida_ Jack var. _longipetiolata_ (King) Kochummen, _stat. nov._

_M. whitmorei_ Kochummen, _sp. nov._

Melanochyla

_M. caesia_ (Bl.) Ding Hou: reduction of _M. kunstleri_ to _M. caesia_.

_M. fasciculiflora_ Kochummen, _sp. nov._

_M. longipetiolata_ Kochummen, _sp. nov._

Rhus


Semecarpus

_S. rufovelutinus_ Ridl.: new record

_S. trengganuensis_ Kochummen, _sp. nov._

Swintonia

_S. floribunda_ Griff. var. _penangensis_ (King) Kochummen, _stat. nov._

Introduction

The Anacardiaceae for Malesia was revised by Ding Hou of Flora Malesiana Foundation. This was published in Flora Malesiana Vol. 8 (1978).

While I was writing up the Anacardiaceae for the 4th volume of Tree Flora of Malaya, based on Hou's revision, I discovered some new species as well as new records. Critical study of the family required reduction of certain taxa as well as establishment of new status for some taxa.

MANGIFERA

_Mangifera indica_ L.

_Mangifera longipes_ Griff., Notul. 4 (1854) 419; _type: Griffith 1096_ (K) _syn. nov._

According to Hou, the main differentiating character between _M. indica_ and
Fig. 1. *Mangifera magnifica* Kochumm. sp. nov.
Leafy twig, with longitudinal section of a fruit (right), and a seed (left). Inset – a & b: flowers; c: sepal, inside view; d: petal, inside view; e: disc, stamen and pistil. (a, × 4; b, c, d, e, all × 5).
M. longipes is the degree of hairiness of the calyx, i.e., densely puberulous on both surfaces especially on the outside in M. indica, but sparsely pubescent to glabrous in M. longipes. However I have come across several collections of the cultivated mango (M. indica) with glabrous calyx and so this character does not hold good. The degree of hairiness varies among the various cultivars. Consequently I have decided to merge M. longipes Griff. with M. indica L. I have not seen the type of M. longipes, but there is one sheet at Kepong, KEP 3637 on which is written in C. F. Symington’s hand: “matches with the type, Griffith 1096”. Many of the collections formerly distinguished as M. longipes are undoubtedly wild forest trees in Malesia and hence the natural range of M. indica must now be considered to extend into the Malesian region.

**Mangifera magnifica** Kochummen, sp. nov. Fig. 1.

Arbo excelsa usque at 54 m alta et 76 cm diametro; caulis sine anteridium; cortex extus cinereo-brunneus, laevis vel fissuratis et squamatis; intus luteolus; latex albus macilentus.

Ramunculi c. 7 mm crassi, glabri, subangulati. Folia spiraliter dispositi, petiolis crassis, 2 - 4.5 cm longis, basi gibbosis. Lamina crassa elliptica vel oblonga, variabilissima, 6 - 26.5 x 5 - 12 cm, apice obtuso vel rotundato, basi rotundato vel cuneato, raro asymmetrica, marginibus reflexibus; nervis secundariis 11-20-paribus, nervis intermediis paucibus, nervis tertiaris reticulationes formatibus obsoletis raro visibilis. Inflorescentia paniculata terminalis axillaris glabra 15 cm longa breviter ramosa, axibus complanatis; floribus brevipedicellatis c. 1.5 mm longis. Sepala 4 triangularia, 1.5 mm lata, acuminata, extus papillosa. Petala 4 oblonga glabra, c. 4 x 1.5 mm, extus intusque papillosa, costata, costa e dimidio petali 3-4-diviso glanduloso. Discus extrastaminalis. Stamen fertilium unicum. Ovarium glabrum sulco distincto, stylo laterale. Drupa oblonga 11 x 7 cm (in sicco), mesocarpio 1 cm crasso, endocarpio longitudinaliter striato; semen 10 x 6 cm, testa papyraceo.

**Typus:** KEP 20562, Gunung Jerai, Kedah (Holotypus KEP, isotypus SING).

**Distribution:** common, lowlands and hill forests throughout Malaya except Perlis, Penang and Malacca.

**Other collections seen:** KEDAH: KEP 11251, 20562, 105245; PERAK: KEP 8025, 9534, 11612, 40613, 63259, 65917, 69063, FRI 13941; KELANTAN: KEP 68315; TRENGGANU: FRI 16869; PAHANG: KEP 17288, 69602; SELANGOR: KEP 84613; NEGRI SEMBILAN: KEP 18422, 64749, 93265, 93797, 104762; JOHORE: KEP 69918, 70058, 70085, 70221, 84698, 92204, 93555, 104734, 105241, 116033, SFN 34970.

This is the thickest-leaved Mangifera with strong recurved margins and having floral parts similar to M. quadrifida.

**Mangifera quadrifida** Jack var. longipetiocolata (King) Kochummen, stat. nov.

Basionym: *M. longipetiocolata* King, J. As. Soc. Beng. 65 (1896) 470; *type: King’s Collector No. 7266 (K)*.

Ding Hou reduced *M. longipetiocolata* to *M. quadrifida* Jack. After examining a photograph of the type of *M. longipetiocolata* and the herbarium collections at
Kepong, I have come to the conclusion that vegetative characters like the very large leaves, often exceeding 24 cm long and 8 cm wide, the leaf stalks 4 - 10 cm long, prominently swollen at their base, and the raised tertiary nerves and lax reticulations on the upper leaf surface are sufficient to merit varietal status.

**Mangifera whitmorei** Kochummen, sp. nov.  

Fig. 2.

Arbor usque ad 30 m alta, corona subrotunda coronellis parvioribus numerosis. Cortex tenuiter fissuratus. Cortex interioris subroseus et rubrostriosus; latex albus gutulosis. Lignum succosum album.

Ramunculi rubro-brunnei glabri inconspicue striati. Petiolus tenuis 4 - 4.5 cm longis basi tumido rugoso. Lamina tenue coriacea angustae oblonga 11 - 13 × 3 - 3.8 cm, acuminata, basi cuneato, nervis secundariorum 15-17-paribus, (nervis intermediis paucibus) improninentibus, supra elevatis; nervis tertiariis reticulationes formantibus, infra visibilis, supra inconspicuis; costa media supra elevata. Inflorescentia axillaris paniculata glabra usque ad 23 × 10 cm, pauciramosa. Flores biseculae cremi pentameri, pedicelli 6 mm longi, infra apice 1 mm articulati. Sepala 5 glabra deltoidea 2 × 1.5 mm, obscuritern 6-lineata. Petala 5 oblonga glabra 4 × 1.5 mm pentacostulata (costuli quam petali ½ breviori), in parte basilarii tertiali confluenta. Stamina 5 fertilia, 4 mm longa, filamentis separatis, antheris globosis; staminodii 5 valde parvioribus oppositoperpetalis. Ovarium subglobosum 2 mm latum glabrum, glandulosum, glandis papilloformibus dispersis. Stylus lateralis 2.5 mm longus. Cetera ignota.

**Typus:** FRI 15820 (Whitmore), Upper Perak, 150 m alt. (Holotypus KEP, isotypi K, L, A, SING).

Known only by the type, however the collector stated that it is common on the hill slopes in the area.

The only other species with 3 - 5 fertile stamens is *M. pentandra* from which it differs by the glabrous inflorescences and long-pedicelled flowers.

**MELANOCYHLA**

**Melanochyla caesia** (Bl.) Ding Hou

*Melanochyla kunstleri* King, J. As. Soc. Beng. 65 (1896) 504; type: King’s Collector No. 6810 (SING); **syn. nov.**

When King described *M. kunstleri* he commented that it is very close to *M. maingayi* Hook. f. and the only difference he could discover was the smaller, more shiny leaves in *M. kunstleri*. Ding Hou later reduced *M. maingayi* to *M. caesia*. After examining the type of *M. kunstleri* and all collections under *M. caesia* and *M. kunstleri* at Kepong and Singapore herbaria I could find no floral or vegetative differences between the two.

**Melanochyla fasciculiflora** Kochummen, sp. nov.  

Fig. 3.

Frutex c. 5 m altus, ramunculis pallidis, gemma terminale ferrugineo hirsuto. Folia tenuicoriaceae, laminis 10.5 - 16.5 × 2.5 - 5 cm, acuminatis (acumen ad 1 cm longis), basi cuneato, pagina supra glabro, infra uniformiter papilloso et ad costam venamque sparsiter hirtello; costa infra canaliculato; nervis secundariorum 14-18-paribus curvato-descendentibus juxta marginem transientibus; nervis intermediis...
Fig. 2. *Mangifera whitmorei* Kochumm. sp. nov.
Leafy twig with inflorescence. Inset – a: flower; b: sepal, inside view; c: petal, inside view; d: disc, stamens and pistil.
brevibus; nervis tertiariis scalariformi reticulatis infra valde elevatis, supra inconspicuis; petiolo 0.7 – 2.2 cm longo. Flores ignoti. Infrutescentia axillaris, fructibus aggregatis, maturitate flavidis, oblongis, c. 1.5 x 1 cm, hispidis; acuminoides.


*FRI 16374*, from the same locality, is another collection belonging to this species.

*M. fasciculiflora* is very distinct from all other *Melanochyla* species because of the clustered axillary fruits.

**Melanochyla longipetiolata** Kochummen, sp. nov.  

Fig. 4.

Arbor usque ad 30 m alta, 100 cm, diametro; cortex cinereus, laevis, rimosus.

Ramunculi pallide brunnei, angulati. Folia crassiter coriacea, petiolo 1 – 4.5 cm longo, basi incrassato; lamina elliptico vel obovata 16 – 26 x 4 – 9.5 cm, acuminato, basi cuneato, infra glauco papillosoque; nervis secundariis 14-16-paribus, tertiariis scalariformibus reticulatis tenuibus. Inflorescentia terminalis paniculata 22 cm longa, floribus incognitis. Drupa ovoidea 4 x 2 cm, acuminata (in sicco), adpressiter pilosa, rugosa.

Typus: *FRI 8478 (Cockburn)*, Trengganu, Kg. Petang, Ulu Trengganu (Holotypus KEP, isotypi K, L, A, SING).

**Distribution**: very rare, lowlands to mountain forests.

**Other collections seen**: TRENGGANU: *FRI 20341*; PAHANG: KEP 26123.

**Rhus succedanea** Linn.

This species is a new record for Malaya. Ding Hou (*in litt.*) confirmed the identification as I was not able to see the type. It is a common tree along the valleys of mountain forests 1400 m at Fraser’s Hill and also at Cameron Highlands in Pahang. It can grow up to 40 m tall and 200 cm girth.

**Collections seen**: PAHANG: KEP 27166, 27171, 31031, 44864, 45411; FRI 23106, 29379, 29425, 29467, 32538.

**Semecarpus rufovelutinus** Ridl.

This species is a new record for Malaya. It is a common small tree in the lowland forests of east Johore and Pahang. I have not seen the type, but the material match Bornean specimens *SAN 39887 & 88330* which have been identified by Ding Hou.
Fig. 3. *Melanochyla fasciculiflora* Kochumm. *sp. nov.*

Leafy twig with fruit. Inset - part of the underside of a leaf, enlarged to show the channelled midrib.
Fig. 4 *Melanochyla longipetiolata* Kochumm. sp. nov.
Leafy twig and fruits.
Fig. 5. 

Semecarpus trengganuensis Kochumm. sp. nov.
Leafy twig with inflorescence. Inset - : a: flower bud; b: petal, inside view; c: petal, outside view; d: longitudinal section of flower. (a & b, × 12; b, c & e, × 20).
Collections seen: PAHANG: Samsuri Ahmad 397; JOHORE: KEP 97982, FRI 13802, Hardial Singh 1064, Samsuri Ahmad 506.

Semecarpus trengganuensis Kochummen, sp. nov. Fig. 5.

Frutex usque ad 3 m altus, ramunculis griseo-brunneis striatis, glabris. Folia alternata sed verticillata, petiolo c. 2 – 4 cm longo, supra canaliculato; lamina obovato vel anguste elliptico 16.5 – 37 × 6 – 15 cm, acuminato, basi cuneato, margine reflexo sinuato albido; nervis secundaris 13–16-paribus, juxta marginem recurvatis; tertiariis reticulationibus distinctis formantibus in paginis ambis. Inflorescentia paniculata terminalis et axillaris usque ad 18 cm longa pauciramosa hirtellae. Flores masculas (in alabastro) 1.5 mm longi, pedicello 0.2 mm longo hirtello, bracteis deltoideis 1 mm longis hirtellis, calyci lobis 5 obtusis 0.5 mm longis marginibus albidos; petalis 5 oblongis 1 × 0.5 mm intus glabris extus hirtellis prominentes 4-venatis; disco intrastaminale apice longe hirsuto; staminis 5, ad 0.5 mm longis, antheras oblongis basifixis. Flores foeminae non vidi. Fructus subglobsus 3 mm latus sparsiter hirtellus, obscure canalicularius, hypocarpio obconico hirtello; pedicello hirtello 3 mm longo.


Other collections seen: TRENGGANU: FRI 3940, 25163, 28300; PAHANG: KEP 28446, SFN 10688.

This species is close to Semecarpus curtisii but differs in the short few branched inflorescences, in the pale wavy-margined leaves and in the obconic hypocarp.

SWINTONIA

Swintonia floribunda Griff. var. penangiana (King) Kochummen, stat. nov.

Basionym: Swintonia penangiana King, J. As. Soc. Beng. 65 (1896) 490; type: Curtis 1579 (SING).

Hou reduced Swintonia penangiana King to S. floribunda Griff. After examining the type and studying the collections at Kepong and Singapore herbaria I find that S. penangiana King differs from S. floribunda Griff. in having non-glauccous leaves with very faint to inconspicuous veins, abruptly acuminate apex, and a characteristic brownish colour when dried. On the basis of these features I am raising it to varietal status.
A new Species of *Nepenthes* from Sulawesi, Indonesia

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**Introduction**

During my stay at the Herbarium Bogoriense in 1972, for the study of their *Nepenthes* collection, I was able to examine much undetermined material from several Indonesian islands. While going through those collected by P. J. Eyma in Sulawesi, I came across a very interesting *Nepenthes*. After subsequent study, I am now able to conclude that it should be described as a new species.

*Nepenthes dentata* Kurata, sp. nov.  


Planta tenuis, alte scandens. Caulis cylindricus vel obtuse trigonus, 4-5 mm crassus, glabra. Folia inferiora ignota. Folia superiora coriacea, sessilia, lanceolata vel elliptica, glabra, 10-12 cm longa, 3-4 cm lata, apice obtusa, basi rotundata vel leviter cordata, caulim \( \frac{1}{4} \) amplexens, sine vagina, utrinque glabra; nervi longitudinales utrinque 3-4, nervi transversales obscure, oblique ascendentes; cirrhus tenuis, cylindricus, 10-12 cm longus, glaber. Ascidia inferiora ignota. Ascidia superiora coriacea 18-22 cm longa, 3.5-4.5 cm lata, parte inferiori anguste ovata, parte superiori cylindrica vel leviter infundibuliformia, intus parte \( \frac{1}{4} \) inferiori glandulosa, costis 2 prominentibus; os ovatum, obliquum; peristomium pectinatum, dentibus magnis, lamellaribus, falciformibus vel lunaribus, 12-16 mm longis, 2-3 mm latis, 5-6 mm distantibus; operculum elliptico-ovatum, 4.5-5.5 cm longum, 4-5 cm latum, subus planum; calcar ca. 6 mm longum, filiforme. Inflorescentia mascula dense racemosa, ca. 15 cm longa; pedunculus ca. 10 cm longus, glaber; pedicelli insigniter tenues, 10-15 mm longi, 0.1-0.2 mm crassi, uniflori, glabri; sepala 4, elliptica, ca. 1.5 mm longa, ca. 1 mm lata, extus glabra, intus glandulosa; columna staminea 2-2.5 mm longa; antherae 6-8, uniseriatae. Inflorescentia feminea ignota.


Stem slender, climbing high, the part with adult leaves 4-5 mm thick, cylindrical or obtusely trigonous, glabrous. Lower leaves unknown. Upper leaves scattered, coriaceous, sessile, lanceolate or elliptic, 10-12 cm long, 3-4 cm broad, the apex obtuse, the base rounded or slightly cordate, obliquely clasping the stem for \( \frac{3}{4} \), longitudinal nerves 3-4 on both sides, pinnate nerves running obliquely towards the margin, irregularly reticulate; tendrils slender, 10-12 cm long, cylindrical, glabrous. Lower pitchers unknown. Upper pitchers coriaceous, 18-22 cm high, 3.5-4.5 cm broad, narrowly ovate in the lower part, cylindrical or slightly infundibuliform in the upper part, with 2 prominent ribs; mouth oblique, ovate; peristome pectinate, the teeth large, lamellate, falcate or crescent-shaped, 12-16 mm long, 2-3 mm broad, arranged on the narrow cylindrical base at intervals of 5-6 mm; inner surface of the pitcher glandular in the lower ovate part, the glands rounded and exposed
Plate 1. Holotype of Nepenthes dentata Kurata sp. nov. (Eyra 3572).
Nepenthes dentata Kurata sp. nov.

(not overarched); lid elliptic/ovate, 4.5–5.5 cm long, 4–5 cm broad, the lower surface without appendage, with small round glands on the marginal part; spur filiform, about 6 mm long. Male inflorescence densely racemose, about 15 cm long, the peduncle about 10 cm long, glabrous; pedicels extremely thin, 0.1–0.2 mm thick, 10–15 mm long, 1-flowered; sepals 4, elliptic, about 1.5 mm long, 1 mm broad, the outer surface glabrous, the inner surface glandular; staminal column 2–2.5 mm long, the anthers 6–8, uniseriate. Female inflorescence unknown. Colour of the

Fig. 1. Nepenthes dentata Kurata sp. nov. A: leaf & pitchers; B: male flower; C: side view of a tooth.
pitcher light-green with dark-red blotches or stripes, tooth yellow to light-green.

This new species is closely related to *N. tentaculata* Hook. f. by its sessile leaves, exposed (not overarched) pitcher glands and purplish brown colour of its dried specimen but differs clearly from it by the presence of its unique and remarkably large teeth at the mouth of the pitcher (hence the epithet “dentata”). The flower also characterizes this species by its small dimensions, which is considered to be the smallest in the genus. The pedicel, extremely slender in relation to its length — at most 0.2 mm in thickness — distinguishes this species too.

The teeth, roughly arranged along the slender peristome with an interval of about 5 mm, have the shape of a thin blade of a sickle or crescent and are about 15 mm long. This shape reminds us of two Bornean species (viz. *N. villosa* Hook. f. and *N. edwardsiana* Hook. f.) but the present species is not to be confused with them by its superficial resemblance as these Bornean species are, all parts considered, quite robust.

The distribution of this species seems limited to a particular area on the mountains of Central Sulawesi.

The author wishes to commemorate P. J. Eyma for his courage and achievement, in bravely stepping into the unknown world of Gunung Lumut forty-five years ago. I also wish to express my thanks to Professor A. J. H. Kostermans of Herbarium Bogoriense for his valuable suggestions in this study and to Dr. R. D. Hoogland who corrected my Latin diagnosis.

**Bibliography**


On the Nature of Leaf-opposed Inflorescences in *Aidia cochinchinensis* (Rubiaceae)

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Abstract

Leaf-opposed inflorescences in *Aidia cochinchinensis*, previously ascribed a terminal origin, is here shown to be axillary instead. Hence, the branch system in this species is not sympodial as believed, but a true monopodium along which inflorescences develop from the axils of reduced leaves at alternate nodes, exemplifying a specialised control of floral development.

Introduction

*Aidia cochinchinensis* Lour., a small tree-species distributed from the northeastern part of the Indian subcontinent to Malesia, exhibits a specialised morphology in its branches. The flowering cymes develop only at alternate nodes along each branch, on its upper side. Along the branches, alternate leaf-pairs have laterally disposed leaves and the intervening (flowering) nodes have a fully developed leaf from the lower side of the branch, the leaf on the upper side being reduced to a tiny scale which subtends the inflorescence. As such, each inflorescence appears leaf-opposed.

Previous Hypothesis for the Origin of Leaf-opposed Inflorescences

Fagerlind (1943) had characterised *A. cochinchinensis* Lour. (therein as *Randia cochinchinensis* (Lour.) Merr.) as having inflorescences terminating the lateral shoots from which subsequent branch extension is formed by an axillary shoot from the most distal leaf-pair, so that a series of such shoots forms a sympodial branch system (Fig. 1A). It was explained that this inflorescence would subsequently be displaced to the upper side of the branch sympodium by the developing shoot from the final node preceding the inflorescence. The displaced inflorescence thus appears lateral and leaf-opposed because the leaf on the upper side of this final node fails to develop normally. Subsequently, Tirvengadum (1978) has also adopted this explanation for the leaf-opposed inflorescences in this species.

Hallé (1967) has recorded a similar mechanism of branch development in *Schumanniophyton problematicum* (Chev.) Aubr. and *Massularia acuminata* (Benth.) Bullock ex Hoyle; in the former he noted a series of three buds in the leaf axil on the lower side of the branch at the final node preceding the inflorescence. The most distal of these buds then develops to continue sympodial extension of the branch, and Hallé designated the period between two successive flowering nodes as equivalent to one year (Fig. 1B). In other words, the branch system is a sympodium of hapaxanthic modules (Hallé et al. 1978).
Evidence for an Axillary Origin of the Inflorescences in *Aidia*

In *A. cochinchinensis*, the origin of the inflorescence is in fact axillary. Several morphological observations lend evidence to this conclusion:—

(a) The branch system is remarkably straight, and during its growth may extend by several internodes and nodes which remain vegetative. In the vegetative state, the current season's branch-extension would be equivalent to a series of successive internodes, and to accept that this is in fact a series of two-internode segments forming a sympodium requires that a whole series of buds terminal to the sympodial segments remain dormant for some time.

(b) Often, an axillary shoot develops on the lower side of the node of leaf reduction, simultaneous with (or even earlier than) the development of the bud from the upper side of the node (which becomes the inflorescence).

An axillary origin of the inflorescence is confirmed by a longitudinal section through the apex of a branch shoot terminated by a node of leaf reduction (Fig. 2). Here, it can be seen that the primordia of the leaf axillary buds (the one subtended by the reduced leaf being destined to form an inflorescence) are already present at an early stage of development, and are distinct from the central terminal bud which develops to continue shoot extension.

At a later stage of development, the central terminal bud extends its growth to form the next node of two normally developed leaves (Fig. 3), while the axillary buds are still dormant. There are no serial buds in leaf axils, as confirmed by sections through nodes of vertical axes and the branches; each leaf axil produces one axillary bud.

On older parts of the branches which have not yet produced inflorescences, longitudinal sections through the potentially flowering (one-leaf) nodes indicate that while there is already a clear and straight continuation of the main vascular cylinder across into the next internode, the inflorescence bud can still remain in a dormant state, not supplied by any clear vascular connection.

The Flowering Habit in *Aidia cochinchinensis*

The branch system in *A. cochinchinensis* is thus a monopodium along which there is leaf reduction at alternate nodes. The dormant bud from the axil of the (reduced) scale leaf, on the upper side of the branch, is destined to develop into an inflorescence. Two modes of flowering behaviour may be seen: either several successive potentially flowering nodes can initially remain vegetative and subsequently flower together, or such nodes can develop inflorescences progressively as branch extension continues. These two modes of behaviour may occur on the same plant, their prevalence seems to depend on the number of internodes added through branch extension during each growing season.
Fig. 1. A. Sympodial branch development explained for *Randia* sect. *Gynopachys*, from Fagerlind (1943); he included *R. cochinchinensis* (a synonym of *Aidia cochinchinensis*) in that section. B. Sympodial branch development explained for *Schumanniophyton problematicum*, from Hallé (1967); note serial buds in the leaf axils.

Fig. 2. Longitudinal section through the apex of a branch shoot in *Aidia cochinchinensis*. To the left of the section is the lower side of the branch, where the petiole of the developed leaf (*pd*) is found; to the right is the petiole of the reduced leaf (*pr*), and the stipules corresponding to these leaves are designated by *S1*. *ad*: axillary bud of developed leaf; *ar*: axillary bud of reduced leaf, which is equivalent to the inflorescence bud; *S2*: stipules corresponding to the next pair of leaves (at right angles to the plane of the section) and which protect the central terminal bud; *gt*: glandular trichomes or colleters found at the inner basal parts of the stipules.
Fig. 3. Longitudinal section through the apex of a branch shoot in *Aidia cochinchinensis*, at the stage of development subsequent to that in Fig. 2. *pd*: petiole of developed leaf; *pr*: petiole of reduced leaf; *S1*: stipules corresponding to *pd* and *pr; ad*: axillary bud of developed leaf; *ar*: axillary bud of reduced leaf (which develops to form the inflorescence); *L*: one leaf from the most distal pair of differentiated leaves; *S2*: stipules corresponding to the most distal pair of differentiated leaves; *t*: terminal bud; *v*: vascular tissue.

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**Literature Cited**


SOME NEW AND CRITICAL PANDANUS SPECIES
OF SUBGENUS ACROSTIGMA
I*. Supplement to Revisio Pandanacearum

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Abstract

Eight species of Pandanus subgen. Acrostigma are discussed in this supplement. Seven of them are additions: four have recently been published, two more are proposed as new herein and one has been omitted. *P. ellipsoideus* was poorly known and is here given a fuller description based on a recent collection. Both new species pertain to sect. Acrostigma subsect. Dimissistyli; one (*P. gladiator*) is from Sulawesi, the other (*P. jacobsii*) is from Papua New Guinea. As is usually the case, most of these species are as yet not represented by staminate specimens (known only in *P. merrillii*). Only one, *P. microglottis*, presents features which suggest a possible addition to the infrageneric scheme, but in the absence of sufficient specimens no change is suggested for the present.

Introduction

A synopsis, based on a critical revision, of two of the eight subgenera of Pandanus, subgen. Acrostigma and subgen. Coronata, was issued recently (Stone, 1978). That study, forming a component of the preliminary work leading to the revision of the family and to a family treatment in the Flora Malesiana, recognized three species in subgen. Coronata and 66 species in subgen. Acrostigma. Since then, a few additional species have been recognized, either as new or newly understood taxa from among the synonyms or nomina dubia. In this paper, these additions are listed in the same order of sections, subsections, and taxonomic order as was followed in the publication cited.

**Pandanus** subgen. Acrostigma (Kurz) Stone Sect. Acrostigma Kurz

**Subsect. Acrostigma**


SULAWESI: Sopu valley, west slope, Roroka Timbu, ridge forest at 1200 m. alt., clay soil; short-stemmed stooling herb, inflorescence erect, fruit green, leaves used for making mats (tikar), 4 May 1979, *M. J. van Balgooy* 3147 (L).

Extended description: short-stemmed, stooling herb. Leaves linear, c. 120 cm long

* This paper is dedicated to the late Marius Jacobs of the Rijksbataarium, Leiden, in memory of his contributions to Malesian botany and his ungrudging help and assistance.
Below left: Fig. 1. *Pandanus ellipsoideus* Warb. — *A*: cephalium. l.s.; *B* & *C*: drupe, *B*: profile and *C*: l.s., note the chamber above the endocarp in *C*; *D*: leaf apex, adaxial surface. All from Balgooy 3147 (L).

Above left: Fig. 2. *Pandanus merrillii* Martelli — Cephalium (upper) ± × 1; and drupes (lower) ± × 1; from the type collection, Merrill 840 (Fl). (Courtesy of Dr. C. Steinberg).

Right: Fig. 3. *Pandanus merrillii* — Infructescence with cephalia, ± × 2/3; from Bermejos BS 232 (Fl). (Courtesy of Dr. C. Steinberg).
Supplement to Revisio Pandanacearum

(plus more), 3.8 cm wide, the apex gradually acuminate; lower surface glaucous; upper surface finely striolate, indistinctly cross-nerved toward apex; lower surface with fine, close longitudinal nerves (c. 84-86 per leaf), very slightly indistinctly raised, interveniece areas densely stomatophorous. Leaf margins near base with spreading slender prickles c. 2 mm long, usually 3-5 mm apart; near middle, the prickles shorter, more appressed, c. 1 mm long, 3-6 mm apart; near apex, the prickles still smaller, c. 0.5 mm long, 1-2 mm apart. Beneath, midrib near base with short erect or retrorsile prickles at least 1 mm long (or reduced and nut-like on scale leaves and lower bracts), often 3-4 mm apart but rather irregularly spaced; near middle, the midrib carinate, with antrorse prickles c. 1 mm long, 4-10 mm apart; near apex, with prickles similar in size and spacing to those on adjacent margins. Apical ventral pleats prickly along distal 30-33 cm with numerous small antrorse prickles c. 0.5-0.7 mm long, nearer the apex mostly 1.5-4 mm apart. Inflorescence erect, the pistillate peduncle to 50 cm long, 8 mm wide, triquetrous, glabrous, bracteate, distally zig-zag-helicous, bearing 5 to 7 smallish ellipsoid cephalia c. 6 cm long, 5 cm wide, composed of numerous drupes, these with projecting, sharp, straight or slightly curved styles. Drupes 15-20 mm long (including style), c. 5 mm wide, the corpus clavoid, mostly 11-13 mm long, the pileus 5-6-angled, steeply pyramidal, gradually and rather indistinguishably produced upward as the sharp spiniform style, this erect or only slightly antrorsely curved, sharp, to 9 mm long; stigma linear, grooved, papillose, almost reaching the style tip. Apical mesocarp chamber large, rounded, c. 4 mm long; lower mesocarp very short fibrous; endocarp pale, c. 6 mm long, apex concave, base tapered, walls c. 0.5-0.6 mm thick.

In its inflorescences, leaves, and fruits, this species very much resembles P. affinis Kurz, a freshwater swamp lowland species common in Western Malesia, but in habit (as noted above) and certainly in habitat, this species appears quite different. The drupes of the cited specimens are an excellent match for those illustrated by Martelli.


A slender upland swamp species of Papua New Guinea, belonging to the group of species including P. adinobotrys Merr. & Perry.


A shrub similar to P. adinobotrys but more slender and smaller in all respects except the longer pistillate peduncles.


This recently described Papuan species is an addition to the small cluster of species centering around P. adinobotrys Merr. & Perry.

PAPUA NEW GUINEA: West Sepik Distr., Telefomin, alt. 1800 m, wet swamp,
erect pandan to 3 m tall, with many short side branches, leaves grey, fruit pale orange-brown solitary, Mar. 1975, Womersley & Waikabu NGF 48718 (holotype, KLU: isotypes, LAE, L, BRI).


Additional collections, all from Palawan; Merrill 7250, 9274 (staminate), 9375, and Bermejos B.S. 232 (Fl).

This species is so similar to _P. affinis_ Kurz that, on the basis of herbarium material alone, discrimination is virtually impossible. The sole difference worthy of note seems to be the presence, albeit slight, of minute bristles on the pistillate peduncle, noticeable in the type collection. The slightly hispidulous peduncle is not, so far, known in _P. affinis_, but is found in _P. monticola_ F.v.M. of Queensland, another (but quite different) species of sect. _Acrostigma_. Following are some supplementary descriptive notes on _P. merrilli_ drawn from the isotypes.

Leaves linear attenuate acute, the apex somewhat prolonged, subflagellate, to 162 cm long (and over), 2.8 cm wide; base with sheath about 3.5 cm long; margins near base with spreading prickles with slightly recurved tips 2-2.8 mm long, 1.5-5 mm apart; near the middle, the marginal teeth slender antrorse, nearly 1 mm long, 3-6 mm apart; near apex, the teeth antrorse, 0.25 mm long, 1 mm apart. Midrib near base with stout broad-based retrorse prickles to nearly 3 mm long, 1.5-11 mm apart; farther out along basal fifth of leaf, the prickles recurved, 2 mm long, more remote, to 25 mm apart; near the middle, the teeth scarcely 1 mm long, antrorse, 10 mm apart; near apex, the teeth similar in size and spacing to those of the adjacent margin. Apical ventral pleats prickly with antrorse prickles scarcely 0.5-0.9 mm long, irregularly spaced, sometimes only 1 mm apart, sometimes several cm apart, extending along the most distal 30 cm of the leaf. Undersurface pale glaucous. Longitudinal nerves about 67-69 per leaf, dorsally overlain by the minute punctiform stomatal complexes visible as 3-5 parallel rows of dots. Infructescence spicate, cephalia 5 (or more?) together, each c. 5.5 cm diameter, the drupes crowded. Peduncle slightly hispidulous toward apex, or not (?). Drupes c. 27 mm long (including styles), the corpus 15 mm long, 4-5 mm wide; pileus 3-4 mm long, produced into a style c. 6 mm long. Staminate inflorescence spicate; spike bearing apparently solitary stamens, each with a short filament 1 mm long and a long anther 8 mm long, the apiculus 0.5 mm long. (Staminate description based on Merrill 9274).


This Sarawak species is noteworthy for its polycephalic infructescence and the
short, ovate-acute stigmas on similarly short, broad, non-spiniform styles. The latter feature suggests that the species has an isolated position in the section and may even deserve a subsectional rank on its own. However, pending the discovery of the staminate plants, this remains a potential status rather than a clearly deserved one, and for the time being, it is merely ranked as a species of subsection *Acrostigma*.

SARAWAK: Mulu National Park (4th Division), Sungei Melinau Paku drainage area along rocky riverbanks beside Transit Camp 2 at c. 150 m alt., 2 Apr. 1978, *Stone* 13654 (holotype, KLU; isotypes, K, SAR).

**SUBSECT. *Dimissistyli* Stone**

*Pandanus gladiator* B. C. Stone, sp. nov.  

Fig. 4.

Frutex arborescens usque ad 5 m altaus, erectus, sparsiter ramosus, strictus; solitarius; corona foliorum densa; foliis lineari-attenuatis coriaceis munitis, usque ad 300 cm longis, et 8 cm latis, apice acutis breviter subcaudatis; marginibus in basi dentatis, dentibus rigidis deltoideis patentibus c. 2.5 mm longis et 2–5 mm sese separatis; in medio, dentibus subappresser curvatis antrorsis c. 2 mm longis, (3–) 5–9 (–12) mm sese separatis; apicem versus, denticulis parvioribus, subappresser antrorse curvatis, klydoniformibus, densis, c. 1–1.4 mm longis et 1 mm sese separatis; *costa media* dorso in basi hamato-acuteo dentibus reflexis 3–3.5 mm longis, 3–12 mm sese separatis; in medio, denticulis subappresser antrorsis parvioribus c. 1.4–1.8 mm longis, (2–) 4–8 (–11) mm sese separatis; apicem versus, denticulis antrorsis gracilibus c. 1–1.2 mm longis et 2–3 mm sese separatis; in cauda, denticulis ad eis in margine adjacenti similimis; pagina infra ut videtur pallido et glauco, densiter et obscuriter venosostriatulo; plicibus apicalibus foliorum ventraliter denticulatis. *Inflorescentia* axillaris, spicata, robusta, bracteata (bracteis delapsis), polycaphala (cephalisis c. 5–7); cephalisis aggregatis, oblato-rotundis, lateraliter subcompressis, c. 9–10.5 cm longis, 10–11 cm latis, receptaculo c. 3–4 × 2.5 cm, drupis numerosis ferentis; pedunculo triquetro c. 40 cm longo, 2.5 cm crasso, robusto. *Drupa* (ex loco mediano) c. 40 mm longa; pileo (corpo styliforme) 25–30 mm longo (stypo incluso); pyrena basali anguste obovoidea 8.9–9.5 mm longa et 3 mm lata, vel (mesocarpio basali incluso) c. 11 mm longa; stylo (sensu stricto) spiniforme, antrorse curvato vel recto, 4–6 mm longo, acutissimo; stignate anguste canaliculato nigro, per totam longitudinem styli; endocarpi pallido parietie c. 0.5 mm crasso. Cetera ignota.

Type: SULAWESI (Celebes), Mt. Roroka Timbu, west slope, c. 80 km SSE. of Palu, disturbed lower montane forest c. 35 m high, with little undergrowth, on steep terrain with shallow clayey soil; solitary “*schopfbaum*” 5 m tall, fruit bright red; leaf c. 3 m long; trunk hardly branched; 11 May 1979; *E. F. de Vogel* 5287 holotype, BO!; isotypes, L! KLU!)

This species fits readily into subsect. *Dimissistyli*, but is the first species in that group to present a spicate, polycaphalike infrutescence, and this seems its principal distinctive character. However, drupe size is smaller than in *P. danckelmannianus* K. Schum. and larger than in *P. misimaensis* St. John ex Stone; but about the same as in *P. erinaceus* Stone and *P. ictor* Stone. The long pilei of the drupe are relatively smooth, unlike the coarsely verruculose pilei of *P. verruculosus* Backer ex Stone.

The species is known so far only from the type collection.

The specific epithet is well known and means “sword-fighter” in allusion to the sword-like leaves; but also more broadly appropriate because of the various weapons which the Roman gladiators used, including the mace, to which the fruit-heads bear
a certain resemblance. The species is also a companion of *P. lictor*, the specific epithet of which means "mace-bearer."

*Pandanus gladiator* is the western-most of subsection *Dimissistyli*, and probably indicates the absolute western boundary of this subsection. There is one other Moluccan species (*P. verruculosus*), from Halmahera, but probably a few more remain to be found. Most of the species are in New Guinea, the Bismarck Archipelago, and the Solomon Islands.

*Pandanus jacobsii* B. C. Stone, sp. nov.  

Frutex usque ad 2-3 m altus, stipite ad 4 cm crasso, simplex; radicibus gralliformibus nullis. Folia linearia ad 220 cm longa, 5 cm lata, infra glauca; apicem versus acuta; marginibus in basi dentatis, dentibus c. 2 mm longis, 1-5 mm sese separatis; in medio, dentibus antrorsis, c. 1 mm longis, 1-5-4 mm sese separatis; apicem versus, denticulis subapressiter antrorsis c. 0.5-1 mm longis, c. 1.5 mm sese separatis. Costa media dorso in basi per spatium 15-18 cm inerme, deinde dentibus deltoideis patento-retrorsis ad 2.5 mm longis, 6-14 mm sese separatis; in medio, costa carinato, denticulis antrorsis 0.7-0.9 mm longis, 1-3 mm sese separatis; apicem versus, denticulis antrorsis 0.5-0.9 mm longis, 1-3 mm sese separatis. Plicae foliorum apicali-ventraliter armatae, denticulis antrorsis 0.75 mm longis, irregulariter separatis, sparsis. Inflorescentia axillaris, pedunculo c. 10 cm longo, 14 mm crasso (apicem versus); cephalio solitario oblato-globoso c. 10 × 11 cm, receptaculo c. 4 cm longo, drupis numerosis composito. Drupa c. 35 mm longa, pileo c. 20 × 4 mm anguloso, verruculoso-tuberculato, in stylo 6-7 mm longo antrorse curvato producto, stigmate lineare subaequilongo; pyreno 12-13 mm longo, 4-5 mm lato, endocarpio 10 mm longo, pariete pallido c. 0.14 mm crasso. Semen c. 8 mm longum. Cetera ignota.

*Type:* PAPUA NEW GUINEA: Southern Highlands Prov., limestone country near Waro airstrip 20 km SSW of Kutubu, 6° 31'S, 143° 10'E, at 500-600 m alt., single-stemmed pandan without proproots, 2-3 m tall, leaves glaucous underneath, fruit light red, 15 Oct. 1973, *M. Jacobs* 9281 (L holotype, 2 sheets!).

Like most species of subsection *Dimissistyli*, *P. jacobsii* has the erect, not or little-branched trunk, with no or few basal proproots, an axillary inflorescence, the pistillate peduncle bearing a solitary oblate globose cephalium, and the drupes ripening red. In *P. jacobsii*, the drupes are quite small, approaching *P. misimaensis* St. John ex Stone, in their dimensions. However, the additional length and the more coarsely verruculos-tuberculat pilei distinguish *P. jacobsii*. The marginal prickles of the leaf apex are moreover smaller in *P. misimaensis*. *Pandanus verruculosus* Backer ex Stone has also the tuberculat pilei intimated by its name, but in this Halmaherian species the cephalia are larger (12-15 cm diameter) and leaves much larger (to 500 × 14 cm). Perhaps the most similar species to *P. jacobsii* is *P. erinaceus* Stone, which however is a taller plant (to 5 m), with basal proproots to 1 m long, and the drupes have a virtually smooth pileus.

The new species is named after the late Dr. M. Jacobs of the Rijksherbarium, Leiden, in recognition not only of his merit in obtaining the type collection but for his botanical contributions to the Flora Malesiana and special assistance to the author.
Right: Fig. 5. *Pandanus jacobii* B. C. Stone sp. nov. — *A*: drupe, profile and *B*: pyrene, l.s.; from the type collection *Jacobs* 9281 (L).

Left: Fig. 4. *Pandanus gladiator* B. C. Stone sp. nov. — *A*: leaf apex, adaxial surface; *B*: idem, detail of marginal prickles; *C*: leaf, middle portion, abaxial surface; *D*: leaf base, abaxial surface; *E*: cephalium, l.s.; *F*: drupe, profile; *G*: pyrene, profile and l.s.; *H*: detail of style & stigma and *I*: infructescence. All from the type collection, *de Vogel* 5287 (L).
SUBSECT. *Alticola*e Stone


A remarkable, small, sprawling decumbent plant, probably a facultative epiphyte, known so far only from the massive limestone peak Gunung Api in Mulu National Park, Sarawak. The solitary cephalium is only 15 mm long (sometimes two occur together), but the size of the fruit at maturity is not known. At the unripe stage the drupes are only about 1 cm long.

SARAWAK: Mulu National Part (4th Division), Gunung Api limestone ridge at c. 1500 m alt., 14 Apr. 1978, Argent & Jermy 973 (holotype, E; isotypes, K, KLU, SAR).

It should be mentioned that the type species of this subsection, *P. alticola* Holtt. & St. John, is also known from Sarawak and has in fact also been collected in Mulu National Park (Ivan Nielsen 662, in AAU).

Acknowledgement

My thanks are due to E. F. de Vogel for his kindness in showing me his collection of *Pandanus gladiator* before final processing at Leiden in 1981, and to the Rijksherbarium for making a duplicate available for study at KLU in 1983.

Literature Cited

STUDIES IN MALESIAN VITACEAE
VII. The genus Tetrastigma in the Malay Peninsula

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Abstract

A revision of the genus Tetrastigma (Miq.) Planch. in the Malay Peninsula is presented. Twelve species are here redescribed and assigned to section Tetrastigma and section Carinata sect. nov. They are: T. pedunculare (Wall. ex Laws.) Planch., T. papillosum (Bl.) Planch., T. pyriforme Gagnep., T. scortechinii (King) Gagnep., T. dubium (Law.) Planch., T. cruciatum Craib & Gagnep., T. lawsoni (King) Burkill, T. dichotomum (Bl.) Planch., T. lanceolarium (Roxb.) Planch., T. hookeri (Laws.) Planch., T. curtisii (Ridl.) Suesseng., and T. godefroyanum Planch. Six species, namely, T. papillosum, T. pyriforme, T. cruciatum, T. dichotomum, T. hookeri, and T. godefroyanum, represent new additions to the flora of the Malay Peninsula, and two established species names are reduced, namely, T. kunstleri (King) Craib (to T. lanceolarium) and T. wrayi (King) Craib syn. nov. (to T. dubium). A general discussion on the growth habits and morphology of stem, inflorescence, flowers, fruits and seeds is also given.

Introduction

The largest genus of the Malayan Vitaceae is Tetrastigma (Miq.) Planch., which comprises 12 species. The genus is characterized by its 4-lobed or 4-cleft stigma in the pistillate flowers. In the other genera, the stigma is subcapitate (as in Ampelocissus, Cissus, and Cayratia) or entire (as in Pterisanthes). The value of the stigmatic characteristic of Tetrastigma was first recognised by Miquel (1861) when he included all the then known species of Vitis (sensu lato) which have a 4-segmented stigma under section Tetrastigma Miq. Later Planchon (1887) raised Miquel’s section to generic status, a taxonomic decision which received mixed support from later taxonomists. Gilg (1896), Gangepain (1910) and Suessenguth (1953), for instance, recognised Tetrastigma as a genus whereas King (1896) and Ridley (1922) did not. Ridley (1922) recognised 3 genera of Malay Peninsula Vitaceae viz. Vitis L., Pterisanthes Bl. and Leea L. ex Van Royen, and treated Tetrastigma as a section of Vitis, along with Ampelocissus, Cissus and Ampelopsis.

The first complete account of the Malayan Tetrastigma was given by King (1896), an account later adopted by Ridley (1922). Seven species, viz., Vitis pedunculare, V. scortechinii, V. wrayi, V. lawsoni, V. kunstleri, V. lanceolarium and V. curtisii were adequately described by Ridley (1922). In a recent study, the author (Latiff, 1978) recognised only six of the species described; the description of V. wrayi King was found to be based on two species, that of the vegetative parts agreeing with Cayratia wrayi (King) Craib and that of the reproductive parts with T dubium which, as a name, has priority over T. wrayi (King) Craib.

HABIT AND MORPHOLOGY

Growth habits. All members of the Vitaceae except Leea climb by means of tendrils. The tendrils are borne opposite the leaves on the long vegetative shoots.
Tetrastigma species may be described as large vines; their stems are comparatively thick, woody and long. Their trailing stems may be found draping trees and shrubs along roads, river banks and in forest edges, especially at higher altitudes.

**Stem.** This description of stem morphology is based largely on the study of herbarium specimens, supported by limited field observations. The stems are striate and terete when young and later they either remain terete as in *T. pedunculare* and *T. pyriforme* or become flattened as in *T. lawsoni* and *T. cruciatum*. Stem lenticels are very prominent; they appear normal as in *T. pedunculare* or protrude externally as corky excrescences, a character diagnostic for *T. papillosum*.

**Leaves.** Only one species, i.e., *T. scortechinii* has simple leaves, its diagnostic character. Other species have compound leaves with leaflets ranging from 3 to 7. However, leaves of *T. cruciatum*, *T. dubium*, and *T. dichotomum* are predominantly trifoliolate while on the same stem some are simple. The simple leaves in these are comparatively larger than any single leaflet of the compound leaf. A few species, for instance, *T. pedunculare*, *T. papillosum*, and *T. curtisii* have only trifoliolate leaves.

In *Tetrastigma* the leaf-outline is found to be diagnostic for some species. *T. goddefroyanum* and *T. curtisii* have obovate terminal leaflets. Specimens of *T. hookeri*, which have widely elliptical terminal leaflets, are distinguishable from those of *T. lanceolarium* which have lanceolate ones.

**Inflorescences.** The inflorescence in all species is pedunculate. In most of them, the peduncles are easily observed but in *T. cruciatum* and *T. lawsoni* they are very short, the inflorescence being almost sessile. The peduncle-length differs in inflorescences of different sexes. In *T. dichotomum*, *T. curtisii*, and *T. lanceolarium* the male inflorescences have a longer peduncle than those of the female. This has made identification of species based on general morphology difficult. The inflorescence in *Tetrastigma* species is a cyme which is of the following kinds: corymbose in *T. papillosum*, umbellate in *T. scortechinii*, *T. cruciatum* and *T. goddefroyanum*, and dichotomous in others.

**Flowers.** *Tetrastigma* is dioecious, having pistillate and staminate flowers in different individuals while all the other genera of Vitaceae have bisexual flowers. The flowers of *Tetrastigma* are largely 4-merous but 5-merous ones are occasionally found. The calyx is small and subcupuliform. The petals are membranous, on the outside glabrous or slightly pubescent and are strongly reflexed in the bud.

The stigma which is either 4-cleft or 4-lobed in the pistillate flowers is an important single character for recognizing the genus. It is entire in the staminate flowers. The four narrow segments of the stigma are orientated in different ways: vertically, as in *T. pedunculare* or horizontally as in *T. dubium*. In other species, the four segments are not very conspicuous because the stigmatic surface is densely covered with simple multicellular hairs or cilia. The ciliate stigma is perhaps an adaptive feature to ensure the better deposition of pollen grains in dioecious plants like *Tetrastigma*. Within the Vitaceae, it is only in *Tetrastigma* that staminodes are present in the pistillate flowers. In shape and position, these are suggestive of
reduced stamens.

Fruits. The fruits of Vitaceae are berries. In *Tetrastigma* the degree of pulpiness varies from species to species. For example, the berries of *T. hookeri* are very pulpy, moderately so in *T. scortechinii* and *T. dubium* while those of *T. godefroyanum* contain hardly any pulp.

In section *Tetrastigma* the variation in size, shape and surface features of the berries is quite useful for species identification. For example, *T. hookeri* has the largest berries (c. 3.5 cm in diameter) and *T. dubium* has the smallest (c. 0.9 cm in diameter) in that section. The dried berries of *T. godefroyanum* are smooth and hard, whilst those of *T. curtisii* are wrinkled and soft. Generally, *T. lawsoni* and *T. dichotomum* are similar but their berries differ in number and shape. The former has globose berries, usually 1–3 per fructification while the latter has ellipsoid ones, usually more than 3 per fructification. Within section *Carinata* the difference in fruit size is also useful for separating the three Malayan species. The fruits are c. 0.7 cm long in *T. pedunculare*, c. 1.4 cm in *T. pyriforme* and c. 0.9 cm in *T. papillosum*.

Seeds. The difference in fruit and seed morphology form the basis for creating two sections in this genus as described in the latter part of the paper (under taxonomic treatment).

Size in general is not useful for distinguishing species even though seeds in *T. pedunculare* and *T. papillosum* are relatively small (0.5 × 0.4 cm). Shape has been found to be diagnostic for the two sections. In section *Tetrastigma* the shape is plano-convex, globose or oblong while in section *Carinata* it is convex-carinate.

The two sections in *Tetrastigma* may also be recognised by the differences in their testa sculpturing or ornamentation. Observations made on all the Malay Peninsular species show differences in their testa pattern which suggest a grouping into the following types (Table 1).

<table>
<thead>
<tr>
<th>Type</th>
<th>Sect. <em>Tetrastigma</em></th>
<th>Sect. <em>Carinata</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rridged</td>
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<td></td>
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<tr>
<td>2. Tuberculate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Glabrous</td>
<td><em>T. lawsoni</em></td>
<td></td>
</tr>
<tr>
<td>4. Rugulose</td>
<td><em>T. dubium</em></td>
<td><em>T. pedunculare</em></td>
</tr>
<tr>
<td>5. Furrowed</td>
<td><em>T. lanceolarium</em></td>
<td><em>T. papillosum</em></td>
</tr>
<tr>
<td>6. Reticulate</td>
<td><em>T. hookeri</em></td>
<td><em>T. pyriforme</em></td>
</tr>
<tr>
<td></td>
<td><em>T. curtisii</em></td>
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<tr>
<td></td>
<td><em>T. dichotomum</em></td>
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<td></td>
<td><em>T. cruciatum</em></td>
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<tr>
<td></td>
<td><em>T. scortechinii</em></td>
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<td></td>
<td><em>T. godefroyanum</em></td>
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</tbody>
</table>
Another character which distinguishes the two sections is the position of the chalazal knot on the dorsal surface of the seeds. In section Tetrastigma the chalazal knot extends ¼- or full-way the dorsal surface while in section Carinata it extends ½-way the surface. On the ventral surface the infolds are deep and converging in section Carinata but shallow and parallel in section Tetrastigma.

Host-parasite relationships. Rafflesia arnoldii R. Br., with flowers 1 m across, was the first parasite reported on Vitaceae. Brown (1842) collected it in Sumatra, growing on the roots of (what he reported) a species of Cissus. As Tetrastigma is now known to be the only host of the parasitic Rafflesia, it is very likely that Brown misidentified the host. In the State of Perak in the Malay Peninsula, T. scortechinii is said to be the host of R. hasseltii Suring. (B. C. Stone, 1978, pers. comm.).

Stirling (1939) reported the occurrence of Sapria himalayana Griff. as a parasite on the roots of T. cruciatum. The seeds of this parasitic member of the Rafflesioideae are said to be deposited (and to germinate) in cracks in the roots or stems of the host. Species such as T. cruciatum, T. scortechinii, T. lawsonii and T. lanceolarium have characteristic straplike stems which are easily broken or cracked, thereby providing a suitable niche for the seeds of the parasite. The physiological relationships between these parasites and their hosts have been the subject of a few investigations (Stirling, 1939; Brown, 1912). Recently, a Rhizanthes species has been noted to be parasitic on stems of T. dubium in the State of Pahang (Francis S. P. Ng, 1982, pers. comm.). Speculation on the evolutionary relationships between these plants is currently given attention to by W. Meijer (1982, pers. comm.).

Tetrastigma (Miq.) Planch.


Type species: T. lanceolarium (Roxb.) Planch.

Large, woody, dioecious vines. Stem terete or flattened, conspicuously lenticellate. Leaves simple or/and compound. Tendrils simple, leaf-opposed, not ending with an adhesive disc. Inflorescence axillary and pedunculate, a cyme, the cyme umbellate, corymbose or dichotomous. Flowers 4(5)-merous; unisexual, pedicellate. Calyx subcylindric to disciform. Petals reflexed in mature flowers. Disc adnate to ovary in pistillate flowers, 4-lobed, free in staminate flowers. Filaments filiform. Anthers orbicular to ovate-oblong. Staminodes filiform. Style terete, short. Stigma minute and entire in staminate flowers, large, 4-lobed, and ciliolate in pistillate flowers. Ovary undeveloped in staminate flowers, 2-loculate, the locules 2-ovulate each in pistillate flowers. Berries pyriform to globose. Seeds with dorsal side convex and ridged or furrowed, ventral side convex or carinate; endosperm T- π, M- π, m, or π-shaped in cross-section.
**Distribution.** About 95 species, in tropical and subtropical Asia, in Malesia (c. 57), Taiwan (4), India (12), Thailand (16), and Indochina (22).

**Ecology.** Occurs in all kinds of habitat from sea-level to high mountains.

**Key to the Species**

1. Berries pyriform when dry, 3- to 4-seeded; seeds convex-carinate, the chalaza extending ½-way across the surface, the ventral infolds converging; endosperm M-shaped in cross-section

2. Leaves 5-foliolate; berries 0.8-1.0 cm long; seeds 0.7 cm long, the beak inconspicuous ........................................ 12. *T. pyriforme*

2. Leaves 3-foliolate; berries 0.5-0.7 cm long; seeds 0.5 cm long, the beak prominent

3. Terminal leaflet broadly elliptical to rhombic; lenticels of old stems not modified; inflorescence dichotomous; leaflets with fine glaucous indumentum beneath; staminodes as long as gynoecium ........................................ 10. *T. pedunculare*

3. Terminal leaflet narrowly elliptical; lenticels of old stems modified to spinelike corky excrescences; inflorescence corymbose; leaflets glabrous beneath; staminodes ½ the length of gynoecium ........................................ 11. *T. papillosum*

1. Berries globose or ellipsoid when dry, 1- to 2-seeded; seeds globose or plano-convex, the chalaza extending ¾-way or more across the surface, the ventral infolds parallel; endosperm M to M-shaped in cross-section

4. Leaves simple, pubescent beneath, leaf-base semi-cordate; anthers kidney-shaped ........................................ 1. *T. scortechinii*

4. Leaves compound (simple leaves sometimes present on the same individual), glabrous beneath; leaf-base acute or obtuse; anthers orbicular or ovate-oblong

5. Flowers glabrous

6. Leaves 5- to 7-foliolate; seed testa reticulate; endosperm M-shaped in cross-section; bark usually shredding; inflorescence usually borne on lateral branches ........................................ 9. *T. godefroyanum*

6. Leaves simple to 3-foliolate; seed testa rugulose; endosperm M-shaped in cross-section; bark usually glossy; inflorescence on the main stem

7. Stigma-lobe pointed; staminodes ½ length of the gynoecium; seeds 0.6 cm long, the chalazal knot clavate and extending ½-way across the surface; leaves chartaceous 2. *T. dubium*

7. Stigma-lobe rounded; staminodes as long as gynoecium; seeds 1.2 cm long, the chalazal knot elongate and extending completely across the surface; leaves coriaceous ........................................ 5. *T. dichotomum*

5. Flowers pubescent

8. Stigma-lobe pointed, glabrous; flowers flat-topped; leaflets with decurrent bases 4. *T. lawsoni*

8. Stigma-lobe rounded, ciliate; flowers conically topped; leaflets with acute base

9. Venation between the secondary veins of leaves very prominent; seed testa reticulate; endosperm M-shaped in cross-section ........................................ 8. *T. curtisii*

9. Venation obscure; seed testa rugulose or furrowed; endosperm M-shaped in cross-section

10. Leaves membranous, simple to 3-foliolate; seeds obovoid; inflorescence very condensed, 1 cm in diameter ........................................ 3. *T. cruciatum*
10. Leaves coriaceous, 3- to 7-foliolate; seeds ellipsoid; inflorescence lax, 5-13 cm in diameter

11. Leaflets lanceolate to narrowly elliptical, the margin obscurely dentate; berries 1.5-2.0 cm in diameter; seeds 12.0 × 0.6 cm 6. T. lanceolarium

11. Leaflets very broadly elliptical, the margin dentate; berries 3.2-3.5 cm in diameter; seeds 1.8 × 0.8 cm 7. T. hookeri

I. Sect. Tetrastigma

Baccae globose vel ellipsoidae. Semina 1-2, globose vel plano-convexa, postice sulcis rectis parallelis 2 leviter exarata. chalaza ner ¼ vel totum longitudinis seminis deorsum extensa, antice sulcis; endospermum in sectione transversali M-forme ad б-forme.

Type: T. lanceolarium (Roxb.) Planch.

1. Tetrastigma scortechinii (King) Gagnep.

T. scortechinii (King) Gagnepain, Not. Syst. 1 (1911) 376; Suessenguth in Engler & Prantl, Nat. Pfl. Fam. 20d (1953) 321.

Lectotype: King’s Coll. 2897, Larut, Perak (SING!, isolectotype K!).

Vitis scortechinii King, J. As. Soc. Beng. 65, 2 (1896) 392; Ridley, Fl. Penin. 1 (1922) 474.

Stem 0.9-1.2 cm in diameter (young), flattened, 2.7-3.1 cm wide (old). Leaves simple 15.4-19.2 × 8.5-10.3 cm, ovate-oblong, acuminate, semicordate at base, sinuate-bristled, subcoriaceous, glabrous above, pubescent beneath, the petiole 3.4-4.6 cm. Peduncle 2.9-3.1 cm; cyme umbellate. Staminate flowers c. 5 mm long, oblong, the stigma-lobe rounded. Pistillate flowers c. 6 mm long, oblong, the stigma-lobe rounded. Berries 0.4-0.6 cm in diameter globose, usually 2-seeded; seed 0.4-0.5 cm in diameter, globose, the endosperm M-shaped in cross-section.

Ecology. On the margin of limestone vegetation and lowland dipterocarp-forest. This species is believed to be the host for Rafflesia hasseltii Suring. (B. C. Stone 1978, pers. comm.)

Distribution. Known only from collections in Gopeng, Larut and G. Pondok (Perak), and Sungai Jelai (Pahang).

Observation. This is the only simple-leafed species in the Peninsula, recognised by its ovate-oblong, pubescent leaves and compact inflorescence.

Specimens examined. PERAK, Gopeng, April 1884, Wray Jr. 5998 (K. BM); Larut, March 1882, King’s coll. 2897 (lectotype, SING); G. Pondok, 7.6.1930, Henderson 23793 (SING). PAHANG, Sg. Jelai, July 1903, Machado s.n. (SING).


*Type: Hooker f. s.n., Sikkim, India (Isotype, K!*)


Stem 1.8-2.4 cm in diameter. Leaves simple or digitately 3-foliolate, chartaceous, glabrous; simple leaves 10.2-12.8 × 4.6-5.2 cm, ovate-oblong, acuminate, rounded at base, entire, the petiole 7.4-9.8 cm; compound leaves with terminal leaflets 9.8-19.2 × 4.3-10.6 cm, elliptical, acuminate, entire, acute at base; the petiolule 1.6-4.5 cm; lateral leaflets 5.7-17.4 × 3.4-8.2 cm, oblong, oblique, the apex and margin as in terminal leaflets, the petiolule 0.3-1.4 cm. Peduncle 1.7-2.2 cm; cyme dichotomous. Staminate flowers c. 3 mm, pubescent. Pistillate flowers c. 3 mm long, pubescent, the staminode c. 1 mm, the stigma-lobe terete. Berries 0.5-0.8 cm in diameter, globose, usually 2-seeded; seeds 0.6 × 0.4 cm, globose, the endosperm M-shaped in cross-section.

Ecology. On the margin of the lowland dipterocarp-forest, and submontane forest.

Distribution. India, Burma, Thailand and the Malay Peninsula.

Observation. The specimens of the Malay Peninsula have two forms of leaves, simple and 3-foliolate, but in India variants with (a) 3- and 5-foliolate leaves (on the same specimen) and (b) with 5-foliolate ones only, are frequently seen.


3. *Tetrastigma cruciatum* Craib & Gagnep.


*Type: Kerr 599, Chieng Mai, Thailand (isotype, K!, BM!).*
Old stem flattened, 0.9–1.2 cm thick, 3 cm wide. Leaves simple or 3-foliolate, membranous, glabrous, the petiole 0.8–2.4 cm; simple leaves 9.5–11.2 × 3.6–5.2 cm, oblong, acuminate, rounded at base, subentire; compound leaves with terminal leaflets 7.9–9.2 × 3.7–4.8 cm, elliptical, the apex, base and margin as in simple leaves, the petiolule 0.3–0.5 cm; lateral leaflets 7.5–8.9 × 3.6–4.3 cm, elliptical, oblique, decurrent, the petiolule 0.2–0.4 cm. Peduncle 0.1–0.3 in diameter; cyme umbellate. Pistillate flowers c. 5 mm long, pubescent, the staminode c. 0.8 mm, the stigma-lobe rounded and ciliolate. Staminate flowers not observed. Berries 0.9 × 0.6 cm, subglobose; seeds 0.7 × 0.5 cm, the testa furrowed, the endosperm M-shaped in cross-section.

Ecology. On the margin of lowland dipterocarp-forest and mostly on limestone hills (e.g. Pulau Langkawi).

Distribution. Thailand and the Malay Peninsula.

Observation. This species is recognized by its very condensed inflorescence, flattened stem and membranous leaves. The first collection, of Griffith, in Malacca, was misidentified by Ridley as *T. lanceolarium*. The other collections are from Perlis. This species constitutes another addition to the flora of the Malay Peninsula.


4. *T. lawsoni* (King) Burkill


Lectotype: King’s Coll. 6287, Larut, Perak (K!, isolectotypes BM!, SING!).


Stem flattened, 2.2–2.8 cm wide, 1 cm thick, tuberculate. Leaves 3-foliolate, coriaceous, glabrous, the petiole 2.2–4.3 cm; terminal leaflets 10.7–13.8 × 4.8–5.8 cm, elliptical to lanceolate, cuneate, decurrent at base, obscurely bristled, the petiolule 1.4–1.8 cm; lateral leaflets 9.4–10.6 × 2.7–3.8 cm, elliptical to oblong, leaf-base decurrent, the apex and margins as with terminal leaflets. Peduncle 0.4–0.5 cm, cyme dichotomous. Staminate flowers c. 3 mm long. Pistillate flowers c. 4 mm long, ovoid, the staminode c. 0.2 mm, the stigma-lobe terete. Berries 1.7–2.0 cm in diameter globose, 1–3 per fructification; seeds 1.2 × 0.6 cm, oblong, the endosperm M-shaped in cross-section.

Ecology. On the margin of lowland dipterocarp-forests of the West Coast of the Malay Peninsula.
Distribution. Malay Peninsula.

Observation. This species is superficially quite similar to the 3-foliolate form of *T. lanceolarium* but differs in fruit and seed morphology. The fructification usually has 3 berries.


Lectotype: Blume s.n. (L!).

*Cissus dichotoma* Blume, Bijdr. 1 (1825) 186.

Stem 0.8-1.2 cm in diameter, lenticellate. Leaves simple or 3-foliolate, coriaceous, glabrous; simple leaves 8.7-10.2 × 3.4-4.8 cm, elliptical, acuminate, obtuse at base, serrate, the petiole 2.7-6.1 cm; compound leaves with terminal leaflets 5.7-9.4 × 2.5-4.4 cm, elliptical, acuminate, decurrent at base, serrate, the petiolule 1.5-2.1 cm; lateral leaflets 4.8-9.7 × 2.1-5.5 cm, the outline, apex, base and margin as in terminal leaflets, the petiolule 0.8-1.0 cm. Peduncle 4.7-5.4 cm; cyme dichotomous. Staminate flowers obvoid. Pistillate flowers oblong, the staminode c. 0.6 mm, the stigma-lobe rounded. Berries 1.2-2.2 × 0.6-1.0 cm ellipsoid, usually 1-seeded; seed 1.2 × 0.5 cm, oblong, the endosperm Χ-shaped in cross-section.

Ecology. On the fringe of hill dipterocarp-forests and submontane forests.

Distribution. Java, Sumatra and the Malay Peninsula.

Observation. This species is recognized by its decurrent and glossy leaflets, and ellipsoid berries. Its leaves are mostly 3-foliolate but occasionally larger, simple leaves have been observed on the same plant. In the Malay Peninsula it is only recorded from Maxwell Hill, Cameron Highlands, Gunung Berumbun, and these represent additional records for the flora of the Malay Peninsula.


*Type: Roxburgh 2429 (CAL, water-colour painting at KL!)*

*Cissus lanceolarium* Roxburgh Fl. Ind. 1 (1820) 430.


*Vitis kunstleri* King, J. As. Soc. Beng 65, 2 (1896) 396; Ridley, Fl. Mal. Penin. 1 (1922) 475

*Tetrastigma kunstleri* (King) Craib, Fl. Siam Enum. 1 (1926) 313; Suessenguth in Engler & Prantl, Nat. Pfl. Fam. 20d (1953) 325.

Young stem terete, 2.6-4.1 cm in diameter, old stem flattened, 6.0-11 cm across, tuberculate. Leaves 3-foliolate to pedately 5- to 7-foliolate, coriaceous, glabrous, the petiole 6.7-11.6 cm; terminal leaflets 13.6-20.5 × 4.2-9.4 cm, lanceolate, acuminate, acute at base, obscurely dentate, the petiolule 0.6-3.3 cm; lateral leaflets 5.8-13.4 × 2.6-6.7 cm, lanceolate, rounded at base, the apex and margin as in terminal leaflets, the petiolule 0.4-2.5 cm. Peduncle 0.5-2.0 cm; cyme dichotomous. Staminate flowers c. 2 mm long ovoid. Pistillate flowers c. 5 mm long, oblong, the staminode c. 0.5 mm, the stigma-lobe rounded, ciliolate. Berries 1.5-2.0 cm in diameter, globose, 1-2-seeded; seed 1.2 × 0.6 cm, oblong, the testa rugulose, the endosperm π-shaped in cross-section.

*Ecology.* Mostly on the margin of lowland dipterocarp-forests, frequently on the margin of limestone vegetation and hill dipterocarp-forests. According to Willem Meijer (pers. comm.) this is the commonest host of *Rafflesia hasseltii.*

*Distribution.* India, Burma, Thailand, Vietnam, Laos, Kampuchea and Malesia.

*Observation.* In the Malay Peninsula it is the most widely distributed species, being recorded from various habitats throughout the Peninsula.


*Lectotype: Hooker f. 162, Sikkim (K!).*


Stem 2.2–2.8 cm in diameter, tuberculate. Leaves pedately 5-foliolate, coriaceous, glabrous, the petiole 10.7–16.2 cm; terminal leaflets 15.1–25.6 × 7.0–13.4 cm, broadly elliptical, caudate, acute at base, dentate, the petiolule 2.6–3.7 cm; lateral leaflets 12.4–22.8 × 5.1–9.4 cm, elliptical, becoming rounded, the apex and margin as with terminal leaflets, the petiolule 2.2–3.1 cm. Peduncle 2.3–2.5 cm; cyme dichotomous. Pistillate flowers c. 5 cm long, the staminode c. 1 mm long, the stigma-lobe rounded, ciliolate. Staminate flowers not observed. Berries 3.2–3.5 cm in diameter, globose, usually 1-seeded; seed 1.8 × 0.8 cm, ellipsoid, the testa rugulose, the endosperm π-shaped in cross-section.

Ecology. On the margin of hill dipterocarp-forests.

Distribution. India, Burma, Thailand, Java, Sumatra, Borneo and the Malay Peninsula.

Observation. The earliest record of this species is a collection of Ridley from Penang Hill, which was identified as *Vitis lanceolarium* (synonym of *T. lanceolarium*). It is recognised by its largely broadly elliptical and dentate leaflets and large berries. It is closely related to *T. lanceolarium* but differs in the character of the leaves, berries and seeds. This species is another new record for the Malay Peninsula.


*T. curtisii* (Ridley) Suessenguth in Engler & Prantl, Nat. Pfl. Fam. 20d (1953) 325.


*Lectotype: Curtis 3363, Penang (K! isolecotype SING).*

Stem 1.7–2.5 cm in diameter. Leaves 3-foliolate, coriaceous, glabrous, the petiole 3.4–8.6 cm; terminal leaflets 9.1–12.3 × 4.6–6.2 cm, obovate, caudate, acute at base, subentire, the petiolule 2.4–4.7 cm; lateral leaflets 7.2–9.4 × 3.7–4.5 cm, oblong becoming obtuse, the apex and margin as with terminal leaflets, the petiolule 1.4–2.2 cm. Peduncle 0.4–0.6 cm, cyme dichotomous. Staminate flowers c. 4 mm long, oblong. Pistillate flowers c. 4 mm long, the staminode c. 0.5 mm, the stigma-lobe
rounded and ciliolate, Berries $1.3-1.7 \times 0.7-1.1$ cm, ellipsoid; seeds $1.2-1.6 \times 0.7-0.9$ cm, broadly ellipsoid, the testa reticulate, the endosperm $\varphi$-shaped in cross-section.

Ecology. On the margin of the hill and lowland dipterocarp-forests.

Distribution. Malay Peninsula.

Observation. This species is recognized by its diffuse venation between the secondary veins, particularly conspicuous on the upper surface of the leaves.


T. godefroyanum Planchon in DC., Monog, Phan. 5 (1887) 436.

Type: Godfroy 663, Kampuchea (Isotype, K!).

Stem 1.5–1.8 cm in diameter, the bark glaucous and usually shedding. Leaves pedately 5–7-foliolate, coriaceous, glabrous, the petiole 5.1–8.3 cm; terminal leaflets $5.2-8.1 \times 3.1-4.8$ cm, obovate to obovate-oblong, acuminate, obtuse at base, crenate, the petiolule 2.5–3.2 cm; lateral leaflets $4.8-7.9 \times 3.0-4.5$ cm, the outline, apex, base and margin as in terminal leaflets, the petiolule 1.7–2.7 cm. Peduncle 2.8–3.3 cm; cyme umbellate, usually borne on lateral branches. Staminate flowers not seen. Pistillate flowers c. 4 mm long, oblong, the staminode c. 0.6 mm, the stigma-lobe rounded. Berries $1.2-1.5 \times 0.9-1.1$ cm, ellipsoid, usually 1-seeded; seed $0.9 \times 0.6$ cm, the beak prominent, the testa reticulate, the endosperm $\varphi$-shaped in cross-section.

Ecology. On the margin of lowland dipterocarp-forests.


Observation. This species is recognized by its thinly pulped berries, hard seed and obovate leaflets which have abruptly caudate apices. This species is a new addition to the flora of the Malay Peninsula.

Specimens examined. SELANGOR, Ulu Langat, 1.5.1960, Gadoh 2156 (KEP). KEDAH, P. Langkawi, Selat Pancor, 21.11.1934, Henderson 28948 (K, SING); P. Dayang Bunting, 27.11.1934, Henderson 18948 (K, SING); Ayer Hangat, 12.10.1970, Chin 494 (KLU), P. Kedrah, 17.11.1941, Corner s.n. (SING), Dalam Ru, 6.3.1983 Latiff & Rahim s.n. (UKMB); G. Senyum, 30.7.1929, Henderson 22372 (SING).
II. Sect. Carinata Latiff sect. nov.

Baccae pyriformes. Semina 3–4, postice carinata et tuberculata, chalaza per ½ longitudinis seminis deorsum extensa, antice concavitibus divergentibus 2; endospermium in sectione transversali T-forme.

Type species: *T. pedunculare* (Wall. ex Laws.) Planch.

10. Tetrastigma pedunculare (Wall. ex Laws.) Planch.


Holotype: Wallich Cat. 6024, Penang (K!, isotype SING!).


Stem 1.8–2.6 cm in diameter, lenticels conspicuous. Leaves digitately 3-foliolate, coriaceous, glabrous above, densely covered with glaucous fine indumentum beneath, the petiole 10.1–13.3 cm; terminal leaflets 16.8–22.2 × 9.8–11.4 cm broadly elliptical to rhombic, acuminate, acute at base, serrate, the petiolule 2.4–3.2 cm; lateral leaflets 12.0–16.8 × 8.9–11.8 cm, asymetrically oblong, oblique, the apex and margin as in terminal leaflets, the petiolule 1.8–2.3 cm. Peduncle 1.2–1.8 cm. Cyme dichotomous, 10–12 cm in diameter often borne on older branches or stem. Staminate flowers oblong; pistillate flowers oblong, puberulose, the staminodes c. 1 mm long, the stigma-lobes terete. Berries 0.5–0.7 × 0.4–0.5 cm; seeds 0.5 × 0.4 cm, the testa ridged.

Ecology. On the margin of the hill and lowland dipterocarp-forest, sometimes on limestone hills.

Distribution. Borneo, Sumatra and the Malay Peninsula.

Observation. This species is recognized by its large dichotomously branched inflorescence which is often borne on older stems and the broadly elliptical to rhombic terminal leaflets. In general appearance, it is similar to *T. lauterbachianum* Gilg of New Guinea but differs in the characters of the inflorescence and the leaflets.

Holotype: Wallich Cat. 6024, Penang (K!, isotype SING!).

Specimens examined. PAHANG, G. Benum, 23.3.1967, Whitmore 3395 (KEP, SING); Jerantut, 3.3.1967, Whitmore 3144 (KEP); Maran-Jerantut Road, 30.5.1979, Latiff & Md Kassim 1650a (UKMB). KELANTAN, Kuala Rek, 27.1.1923, Haniff & Nur 10176 (K, SING). JOHORE, P. Pemanggil, 29.1.1980, Latiff 140 (UKMB). SELANGOR, Ulu Gombak, 1.4.1921, Hume 9398 (SING); Genting Highlands, 10.9.1979, Latiff 19 (UKMB). PERÄK, Larut, Dec. 1883, King’s Coll. 5364 (K, SING). MALACCA, Bt Tampin, May 1896, Goodenough 1953 (SING); NGERI SEMBILAN, G. Angsi, Feb. 1904, Ridley s.n. (SING); Ulu Bendul,

11. Tetrastigma papillosum (Bl.) Planch.


*Lectotype: Blume s.n., Java (L! isolectotypes K! BM!)*

*Cissus papillosa* Blume Bijdr. 1 (1825) 183.

Stem 1.4–1.8 cm in diameter, with spinelike corky excrescences. Leaves digitately 3-foliolate, coriaceous, glabrous, the petiole 3.3–7.5 cm; terminal leaflets 8.2–9.7 × 3.6–4.8 cm, elliptical, acuminate, obtuse at base, coarsely crenate, the petiolule 2.7–3.3 cm; lateral leaflets 7.6–8.9 × 3.1–3.6 cm, elliptical, oblique, the apex and the margin as in terminal leaflets, the petiolule 1.0–1.4 cm. Inflorescence a corymbose cyme. Staminate flowers pubescent; pistillate flowers c. 2 mm long, pubescent, the staminode c. 0.5 mm, the stigma-lobe terete. Berries 0.6 × 0.7 cm. Seed 0.5 × 4.0 cm, the testa ridged.

Ecology. On the margin of hill and lowland dipterocarp-forests, rarely on limestone hills.

Distribution. Thailand, Borneo, Philippines, Celebes, New Guinea, Java, Sumatra and the Malay Peninsula.

Observation. The epithet papillosum refers to the papillate structures on the old stem. Strictly speaking these are not papillae but rather, spiny excrescences formed by the changes in the lenticels. Although Ridley himself collected the species in Johore, he did not distinguish it from *T. pedunculare*. Recently the author collected some specimens of the species in Frasers’ Hill, Gombak and Genting Highlands. These constitute additional records to the flora of the Malay Peninsula.

Specimens examined. PAHANG, Cameron Highlands, 10.4.1934, Symington 36201 (KEP); Fraser’s Hill, 25.10.1979, Latiff 77 (UKMB). JOHORE, Sg. Tebrau, March 1908, Ridley s.n. (SING); G. Panti, in 1892, Ridley 4180 (K, SING); G. Sumalayang, 19.2.1971, Chin 715 (SING, KLU). SELANGOR, Gap 24.8.1959, Burkil 1989 (K, SING); Genting Highlands, 25.10.1977, Latiff 36 (UKMB); Genting Highlands, 10.9.1979, Latiff 18 (UKMB); Ulu Gombak, 20 m.s, 25.9.1979, Latiff 59 (UKMB).

12. Tetrastigma pyriforme Gagnep.


Type: Poilane 25625, Tonkin. Vietnam (isotype, K!).
Stem 2.0-2.1 cm in diameter, smooth. Leaves pedately 5-foliolate, coriaceous, glabrous, the petiole 6.5-11.2 cm; terminal leaflets 9-11.2 × 4.6-5.2 cm, elliptical, acuminate, acute at base, serrate, the petiolute 2.1-2.3 cm; lateral leaflets 7.9-9.3 × 3.8-4.4 cm, asymmetrically oblong, oblique, the apex and margin as in terminal leaflets, petiolute 2.0-2.1 cm. Peduncle 4.1-4.3 cm; cyme dichotomous. Flowers not observed. Berries 0.8-1.0 cm in length. Seeds 0.7 × 0.5 cm, the testa tuberculate.

Ecology. Known only from the hill forests in Cameron Highlands, Bukit Kemaman (Trengganu) and Maran-Jerantut Road.


Observation. This is the only species in the Malay Peninsula of sect. Carinata with 5-foliolate leaves. This species could not be identified with the literature of King (1896) and Ridley (1922). It was finally established by comparative studies with type material of Laos and Vietnam. The species is a new record for the Peninsula.


Acknowledgements

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New and Interesting Plant Records for Singapore, II*

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Abstract

Plant collecting in Singapore in 1983 has resulted in 3 new records and other species that have not been recorded here in many years. Brief notes on these plants, with information on their collection localities and general distribution, are included.

Introduction

Continued floristic work in Singapore during 1983 has resulted in the following finds: 3 new records and 3 other rare and interesting plants which have not been collected recently. It is hoped that other botanists will take an active interest in Singapore's native flora and continue the work.

Annonaceae

1. Goniothalamus macrophyllus (Bl.) Hk.f. & Thoms.

Fruiting material has been collected from a small, cauliflorous understorey treelet at Ngadiman Bridge in the Bukit Timah Nature Reserve in a shaded undisturbed area. This species is found throughout most of the Malay Peninsula, in Thailand, Borneo, Java, and Sumatra. In Singapore, previous collections date 1890's and early 1900's from the following localities: Tanglin, Serangoon Road, Sungei Tengah, Tuas, Bukit Mandai, Ang Mo Kio, and Bukit Timah.


Elaeocarpaceae

2. Elaeocarpus acmosepalus Stapf ex Ridley

Ridley's descriptions (1917, 1922) of this species do not match well with actual specimens in our Herbarium, collected so far by several persons, as pointed out by Corner (1939) and do not match my collection. The problem, as Corner (loc. cit.) notes, is that the three type collections are not in the Singapore Herbarium. These are presumably at Kew. The name used with some reserve by Corner for those specimens in the Herbarium, which match mine is E. floribundus Bl. (1939, 1978). The specimens are:— Corner 32290 (18 Feb. 1937), C.F. 4120 (Mohd. Yusop, 8 March 1920), and SFN 33969 (Mohd. Nur, 1 Oct. 1937). R. Weibel (of the Conservatoire et Jardin Botaniques de Genève), who has recently published descriptions of

* continued from Gard. Bull. Sing. 35: 198, 1982
Fig. 1. *Pterocymbium tubulatum* (Mast.) Pierre. *A*: branchlet with leaves (Goodenough 1428, Malacca, Aug. 1893); *B*: mature fruits (Mohd. Noor 789, Singapore 8 Sept. 1983). Drawn by Mr. Wan Ah Keong.

Plate 1. *Neptunia plena* (L.) Bth. Mature pods and seeds; insert: mature inflorescence with staminodes, and staminate and bisexual flowers. Photograph by Mr. Wan Ah Keong.
new species of the same genus for the Malesia Region, has annotated these collections as *E. acmosepalus*. The peculiar setae on the tip of the awns of the anthers are, by the author's description, quite distinctive a feature for *E. acmosepalus*. The anthers in *E. floribundus* differ in that the tips have no setae.

A fully mature tree 12 m tall was found along the pipeline at Nee Soon on the partly open margin of the swamp-forest. This species is, apparently, rather rare as is shown by the meager collections in our herbarium. These are from Selangor, Pahang and Johore. It is also known from Sarawak.


**Gramineae**

3. *Eriachne triseta* Nees ex Steud. New Record

This interesting grass, which is readily recognised by having 2-awned paleas, was referred by Gilliland (1971) to *Massia triseta* (Nees ex Steud.) Balansa in his book on the Grasses of Malaya. There are only a few collections of this species from Malacca, Pahang, Trengganu, and several specimens from SE. Thailand, Philippines, Sabah, and northern Queensland in the herbarium. It is also known from Sri Lanka and Burma.

A very localized group of this grass was found near the Pasir Panjang Nursery on a partly shaded, lateritic, periodically mown slope.


**Leguminosae**

4. *Derris amoena* Bth. var. *maingayana* (Baker) Prain

Previous collections are:— without locality (Hullet, 1885), the Economic Garden of our Botanic Gardens (Ridley, 1898) and Siglap (Ridley, 1899). My collection was from the open margin of the swamp-forest in Nee Soon. The same variety has been collected in Malacca and Johore. The flowers on my Singapore plant produced sparse fruit.


5. *Neptunia plena* (L.) Bth. Plate 1 New Record

I found several individuals of this hardy, decumbent shrub with spreading branches and bright yellow inflorescences along West Coast Road in an open waste
area. Aside from having two types of flowers, this species lacks thorns and spines. It, therefore, would be a very desirable species to plant on Singapore’s sandy reclaimed land, where it will surely thrive. This species, which is native to tropical America and the West Indies, produces viable seeds here which have been successfully propagated at the Pasir Panjang Nursery.

_Voucher specimen: Maxwell 83-2, 7 Jan. 1983._

6. _Pterocymbium tubulatum_ (Mast.) Pierre

Winged fallen fruits of this species, a canopy tree of primary forests, was collected by Mohd. Noor from one which is in the Fern Valley in Bukit Timah Nature Reserve. It is the second ever collected in Singapore, _Ridley 6435_ in 1894, from the same Reserve, being the first and it bears flowers. This species is apparently rare and is known from Malaya (Kelantan, Malacca, and Johore), Singapore, Sumatra, Sabah, Sarawak, and Kalimantan.

_Voucher specimen: Mohd. Noor 789, 8 Sept. 1983._

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**Lobaria clemensiae** Vain. (Lobariaceae, Lichenes) on Halmahaera Island, Indonesia

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**Abstract**

*Lobaria clemensiae* Vain., a lichen species, originally described from the Philippines, is reported from the Halmahera Island, Indonesia.

During my work on the Philippine material of the genus *Lobaria* (Schreb.) Hoffm., it has become necessary to study *Lobaria* specimens from the neighbouring countries particularly those collected from within the natural phytogeographical unit known as Malesia. And, from the abundant specimens obtained on loan from the Herbarium Bogoriense (BO), Indonesia, one collection represents an interesting phytogeographical record for *Lobaria clemensiae* Vain.


Thallus adpressed, small to medium-sized, 2-4 (-10) cm wide, strongly lacinulate; lobes 2-10 mm broad, their margin crenulate, often distinctly fringed with small simple or forked lobules; dorsal surface of thallus smooth, partly canaliculate, yellowish grass-green to yellowish brown, without soredia or isidia, instead with lobules formed from cracked cortex; ventral surface of thallus pale to yellowish brown, thickly tomentose and sparsely rhizinate at midportion of lobes; tomentum dark chocolate brown to nearly black, crowded on older lobes, pale brown, scattered near apex or margins; rhizines simple, pale brown, 2 mm long. Apothecia absent. Pycnidia not seen. Plate 1, A & B; Fig. 2.

Dorsal cortex paraplectenchymatous, c.30 μ thick; medulla 170-220 μ thick, medullary hyphae 3 μ wide; ventral cortex paraplectenchymatous, pale brown, 15 μ thick, composed of 2-3 cell-layers; tomentum elongate, branched, loosely interwoven, 5-7 μ wide, up to 300 μ long. Inner cephalodia often present.


*Chemical substance:* gyrophoric acid.

*Specimen examined:* HALMAHERA ISLAND. Mt Sembilan (Siu), Bivak Ake
Biaur, alt. c.550 m, on tree, 10 October 1951, P. Groenhart 8336 (BO 7307).

**Habitat:** *L. clemensiae* is usually found tightly adnate on bark of trees from 200-1300 m altitude in lowland to midmontane virgin or mixed dipterocarp forests, and up to the mossy forest zone.

**Distribution range:** In the Philippines, *L. clemensiae* has been collected from: 1, Tandul Mati, Naujan, Mindoro Oriental Province; 2, Sitio Manlangco, Sibulan, Negros Oriental Province; 3, Mt Kampalili, Davao Province; 4, Tungao and Florida, Butuan City, Agusan Province; and 5, Camp Keithley, Lake Lanao, Lanao Province, the type locality (Gruezo, 1979). (Fig. 1).

Outside of the Philippines, *L. clemensiae* is known only from the following collecting stations: 1, near Mt Silam and Kundasan, Sabah (Borneo) and 2, Mt Gede, Tjibodas and Mt Tantjar, all in Java (Yoshimura, 1971). Its discovery in the Halmaheira Island (Mt Sembilan) extends the distribution range further southeast (Fig. 1). Very likely, this species is expected to be found in New Guinea and its nearby islands.

Fig. 1. Geographical range of *Lobaria clemensiae* Vain.

Fig. 2. *Lobaria clemensiae* Vain. Thallus showing position of lobules. *(Groenhart 8336).*
The diagnostic features of *L. clemensiae* are: the presence of very fragile lobules (phyllidia) along the lobe margins and rims of cracked cortex of the thallus (fig. 2); the more or less veined type of tomentum on the lower surface of the thallus (plate 1, B); the presence of gyrophoric acid; and the thallus being comparatively small, thin and fragile, and usually tightly adnate to the substratum.

Incidentally, Yoshimura (1971) described as new *Lobaria clemensiae* Vain. var. *crassa* based from a single collection (S. Kurokawa 6280, TNS; isotype, NICHI) from the Western Highland district of New Guinea. However, comparison of plate 7 a-e (*L. clemensiae* Vain. var. *clemensiae*) and plate 7f (*L. clemensiae* Vain. var. *crassa* Yoshim.) (Yoshimura 1971, p. 343) suggests that when additional materials of var. *crassa* are obtained and studied, the latter taxon might prove to be a distinct species. For the time being, var. *crassa* is distinguished from the typical variety by its thicker dorsal cortex (50 μ vs. 30 μ) and the K+ thalline reaction (Yoshimura 1971).

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Influence of Growth-Regulating Chemicals on *Hippeastrum hybridum* hort.

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Contribution No. 178/82 of I.I.H.R.

Abstract

The effect of bulb-dip application of each of the following – chlormequat chloride (CCC), daminozide (B-Nine), etephon (Ethrel), maleic hydrazide (MH), triiodobenzoic acid (TIBA), indole-acetic acid (IAA), gibberellic acid (GA$_3$) and naphthylacetic acid (NAA) – was studied on growth, flowering and bulb formation of *Hippeastrum hybridum*. CCC and B-Nine induced early sprouting of bulbs, delayed flowering, increased the size and longevity of flowers, accelerated bulb production and improved the quality of bulbs in size and weight. Longer flower spikes were obtained with B-Nine-treated bulbs. Ethrel and MH delayed sprouting, but induced early flower-bud appearance and increased longevity of flowers. Beneficial effects on bulb formation with Ethrel was also recorded, while MH, NAA and TIBA were ineffective. IAA and GA$_3$ promoted vegetative growth, induced early flowering, stimulated flower size and stalk length, yielded a greater number of flowers per stalk, extended longevity of flowers, increased bulb production, and improved the size and weight of bulbs.

Introduction

*Hippeastrum hybridum* is one of the well known bulbous ornamental plants, which produces attractive lily-like flowers on long stalks. This most popular spring- and summer-flowering plant is commercially grown in the Netherlands and exported to different countries. Synthetic growth-regulating chemicals are being increasingly used to manipulate growth and flowering of bulbous plants. These chemicals offer a broad range of effects, both morphological and physiological. Stem elongation of *Lilium* cultivars has been effectively reduced by soil drench of CCC (Pearse, 1972), ancymidon (Dicks and Rees, 1973), Ethrel (Wade, 1972) and Phosphon (chlorphonium chloride) (Stuart *et al.*, 1961). Bhattacharjee *et al.* (1976) reported that in dahlia, treatment with GA$_3$ increased the number of flowers, and with IAA and GA$_3$, promotion of shoot length. Application of IAA increased the corm weight of gladiolus, whereas GA$_3$ treatments increased the weight of cormels (Winkler, 1969). In the present investigation an attempt has been made to evaluate the effectiveness of different growth-regulating chemicals on growth, flowering and bulb formation of *Hippeastrum hybridum*.

Materials and Methods

Experiments were conducted at the Institute in Hessarghatta, Bangalore during 1981-1982. *Hippeastrum hybridum* bulbs of uniform size and weight were soaked for five hours in different growth regulating chemicals prior to planting in September 1981. The untreated bulbs of the control were soaked in distilled water. The chemicals used were CCC and B-Nine at 1000, 2500 and 5000 ppm of each; Ethrel, MH and TIBA at 500, 1000 and 2000 ppm of each; and IAA, GA$_3$ and NAA at 10, 100 and 1000 ppm of each. The soaked bulbs were then dried in the shade.
in open air for eighteen hours. Thereafter the bulbs were planted in 25-cm earthenware pots, one in each, in a pot mixture of one part each of sand, soil, leaf mould and farm yard manure. A mixed fertilizer at the rate of 25 gms per pot was also added, irrespective of the treatment. The experiment was laid out in a completely randomised design, involving twenty-five treatments. Five pots were kept for each treatment. Observations were taken on vegetative growth, flowering and bulb formation. Data on bulb formation was collected by carefully removing the bulb and bulblets at the cessation of vegetative growth, twelve months after planting.

Results and Discussion

Sprouting of bulbs. In both the control and the treated ones there was 100% sprouting with all the treatments including the untreated control. Days taken for sprouting of the treated bulbs varied with the chemicals and their concentrations. At all concentrations, B-Nine and CCC significantly induced advanced sprouting by 12.2 to 20.0 days over the control. The lowest concentration of Ethrel, GA\textsubscript{3} and NAA also exhibited earlier sprouting of bulbs by 3.4 to 5.2 days. Treatments with MH and TIBA, and NAA at 1000 ppm delayed sprouting to a great extent. For inhibition of sprouting of storage tubers of potato and bulbs of onion, MH is largely used (Skoog, 1980). Junge (1964) and Rudinicki et al. (1976) reported early sprouting with the application of GA\textsubscript{3} in Freesia hybrida and tulips respectively (Table 1).

Vegetative growth. It was observed that the highest concentration of Ethrel and NAA, and treatments with MH and TIBA markedly retarded leaf length. Maximum retardation was obtained with TIBA at 2000 ppm, and the percentage of retardation was 37.09 over the control. The lowest concentration of CCC, B-Nine and NAA, all concentrations of GA\textsubscript{3} and IAA at 100 and 1000 ppm promoted leaf length appreciably. Promutive effect was greater with GA\textsubscript{3}, and the highest acceleration, exceeding 27.33 per cent over the control, resulted with GA\textsubscript{3} at 1000 ppm. Application of MH inhibited growth of Croft Easter lilies (Struckmeyer and Beck, 1952). Dicks and Rees (1973) observed height reduction in Lilium with Ethrel at 1000 ppm. Promotion of plant height with GA\textsubscript{3} in Mid-Century Hybrid Lily was reported by Dicks et al (1974). The number of leaves per plant increased significantly with CCC at 1000 ppm, GA\textsubscript{3} and IAA at 100 ppm of each. An increase in the number of leaves of Hippeastrum hybridum with the application of IAA and GA\textsubscript{3} was also reported by Bose et al. (1980). Though the number of side shoots per plant due to the treatments with growth-regulating chemicals had not affected significantly, treatments with CCC at 1000 ppm, and GA\textsubscript{3} and IAA at 100 ppm of each considerably stimulated the production of a greater number of the side shoots (Table 1).

Bulb yield. The application of chemicals increased bulb yield, in general, except with NAA at 100 ppm, IAA at 1000 ppm, TIBA at 500 and 2000 ppm. A significant rise in the production of bulbs was recorded with all concentrations of CCC, B-Nine, GA\textsubscript{3}, IAA and MH. The two higher concentrations of Ethrel, two lower concentrations of IAA, and NAA at 10 and 1000 ppm, also showed appreciable improvement in bulb production (Table 1).
Bulb weight and diameter. The total weight of bulbs varied with the chemicals and concentrations. Among different chemicals only the two higher concentrations of TIBA, and NAA at 1000 ppm significantly reduced the bulb weight. Increase in the total weight of bulbs varied from 2.69 to 72.31 per cent. over control with the treatments of CCC, B-Nine, Ethrel, GA₃, NAA, IAA and MH. Maximum beneficial effect was seen with the two lower concentrations of CCC, B-Nine and GA₃. Diameter and weight of the largest bulb markedly increased with all concentrations of CCC.

Table 1

Effect of Growth Regulating Chemicals on Vegetative Growth and Bulb Formation of *Hippeastrum Hybrida* hort.

<table>
<thead>
<tr>
<th>TREATMENT (ppm)</th>
<th>BULBS/BULB</th>
<th>LEAF</th>
<th>LEAVES</th>
<th>SIDE-SHOOTS</th>
<th>BULBS</th>
<th>LARGEST BULB</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>days (days)</td>
<td>length (cm)</td>
<td>number</td>
<td>number</td>
<td>total number</td>
<td>weight (g)</td>
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<td>1.2</td>
<td>2.0</td>
<td>115.2</td>
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<td>53.1 (15.18)</td>
<td>9.2</td>
<td>2.0</td>
<td>3.0</td>
<td>195.5 (72.31)</td>
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<tr>
<td>CCC 2500</td>
<td>31.8</td>
<td>49.4 (7.16)</td>
<td>8.2</td>
<td>1.4</td>
<td>3.0</td>
<td>160.7 (39.49)</td>
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<td>CCC 5000</td>
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<td>47.4 (2.82)</td>
<td>8.0</td>
<td>1.6</td>
<td>3.8</td>
<td>150.2 (30.38)</td>
</tr>
<tr>
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<td>25.2</td>
<td>52.3 (13.45)</td>
<td>7.6</td>
<td>1.2</td>
<td>3.2</td>
<td>190.5 (65.36)</td>
</tr>
<tr>
<td>B-Nine 2500</td>
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<td>48.3 (4.77)</td>
<td>8.0</td>
<td>1.4</td>
<td>4.8</td>
<td>165.8 (43.92)</td>
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<td>49.3 (6.94)</td>
<td>7.6</td>
<td>1.6</td>
<td>3.0</td>
<td>128.5 (11.55)</td>
</tr>
<tr>
<td>Ethrel 500</td>
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<td>8.0</td>
<td>1.0</td>
<td>2.6</td>
<td>125.5 (8.94)</td>
</tr>
<tr>
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<td>1.4</td>
<td>3.6</td>
<td>148.8 (29.17)</td>
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<td>3.6</td>
<td>138.2 (19.99)</td>
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<td>105.8 (-8.16)</td>
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<td>1.0</td>
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<td>1.6</td>
<td>3.0</td>
<td>134.3 (16.58)</td>
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<td>140.2 (-21.70)</td>
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<td>2.0</td>
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<td>4.4</td>
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<td>145.2 (26.04)</td>
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<td>2.0</td>
<td>118.3 (2.69)</td>
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<tr>
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<td>6.2</td>
<td>1.0</td>
<td>3.2</td>
<td>75.4 (-34.55)</td>
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</table>

*F*-test: ** * N.S. ** ** **
S.Em 1.97 1.91 0.43 0.34 0.29 4.94 0.16 4.65
L.S.D. at 5% 5.54 5.39 1.19 - 0.81 13.90 0.44 13.07

* * highly significant; N.S. non significant.
Figures in the parenthesis indicate the percentage of increase or (-) decrease over control.
and B-Nine, GA₃ at 10 and 100 ppm. Halevy and Shilo (1970) reported that Ethrel on gladioli increased the yield of cormels. Application of GA₃ in Begonia increased the tuber weight (van Onsem and Haegeman, 1961). In tulips, Mohamed and Fawzi (1980) recorded an increase in the weight of mother and daughter bulbs.

**Flowering.** Advanced flower-bud appearance, by 22.0 to 79.8 days, was induced by treating with Ethrel, GA₃, IAA and MH. Application of CCC, B-Nine and NAA

**Table 2**

<table>
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<tr>
<th>TREATMENTS</th>
<th>(ppm)</th>
<th>Days taken for initiation of FFB</th>
<th>Days from initiation of FFB</th>
<th>FLOWER SPIKES length (cm)</th>
<th>FLOWERS length (cm)</th>
<th>FLOWERS diameter (cm)</th>
<th>FLOWERS SPIKES number per plant</th>
<th>FLOWERS number per spike</th>
<th>Longevity of first opened flower (days)</th>
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<td>1.0</td>
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<td>5.2</td>
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<tr>
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<td>190.6</td>
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<td>32.3 (6.95)</td>
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<td>2.0</td>
<td>1.6</td>
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<td>205.2</td>
<td>24.0</td>
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<td>22.2</td>
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<tr>
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<td>28.4 (5.92)</td>
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<td>2.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

'*' — highly significant.

Figures in the parenthesis indicate the percentage of promotion or (-) retardation over control.
delayed flowering by 40.4 to 68.0 days. Treatment with TIBA at 1000 and 2000 ppm completely suppressed flowering. Flower-bud opening was also affected by the chemical treatments. All concentrations of GA\textsubscript{3} and NAA, and the two lower concentrations of IAA resulted in the early opening of flower buds. Flower-bud opening was delayed in MH and TIBA treatments (Table 2). Jansen (1960) reported early flowering in cyclamen with GA\textsubscript{3}. Will (1977) observed that B-Nine delayed flowering in gloxinia. It was observed that treatment with CCC at 2500 and 5000 ppm, B-Nine and GA\textsubscript{3} at all concentrations, and IAA at 100 and 1000 ppm accelerated the flower-stalk length significantly, and the resulting acceleration from these treatments was 13.58 to 50.0 per cent. Higher concentrations of Ethrel and MH, and TIBA at 500 ppm reduced flower-stalk extension. Bose et al (1980) reported increase in flower-stalk length of Hippeastrum with IAA, GA\textsubscript{3} and CCC at 10 and 1000 ppm. Application of CCC, B-Nine, GA\textsubscript{3} and IAA, in general, and MH at 500 and 1000 ppm appreciably increased the length and diameter of flowers. The highest number of flower spikes per plant resulted with treatment with GA\textsubscript{3} at 100 ppm. The number of flowers per stalk also varied with the treatments, and the application of GA\textsubscript{3} and IAA, in general, showed the most beneficial effect. Treatments with the higher concentrations of CCC and all concentrations of B-Nine also induced a greater number of flowers per spike. The longevity of the first-opened flower was optimal with MH treatments. Treatments with CCC, B-Nine, Ethrel, GA\textsubscript{3} and IAA also extended the life of the first-opened flowers to a significant extent (Table 2). Sheehan and Joiner (1964–1965) in Lilium longiflorum reported an increase in the number of flowers with the application of CCC. Increased flower number and size in Hippeastrum with GA\textsubscript{3}, IAA and CCC was also observed by Bose et al., (1980).

Acknowledgement

The author is grateful to Dr. K. L. Chadha, Director, Indian Institute of Horticultural Research, Bangalore for providing the necessary facilities to carry out the investigation.

Literature Cited


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