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SINGAPORE

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Published by
National Parks Board
Singapore Botanic Gardens
Cluny Road
Singapore 1025
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New and Noteworthy Malesian Myrsinaceae, VI.
Revision of the Genus Hymenandra A.DC.

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EFFECTIVE PUBLICATION DATE: 23 MAR 1992

Abstract

Hymenandra A.D.C., with eight species, is revised. Four new species are proposed and one species originally placed in Ardisia is transferred. The genus is subdivided into two subgenera, Hymenandra and Lacrimopila subg. nov. (the first with 6, the second with 2 species). A key to the species, new descriptions, illustrations, and a list of exsiccatae examined are included.

Introduction

Hymenandra A.D.C. (1841), first established as a section (Sectio 2) of Ardisia (De Candolle 1834) was based entirely on Ardisia hymenandra Wall., first described in 1824. The genus was monotypic and was accepted as such by Mez in his monograph (1902). It was not until 1958 that a second species was attributed to the genus when Furtado (1958) transferred Ardisia iteophylla Ridl. 1924 to it. In “1975” (1976) Nayar and Giri described another species from Burma. Subsequently there have been no further reviews of the genus.

Furtado (1958) described Ardisia calcicola from Kalimantan. After re-examination of the type material, this too is found to be a species of Hymenandra. The most significant character of the genus, emphasized by De Candolle, is the staminal tube in which the anthers are laterally connate by the thecal margins. Moreover, the inflorescence is lateral either on a short and much reduced branch with one or two small but otherwise normal leaves, or on a peduncle subtended by foliaceous bracts crowded so as to form almost an involucre. The flowers, and the individual floral organs, are often unusually slender and elongated.

The relationship of Hymenandra appears to be with Ardisia, and especially with subgenera Pyrqu and Crispardisia, at least in regard to the position and form of the inflorescence. It seems hypothetically possible that intermediate forms could form a transition between Ardisia and Hymenandra. The other generic character, more emphasized by Mez, is the ovular number, which in Hymenandra is “few” i.e. about 5-12. This too conforms with the situation in Ardisia subgenus Crispardisia, but not with subg. Pyrqu. The tendency to lateral inflorescences is accompanied in several species by the occurrence of papillae (suberect glandular trichomes) on the interior surface of the calyx-lobes, which is also quite noticeable in Ardisia subgenus Crispardisia.

The genus Hymenandra is divided here into two subgenera. Six species are retained in the typical subgenus, and these agree with H. wallichii, the type species, in possessing mostly obovate to oblanceolate leaves with rather short broad petioles; stature with
the main stem simple or very sparsely branched; and most also have the inner surface of the calyx-lobes rather densely and minutely papillose. In addition, these species have mostly oval to distinctly oblong glands in the perianth and stamens.

In subgenus Lacrimopila, the habit is more ramified, with the branch bases ampullate (gusseted) as in Ardisia, and the plants may reach 3 m (10 ft.) height. The leaves are elliptic to ovate, and distinctly petiolate. The inner surface of the calyx-lobes is not papillose, but may be hirtellous. In one species, H. iteophylla, the inflorescence axes and calyx are lepidote with stelliform to flabellate somewhat stalked scales, but the anthers and ovary are glabrous. In the other species, H. diaphidia, the inflorescence axes and vegetative innovations, the calyx on both surfaces, the backs of the corolla-lobes, the anthers on both sides, and the ovary and style base, are all hirtellous with shortly stalked ferrugineous hairs with twinned apical cells of a form resembling a tear-drop (the subgeneric name being derived from this feature). In this species there are usually 8 or 9 ovules in two series.

It is apparent that the two species assigned to subgenus Lacrimopila are rather more different from each other than the species of subgenus Hymenandra are from one another. Moreover there is a geographic difference, with H. iteophylla known so far only from the Malay Peninsula, while H. diaphidia is only known from Sabah. Possibly these two species should be distinguished further by establishing another taxon for H. iteophylla alone.

As here construed Hymenandra should no longer be considered an exclusively mainland Asian genus but may be termed an Indo-Malesian genus, with its centre of diversity in Borneo. Five of the eight species are in fact confined to Borneo. Hymenandra wallichii remains as a Himalayan species known from Sikkim, Bangladesh, Assam, and northwestern Burma, while H. iteophylla is the least known and is restricted to the southernmost part of the Malay Peninsula. The most recently described species, H. narayanaswamii Nayar & Giri, is known so far only from Burma.

All the species are more or less poorly represented in collections. Several species are known only from single collections and the rest from a very few. However, Hymenandra wallichii is represented in cultivation in some botanic gardens (e.g. Edinburgh). Otherwise, further study will depend largely on the acquisition of newly collected materials.

**Generic Distinctions**

The tubular androecium is the chief feature on which the genus Hymenandra was founded. In fact, the filaments are free from just below the anthers to the point where each is adnate to the corolla-tube, so that the androecial tube is partly interrupted. The connation of the anthers is minimal and not very tenacious but is quite real; yet if the anthers were not connate, it would be difficult to distinguish these species from Ardisia on technical grounds. They do, however, have certain habit characters in common. The species in subgenus Hymenandra appear to form a coherent taxonomic group. Those in subg. Lacrimopila deserve renewed study and comparison when additional material is available. The strikingly different forms of indument of H. diaphidia and H. iteophylla comprise a very noticeable character and the tendency of the distal cells in the trichomes of the former species to be twinned (either adnate or slightly separated) is noteworthy. Perhaps this is a character that may be regarded as comparable to, but less elaborate than, the stalked scales of H. iteophylla.

Hymenandra narayanaswamii Nayar & Giri differs from H. wallichii in its distinctly petiolate, elliptic leaves, apparent lack of conspicuous inflorescence bracts, and lack of papillosity inside the calyx. The authors regrettably failed to report the ovule number.

Hymenandra wallichii, the type species of the genus, has a unique foliar character; the crenate leaf margins. The crenation is here termed "double" because each lobe is
notched, and a veinlet ending terminates in this notch; while the lobes themselves are separated by a broad, shallowly scooped interval of the margin, without a comparable veinlet termination. The remainder of the species all appear to have entire leaf margins.

Clearly, *Hymenandra* depends for its taxonomic status heavily upon the single character of anther connation, and I find no other character which could supplant it.

### Systematic Treatment

**Hymenandra** A.DC.


**Type:** *Hymenandra wallichii* A.DC. (= *Ardisia hymenandra* Wall. in Roxb. Fl. Ind. ed. Carey 2: 282. 1824). (Wallich's epithet cannot be used under *Hymenandra* because of tautology).

**Revised description:** Flowers hermaphrodite, 5-merous. Sepals quincuncial, spreading at anthesis, connate shortly at base, mostly papillose on interior surface (or hirtellous), often rather elongated, valvate or scarcely imbricate. Corolla with short tubular base adnate to tubular (filamentous) base of androecium, lobes slightly imbricate, ovate to narrowly ovate, glabrous or sparsely papillose within toward base. Internal glands in sepals, petals, and anthers roundish or oval or frequently elongated (oblange to sublinear). Stamens connate, in the lower part as a filament tube adnate to the base of the corolla tube, but the filament tips free between the base of the anther and the point of adnation to the corolla; anthers connate laterally by the thecal margins, narrowly ovate-acuminate or oblong-ovate and acuminate, dorsally glandular. Gynoe- cium with ovoid ovary and slender, elongated style; stigma punctiform. Placenta ovoid to turbinate, with 5-12 ovules in 1 or 2 series. Fruit 1-seeded, globular, sometimes oblate, exocarp glandular, (sometimes?) subtended by the persistent clayx.

### Key to the Species

1a. Inflorescence condensed umbelliform or compactly cymose, at first conspicuously bracteate. Calyx, corolla and anther connective with oval or oblong-linear immersed glands. Calyx lobes papillose on inner surface. Filaments short, less than half as long as anther. Leaves obovate, petioles short and rather complanate, margins entire to slightly crenulate. Main stem short suberect or ?decumbent, not or few-branched

.......................... subgenus *Hymenandra*

2a. Ovary tomentellous; leaves larger, to over 30 cm long, obovate, gradually narrowed to base, the broad petiole 5 mm long; lateral veins numerous; margins of blade distally crenulate, each lobe notched with a veinlet termination in it; ovules biseriate; sepals c. 3-4 mm long. Distrib. Sikkim, Assam, Burma

.......................... (1) *H. wallichii*

2b. Ovary glabrous; leaf margin entire.

3a. Leaves as in *H. wallichii*, large obovate, to 40 cm long and 10 cm wide, sub sessile with broad, short petioles; sepals over 6 mm long, ovate-oblong and acute; ovules uniseriate. Distrib. Borneo

.......................... (2) *H. lilacina*

3b. Leaves smaller, sometimes to 35 cm long, but often narrower, obovate or oblanceolate; petioles rather distinct; sepals narrowly ovate or ovate, less than 6 mm long; ovules uni- or biseriate.

4a. Lateral fertile branch very short, c. 1 cm long; leaves elliptic-lanceolate; anthers 3 mm long; placenta with 5 uniseriate ovules. Distrib. Borneo

.......................... (3) *H. rosea*
4b. Lateral fertile branch longer, usually 9-12 cm long; leaves oblanceolate to obovate; anthers 3-4.5 mm long; placenta with 8-10 uniseriate ovules.

4a. Leaves oblanceolate, at base obtuse to almost subcordate, at apex obtuse, 12-18 cm long, 7-9 cm wide; petioles 5-6 mm long; flowers 8 mm long; sepals ovate-subrhombic, c. 5.5 mm long. Distrib. Borneo

5b. Leaves oblanceolate, 30-35 cm long, 4-5 cm wide; petals 1-2 cm long; flowers 5-6 mm long; sepals elliptic ovate, 4.5 mm long. Distrib. Borneo

5a. Leaves oblanceolate, at base obtuse to almost subcordate, at apex obtuse, 12-18 cm long, 7-9 cm wide; petioles 5-6 mm long; flowers 8 mm long; sepals ovate-subrhombic, c. 5.5 mm long. Distrib. Borneo ... (4) H. beamanii

lb. Inflorescence compact or open, up to 3 times pinnate, paniculate, axes somewhat to considerably elongated; bracts caducous; calyx-lobes narrowly hirtellous and their interior surfaces not papillose, but either hirtellous or glabrous; taller, more ramified plants.

6a. Inflorescence condensed, axillary and terminal, the peduncles 10-15 mm long.

7a. Calyx lobes triangular-ovate, 1.5 mm long; calyx and pedicels with scattered substelliform or flabellate scales; filaments elongate, about 1.6 mm (c. one-half as long as the anther); anther glabrous; ovary glabrous. Distal. Malaya ... (8) H. iteophylla

7b. Calyx lobes and pedicels densely puberulous; filaments short, c. 1 mm long, much shorter than the anther; anther glabrous; ovary glabrous; style 8-10 mm long. Distrib. Burma

Subgenus Hymenandra

1. H. wallichii A.DC.


Leaves c. 30 cm long, to 11 cm wide; petiole 5-12 mm long, broad, complanate. Leaf margins along distal half double-crenulate, each crenation-lobe notched, with a veinlet termination in the notch. Blade with rather numerous (about 25) pairs of lateral veins. Inflorescence terminal on short lateral fertile branch, compact, overall c. 10 cm long, at first with pseudowhorled conspicuous bracts, decurved. Flowers c. 10 mm long, calyx-lobes about 2 mm long, narrowly ovate, gland-dotted, the margins finely ciliate; corolla-lobes narrowly long-ovate, the margins subacuminate, distinctly papillose within; staminal tube elongate, the filaments very short, anthers much elongated, 7.5 mm long, slenderly acuminate, laterally conuate but the tips free, the connectives dorsally set with oblong glands. Ovary tomentellous, 1 mm high, the style slender, 6.75 mm long; stigma small, punctiform-truncate. Placenta about 0.5 mm high, with about 10 to 12 ovules in two rows.

Type: Wallich Cat. 2226 (from Sylhet, mountains of Juntiyapoor, now in Bangladesh), K! holotype; CAL isotype.

Specimens examined: ASSAM: Khasia, Griffith 3596 (K!). (Two sheets, here designated 3596a and 3596b; the former bears a label with the annotation “Frutex humilis, foliis subcardenosis; inflorascencia carnea nutans sub hemisphaerica”; towards Beesale Colliea; this sheet possesses old flowers, the second has fruits.) Cachar, “shrub of shade, with nearly simple stem and reddish flowers borne in shortly pedunculate cluster close to the somewhat succulent stem”; Gopal teetah B. masu, 5 June 1873, coll. Memang Sirdar for Keenan (K!). Meghalaya, 1,000 m alt., June 1876, coll. ignot. 312 (CAL, not seen, cited by Nayar & Giri). Naga hills, May 1899, Prain’s collector 100021 (CAL, cited
Fig. 1. *Hymenandra wallichii* A.DC. a. Flower in profile. b. Calyx-lobes. c. Corolla-lobes. d. Detached stamen, dorsal view. e. Ovary and style. f. Placenta, with 12 ovules. g. Capitate glandular trichomes from ovary. h. Fruit. i. Fruit in transverse section (dried, the seed omitted). j. Leaf undersurface. k. Portion of leaf margin, showing double crenulation. l. Peltate scale from leaf undersurface. (a–i, from *De Silva*, Wallich list no. 2266, type collection; j–l, from *Keenan*.)
by Nayar & Giri). **BANGLADESH:** Sillet (Sylhet), in mountains of Juntiyapoor, flowering in March, coll. *De Silva for Wallich*, Wall. List 2266 (K!), holotype, isotype CAL.
Cultivated in some botanic gardens/greenhouses (ref. Edinburgh).

2. **Hymenandra lilicina** B.C. Stone, *sp. nov.*

Suffrutex glaber, stipite brevi, crasso, subrecto ad 20–30 cm alto, ad 10 mm diametro, cortice 2 mm crasso; foliis spiraliter dispositis, magnis, obovato-oblancoceolis, usque ad 40 cm longis et 10 cm latis, coriaceis, integris, acutis vel obtuse acuminatis, basi longe angustatis decurrentibus demum abrupte subtruncatis vel subrotundatis, petiolo breve, lato, 5–10 mm longo et 4–6 mm lato, dorso rotundato, infra subcanaliculato; costa supra leviter et infra valde elevato; venis lateribus numerosis (c. 10–12–paribus), venis secundariis et tertiaris distinctis prominulentiis; pagina infra in sicco brunneo. Ramus fertilis lateralis angustis c. 15 cm longis, 1.5–2 mm diametro, nudo termini excepto dein 1–2–foliati, foliis valde reductis, ad 10 cm longis, subsessilibus. Inflorescentia bisumbellata, compacta bracteis lanceolatis pseudo-involucello formantibus; pedunculis 5 (postea —9) mm longis; pedicellis 3–5 mm longis. Flos c. 7 mm longus, calycis lobis anguste ovoato-oblongis, copiose glandulosi (glandulis oblongo-sublinearis), 5-venosis, glabris sed margine minute ciliatis; pagina intus copiose et ubique papillosa (papillis subcapitatis); corolla in parte basali quaterni tubulosi, in toto 7 mm longo, lobis ovdatis acuminatis, in basi subauriculatis, integris, copiose glandulosi, utrinque glabris vel intus basilarit perspere papillosa; tubo staminorum 5 mm longo antheris 4.5 mm longis apiculatis, dorso bilineatim glandulosi (glandulis c. 12–15 nigris); ovario conico glabro, postulato-glanduloso, 1 mm alto, stylo erecto 4.5 mm longo gracillimo (glandulis internalibus evidentibus), stigma albo subtruncato; placenta 0.75 mm alto, ovulis 8 vel 9 uniseriatis. Fructus globosus apiculatus 6 mm longus, 5.5 mm latu, glandulosi, monospermus, lobis calyci persistentibus.

Type: **BORNEO:** East Kalimantan, Berouw, Mapulu, foot of Mount Ilas Mapulu, sandstone, 300 m alt., locally common, subshrub c. 30 cm high, flowers pale purple, fruit red, 19 September 1957, *A.J.G.H. Kostermans I3951* (K! holotype; 2 sheets; isotypes CANB, L).

A striking plant with considerable horticultural potential, similar in gross appearance to *H. wallichii*, but with entire leaf margins, somewhat shorter flowers, more briefly apiculate anthers, glabrous ovary, and uniseriate ovules.

3. **Hymenandra rosea** B.C. Stone, *sp. nov.*

Fruticulus 30 cm altus, stipite suberecto-decumbente, ad 4 mm diametro, cortice atro, ubique glabro lobis calycis ciliatis excepto. Folia paucia, subconferata. Folia petiolis 12–16 mm longis, laminis lanceolate-ellipticis, ad 13 cm longis, 3.4 cm latis, acutis non-acuminatis, basi angustatis, marginibus integris vel perobscuri crenulatibus apicem versus, glabris; costa media infra prominentre; venis lateribus gracilibus, subobscursis, c. 10–12–paribus, venis tertiaris xix manifestis; pagina infra pallidiora, lineis brevisibus oblique et perdisse dispersis atris evidentis; glandulis perminutis. Inflorescentia terminalis in ramulo laterale brevissimo c. 1 cm longo, 1–2–foliato (foliis valde reductis) situata; bracteis lanceolatis 3–5 mm longis atroglandulosi; umbellos compitum umbellis secundariss 1 vel 2 involucellati, pedicellis 5–6 mm longis. Flos c. 7 mm longus, calycis profunde lobato, lobis ovdato-ellipticis subacutis, 4.5 mm longis, 2 mm latis, margine ciliatis (trichomiis anguste clavatis 0.05 mm longis), 5-venatis, glandulis ovalibus vel oblongis atris; corolla profunde lobato, lobis late ovdatis acutis, 6 mm longis, 3.5 mm latis, integris, 7-venatis, glandulosi; filamentis distinctis 1 mm longis glabris; antheris angustis subacuminiatis 3 mm longis, dorso ad connectivo glanduloso; ovario glabro subconico glanduloso, c. 1 mm alto, stylo graciile 4.5 mm longo stigma truncato; placenta conico acuminatoide subterminali 0.75 mm alto, ovulis 5 uniseriatis.

Type: **BORNEO:** Sabah: Sandakan district, Gomantong Hill, primary forest, black soil, flowers pink, 27 June 1963, *J. Ah Wing (Awing) SAN 38111* (K! holotype, isotype SAN).

It is not clear if the anthers are all united in this species. The flowers studied had apparently free anthers, but they may have separated in the drying or boiling process. The overall habit and general floral features of this plant are highly concordant with *Hymenandra.*
Fig. 2. *Hymenandra lilacina* n. sp. a. Flower in profile. b. Calyx-lobe, interior view; entire surface with suberect papilliform glandular trichomes. c. Corolla-lobe, interior view; antistaminal subbasal zone sparsely and infrequently with a few papillae. d. Staminal tube, with glandular connectives. e. Ovary and style with dermal glands. f. Ovary in longitudinal section displaying placenta. g. Placenta with 9 ovules. From type collection, Kostermans 13951.
Fig. 3. *Hymenandra rosea* n. sp. a. Flower in profile. b. Calyx-lobe, interior view, showing surface almost uniformly set with suberect papilliform glandular trichomes. c. Corolla-lobe, interior view, the glands are subdermal. d. Stamen, dorsal view, the dotted lines showing attachment to base of corolla-tube. e. Ovary and style; subdermal glands only in ovary. f. Placenta in profile (lower) and top views; ovules 5. All from type collection, *SAN 38111*.


Glabrous subshrub to 50–75 cm tall; upper part of stem 5 mm diam. Main leaves oblanceolate or obovate, subacute to acute, toward the base gradually narrowed, to 20 cm long and 5 cm wide. Petioles rather distinct and somewhat long, up to 20 mm long and less than 2 mm thick. Lamina subcoriaceous, entire, obscurely undulate or entire, midrib beneath prominent; undersurface darker than midrib; lateral veins obvious, about 6–10 pairs with subequal intercalated veins, prominent beneath; tertiary veins mostly obscure; glands very minute, reddish, scattered. Lateral fertile branches slender, 9–12 cm long, 1 mm thick, at apex with one much reduced leaf (this subsessile, narrowly elliptic-lanceolate, acute at both ends). Inflorescence an umbel of umbels, about 2 cm long and equally wide, peduncles 5–8 mm long, bracts lanceolate-acuminate, to 5–6 mm long; pedicels 5–7 mm long, slender. Flower c. 6 mm long, calyx-lobes 4 mm long, 1.8 mm wide, subentire, but sparsely ciliate near base, copiously black-glandular with oval-oblong glands; interior surface entirely papillose with suberect glands. Corolla tubular in basal fifth, lobes ovate-acuminate, entire, internally and externally quite glabrous, rather sparsely glandular with oblong reddish glands. Stamen tube 5 mm long, anthers 4.5 mm long, connective rather sparsely glandular (about 8 glands in each of the two rows); ovary glabrous, distinctly glandular, conic, almost 1 mm high, style slender, glandular, 3 mm long; stigma truncate. Placenta with 10 ovules in one series, c. 0.7 mm high. Fruit not seen.

Type: BORNEO: KALIMANTAN: West Koetai subdistrict, 30 m alt., edge of limestone rockface in flat country, in forest, shrub to 75 cm high, flowers dark red, 22 November 1925, F.H. Endert 5134 (SING! holotype, isotypes K, L).

Additional specimen examined: BORNEO: KALIMANTAN: Berau, Mt. Njapa on Kelai River, 1,000 m alt., shrub 1 m, flowers and fruits red, 25 Oct. 1963, Kostermans 21518 (L!)

Although placed in *Ardisia* by Furtado, this species appears to have a staminal tube; as noted in the caption to the illustration provided by Furtado in his protolog, which states “E, *Flos juvenilis sepalis desumptis ut stamina tubiformiter collata apparent.*” Furtado’s diagnosis also specifies that the calyx-lobes are lepidote on both sides; I equate this term in this case with papillose. This species clearly is very near to *H. lilacina* and *H. rosea.*

5. *Hymenandra beamanii* B.C. Stone, *sp. nov.*

Suffrutex suberectus humilis ad 50 cm altus, stipite simplici, ramuli unifoliati fertili excepta; foliiis cauliniisibus magris obovatis obtusis basi truncatis vel subcordatis, petiolis crassis 5–6 mm longis, laminis 12–17 cm longis, 7–9 cm latis, glabris, sed in pagina infra minute et dissite lepidotis. Folia in ramuli laterali solitaria multo minores subsessilia. Inflorescentia compacta congeste bisumbellatis, apicale in ramulis lateraliusibus, axibus valde contractis, pedicellis 5–11 mm longis. Flores numerosi conspersi, 7–8 mm longi, bracteis lanceolatis c. 5 mm longis. Calyx cupulari-urceolatis profunde lobatis, scarioso-marginatis, extus glabris, margine minute et sparsiter capitato-ciliatis, glandulis immersis ovalibus vel oblongis; intus minute et perdense papillosae. Corolla 7.5 mm longa in basi tubulosa per 1.5 mm, lobis ovatis acutis leviter asymmetricis, glandulis immersis ovalibus vel oblongis distaliter auctis, integris, utrinque glabris. Stamina fere 6 mm longa, per antheras coalescens basi per filamentas tubulosa, filamentis liberi ad basi corollae adnatis 1.5 mm, parte libera 0.5 mm longo, antheris lanceolatis 4 mm longis, marginaliter connatis introrsis, dorso glandulo quando glandulis paucis (c. 12) atris rotundatis, apiculis antherarum breviter liberatis. Ovarium conico-ovoideum, obscure glandulosum, c. 1 mm altum, in stylo elongato 6 mm longo productum, stigma minute punctiforme. Placenta turbinata minute apiculata, 0.75 mm alta, ovulis 6–9 uniseriatis. Fructus ruber globosus, c. 6 mm diam., minute apiculatus.
**Fig. 4.** *Hymenandra beamanii* n. sp.  
(a) Flower in profile.  
(b) Calyx-lobe, interior view; surface with small papillae; immersed glands reddish or blackish.  
(c) Corolla-lobe, interior view; note basal area (dotted) to which filament is adnate.  
(d) Stamen tube; filaments adnate to corolla-tube on dotted areas.  
(e) Stamen, ventral view.  
(f) Gynoecium.  
(g) Placenta (ovules 8).  
(h) Placenta in transverse section. From *SAN 77243*, type.

*Type:* BORNEO: SABAH: Ranau district, about 3 miles north of Kampong Takutan, primary forest on ridge at 2,800 ft. alt., flowers whitish, 28 May 1973, G. Shea & Aban Gibot *SAN 77243* (K! holotype, isotypes L! SAN).

*Additional specimen examined:* BORNEO: SABAH: Ranau district, southwest side of Lohan River, 700–900 m alt., on cliffs and slopes over ultramafic substrate, low stature forest, 5 April 1984, *J.H. Beaman 9229* (PH! MSC, UKMS).
Fig. 5. *Hymenandra beamanii* n. sp. From Beaman 9229 in PH.
The very compact umbelliform inflorescences borne on slender subterminal fertile branches, each with a strongly reduced leaf, the elongate sepals with densely papillose inner surfaces, and the laterally joined anthers readily distinguish this species as a Hymenandra. The floral details in the description above are taken from the SAN collection, those of the fruits from the Beaman collection, and the habit and leaf information from both.

The epithet commemorates the collector, Professor John Beaman of the Michigan State University, who collected this and numerous other Sabah plants during the course of a Fulbright-sponsored stint at the National University of Malaysia, Sabah campus.

6. Hymenandra narayanaswamii Nayar & Giri


Shrubs with terete, glabrous stems. Leaves oblong to oblong-elliptic, 8–18 cm long, 3–11 cm wide, acute at both apex and base, entire, pellucid-glandular-punctate, membranaceous, the midrib prominent beneath; lateral veins about 30 with about as many nearly as prominent intersecondaries; reticulations evident; petiole 10–12 mm long, canaliculate above. Inflorescence axillary, 4–7 cm long, subcorymbose paniculate, shorter than the leaf, densely puberulous, glandular-dotted; flowers 5-merous, corymbosely to subumbellately arranged; pedicels 4–8 mm long; calyx lobes triangular-lanceolate, densely puberulous and glandular-punctate; corolla lobes shortly united at base, lanceolate, 7–8 mm long, 1.5–2 mm wide, long acuminate, glandular-punctate, dextrorsely imbricate; stamens with very short (0.5 mm) free filaments, anthers linear-lanceolate 6–7 mm long, laterally connate, glandular-punctate dorsally along the connective; ovary subglobose, scarcely 1 mm high, glandular, abruptly narrowed at apex into the slender 8–10 mm long style; stigma inconspicuous; placenta ... and ovules ... (not reported).

Type: BURMA: Tavoy, P.T. Russell 2105 (CAL, not seen).

Nayar & Giri state of this species that it is allied to Hymenandra wallichii but differs in having oblong or oblong-elliptic leaves with cuneate base, acute apex, entire margin, and membranous texture, triangular lanceolate calyx lobes and abruptly attenuated apex of anther; whereas in H. wallichii, the leaves are obovate-lanceolate or oblanceolate with attenuate base, rotund apex, dentate margin, and fleshy texture; calyx lobes are ovate; and apex of anther is gradually attenuate. Most unfortunately, these authors do not report on certain critical characters such as whether or not the interior faces of the calyx lobes are papillose, and what the number and disposition of the ovules may be on the placenta. The species is illustrated but these features are not shown in the drawings either, nor are there descriptions or drawings of the trichomes. No mention of the bracts is made. The authors do not redescribe H. wallichii or H. iteophylla.

Subgenus Lacrimopila B.C. Stone, subg. nov.

Inflorescentia compacta vel laxe tripinnatim paniculata, axibus pedicellisque satis vel bene elongatis, bracteis cito caduca; calycis lobis marginaliter hirtellis vel lepidotis, intus epapillosi (sed in species typicum hirtellis); indumento ferrugineo, pilibus cellulis apiocalibus capitulatis lacrimiformibus, vel lepidis flabelliformis vel stellatiformis. Arbusculae vel frutices modice erectae ramis pluralibus basi ampliati alternatim foliatis. Typus: Hymenandra diamphidia Stone.

7. Hymenandra diamphidia B.C. Stone, sp. nov.

Arbuscula usque ad 3 m alta, sparse ramosa, ramis ramulisque gracilibus, subteretibus, ad 3–4 mm diametro, coriace atro, subdensiter ferrugineo-tomentellis, demum glabrescentibus; indumento trichomis

Fig. 6.
stipite cellulis 1 vel 2 pellucidis cellulis terminalibus ovoideis plerumque gemellatis translucide brunneis acutis vel bifidis c. 0.05–0.075 mm longis dissepte dispersis in superficiem pedicelli, calycinis, corollae, antherae, et gyroecii, et axium omnium inflorescentie; partibus alis fibris. Folia excta anguste ovatae vix acuminatae, 3–20 cm longae, 1.5–6.5 cm latae, basi rotundata vel subcordata, Valle petiolatis, petiolis gracilibus 10–30 mm longis, subdensiter minutque tomentellis; lamina integra submembranacea, per- conspicue multiglanduloso glandulis atris orbicularibus, pagina supra glabra (marginibus et costa tomentellis excepta), infra pallidiora sueto purpurata ad venis tomentellis; costa supra vado impresso, infra valde carinato, venis lateralis manifestis, 6–9-paribus, curvato-patentibus, praetex margos sublonge continuatiis; reticulationibus tenuibus sed manifestis. Inflorescentia in ramulis lateralis terminalis, pendula, laxe tripinнатiam racemoso-paniculatis, 10–15 cm longis, multifloris, axibus omnibus gracilibus minuteque tomentellis, floribus in pedunculis laxe dispositis, pedicellis 5–8 mm longis in statu floriferi (vel usque ad 10 mm longis in statu fructiferi). Flores angusti c. 6 mm longi purpurei 5-meri tomentell. Calyx profunde lobatus, lobis peranguste triangularibus 3–5 mm longis, basi 0.6–0.7 mm lati utrinque et marginaliter tomentellis, basem versus persparg fandelos, Corolla profunde lobata 6.5 mm longa, lobis anguste ovatis subacuminatis apicem versus leviter convolutis, medialiter persparg glandulos, integris, extus dorso tomentellis, intus glabris, obscure paucivenosis, basi minime tubulosus. Stamina per antheris connata filamentis libris brevissimis complanatis 0.5 mm longis perminime ad tubo corollae adnatis, antheres lanceolatis acuminatis 4.5 mm longis, utrinque sparse tomentellis, haud glandulos, rimoso apertentibus, apiculis brevissime liberatis, polline luteo. Ovarium breviter conicum vix 1 mm altum in stylo gracile albo 4 mm longo basem versus sparse tomentello productum, stigma punctiforme perminime sparseque subpapillosa; placenta turbinato ovulis 8–9 irregulariter biseriatim dispositis. Fructus globosus tomentellus, miniatus vel scarlatinus, apiculatus, c. 6 mm diametro, calycinis lobis patentibus persistentibus et pedicellis gracilibus acutus.

Type: BORNEO: SABAH: Ranau District, Mount Kinabalu, Ulu Liwagu and Ulu Mesilau (6 N, c. 116 35' E), c. 5,000 ft. alt., shrub 3–5 ft. tall, sparingly branched, flowers purplish, berries pink, young leaves purple beneath, inflorescence and infructescence hanging, 6 November 1961, W.L. Chew, E.J.H. Corner and J.D. Stainton RSNB 2809 (K! holotype).

Additional specimens examined: BORNEO: SABAH: Mount Kinabalu, Ulu Liwagu and Ulu Mesilau, Tenompok, 5,000 ft. alt., tree 10 ft. tall, in oak-podocarp forest, fruit red, 8 September 1961, Chew, Corner and Stainton RSNB 1454 (K!). Same locality, Ulu Langanani, Sungei Mamut (6 04' N, 116 40–44' E), 4,500 ft. alt., shrub 8 ft. tall, fruit scarlet, in montane oak forest, 10 August 1961, Chew, Corner and Stainton RSNB 1265 (K!).

A most extraordinary species, with numerous peculiar features, differing from all other species of Hymenandra other than H. iteophylla in habit, indument, shape and size of glands, and type of inflorescence. The comparatively slender and elongated petioles, narrow leaves, with rather large scattered black pustular glands, the open, pendulous, slender-stalked inflorescence, the characteristic form of the glandular trichomes, the tomentellous ovary, and the presence of hirtellous indument on the anthers, are all manifest and remarkable features of this species. The epithet “diampidia” meaning (Greek) “utterly different” seems appropriate for this plant.

The glandular trichomes have a short stalk of one or two cells, and terminate in one or usually two cells which are laterally adnate or more or less separated at the tip, thus appearing “twinned”. These apical cells are in the shape of a teardrop (lacrimiform) and are translucently ferruginous.

While placing this species in a subgenus separate from that including the type species of Hymenandra, the tubular androecium and the ovular number conform well to the generic characters. Yet there are several peculiar or unique features of this species. Including H. iteophylla with its very different kind of indument, but similar habit, may be incorrect, but I would prefer newer collections to become available for study before reassessing this relationship.
Fig. 6. *Hymenandra diamphidia* n. sp. a. Flower in profile. b. Calyx with one lobe removed. c. Corolla- lobe, interior view. d. Stamen tube. e. Single detached stamen, ventral face oblique. f. Ovary and style. g. Placenta with 9 ovules. h. Tip of style showing sparsely papillate stigma. i. Trichomes showing the twinned apical cells of lacrymiform shape, and 1–2-celled stalks; representative of the indument on all parts. j. Leaf undersurface, the tertiary veins omitted for clarity. Scat- tered dots are immersed glands. k. Branch base (gusset). All from type collection, Chew, Corner & Stainton RSNB 2809. (All illustrations original.)
8. *Hymenandra iteophylla* (Ridl.) Furtado


Entirely resembling an *Ardisia* (Ridley); branchlets with broad triangular gussets at base; shrubby with ascending branches; leaves lanceolate-elliptic, thinly coriaceous, slightly acuminate, cuneate, tapered to base, 5–10 cm long, 1–2 cm wide, the petiole 5–10 mm long; young leaves brown-lepidote (or golden) beneath; scales irregular, sub-stellate; indument of young branches ferrugineous, with the scales erect, flabellate to substellate, later evanescent; midrib elevated beneath, lateral and tertiary veins obscure, numerous, close; undersurface densely lepidote. Inflorescence terminal and axillary subterminal, with foliaceous bracts; umbels with lepidote-puberulent axes and bracts; pedicels 6–7 mm long, slender; calyx tuberculate-glandular, the lobes narrowly ovate, 1.5 mm long, copiously glandular; ciliate; corolla-lobes pink, long and narrow, imbricate, acute, entire, glabrous, not or very obscurely glandular, 4–5 mm long, the tube 0.75 mm long; stamens lanceolate, the filaments much elongated (more than half as long as the anthers), distinct; anthers lanceolate, 4.25 mm long, connate marginally, but tips free; outer thecae with fertile portion about ⅓ as long as anther, inner thecae with fertile portion shorter, about half as long as anther; connective set dorsally with two rows of large convex glands; ovary subglobose, 1.5 mm high, glabrous, with the slightly glandular style 6.5 mm long and projecting beyond the corolla. Placenta 0.5 mm high, with about 6 to 8 ovules in one row.

Type: MALAYSIA: JOHORE: Gunung Besidong, 1,500 ft. alt., hill forest, R.E. Holtum SF 10973 (SING! holotype).

Additional specimens examined: MALAYSIA: JOHORE: Gunung Belumut, northwest, 1,200 ft. alt., rocky stream bed, monopodial treelet 6 ft. tall, flowers purplish-pink, leaves golden beneath, 15 May 1968, TC. Whitmore FRI 8782 (KEP!) TRENGGANU: Bukit Bauk Forest Reserve, 1,000 ft. alt., shrub 6 ft. tall, on ridge, fruits green, 13 November 1968, K.M. Kochummen FRI 2601 (KEP!).

This species is very distinctive in its small leaves with a golden-brown indument beneath, the subterminal umbels, the scattered multiform flabellate to substellate erect or suberect scales on the axes (while the scales on the leaves are peltate and appressed), the dark roundish glands of the calyx and connectives, and the long, slender filaments. Its relationship to *H. diamphidia* is perhaps rather dubious, though in habit it corresponds well. The highly different type of indument, glabrous anthers and ovary, elongated filaments, and smaller, lepidote leaves are obvious distinguishing features.

A character worthy of note is the unequal length of the thecae in each anther. The inner adjacent thecae are about half the anther length; the outermost thecae are about two-thirds the length of the anther.

References


Fig. 7. *Hymenandra iteophylla* (Ridl.) Furt. **a.** Flower in profile. **b.** Corolla interior, showing two lobes with filaments intact but anthers removed. **c.** Androecium, detached from corolla. **d.** Ovary and style. **e.** Placenta. **f.** Placenta, enlarged, with 8 ovules. **g.** Placenta in transverse section. **h.** Portion of inflorescence showing one branch, with axillant bract and bracts of the branch. **i.** Various flabellate and stelliform scales of the indument. (All from Holtum SF 10973, type collection.)


New Algal Records from the Singapore Mangroves

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EFFECTIVE PUBLICATION DATE: 23 MAR 1992

Abstract

The following marine algae are newly recorded for Singapore mangroves: Bostrychia pinnata Tanaka et Chihara, Bostrychia simpliciuscula Harvey ex J. Agardh (Rhodophyta, Ceramiales, Rhodomelaceae), Caloglossa angustalata nom. prov. (Rhodophyta, Ceramiales, Delesseriaceae) and Boodleopsis carolinensis Trono (Chlorophyta, Caulerpales).

Collections and Observations

The rapidly dwindling mangroves of Singapore are an interesting and diverse habitat of various estuarine algae. Johnson (1979), Teo and Wee (1983) and Chapman (1984) recorded many of these. In June 1989 I had the opportunity to collect specimens in several sites for laboratory culture investigations on their reproductive biology. Below are listed four taxa previously unrecorded in Singapore. The classification, reproductive condition, date of collection, specific location, habitat and culture observations are given for each record.

Chlorophyta, Caulerpales

Boodeopsis carolinensis Trono

Johnson (1979) recorded Derbesia fastigiata Taylor as the only genus of the Caulerpalcs in the Singapore mangroves, but the vegetative and reproductive features of the present specimens are similar to B. carolinensis. A dense green turf is formed by erect filaments 15–21 μm diam., di- to tri-chotomously branched and with prominent constrictions present at the nodes. This system arises from a basal system comprised of lighter pigmented, more irregularly shaped and branched filaments of a greater diameter. Subspherical sporangia up to 110 μm diam. are present occasionally on the erect filaments. These features generally fit the description provided by Trono (1971) for B. carolinensis. Boodleopsis pusilla (Collins) Taylor, Joly et Bernatowicz (Taylor, et al. 1953, Calderon-Saenz and Schnetter 1989) is a more widely distributed species but the filament diameter is greater (23–45 μm). Boodleopsis siphonacea A. et E.S. Gepp also is larger in filament diameter (30–60 μm) according to the comments of Tanaka and Chihara (1988). Boodleopsis hawaiiensis Gilbert also conforms to the general appearance of these specimens except for the greater range in filament diameter (60–110 μm) and the apparent lack of sporangia (Gilbert, 1965).

Collections were made on 12 June 1989 at Kranji and on 13 June 1989 at Mandai. In both sites Boodleopsis formed a dense turf at the +3.0 m level above chart datum on decaying logs and on mud.
Rhodophyta, Ceramiales, Rhodomelaceae

Bostrychia pinnata Tanaka et Chihara

This species, described in 1984 by Tanaka and Chihara from Okinawa, appears to be distributed widely in Asia (Indonesia: Tanaka and Chihara, 1988, Australia: King and Puttock, 1986, West et al., 1992). It was found in two localities in Singapore: Lim Chu Kang, mixed with Catenella and Caloglossa, 13 June 1989 and Lim Chu Kang, on Avicennia bark at +3.0 m above chart datum, 16 June 1989. All field plants were nonreproductive, but both isolates have developed tetrasporangia in culture. Tetraspores developed into unisexual and bisexual gametophytes. Both female and bisexual gametophytes formed well developed carpogonophores that released viable carpospores that again developed into tetrasporophytes.

Bostrychia simpliciuscula Harvey ex J. Agardh

This species also is widely distributed in Asia (King and Puttock, 1989). It was obtained in two localities in Singapore: Tetrasporangiate plants occurred at Mandai in a Boodleopsis turf at +3.0 m above chart datum on 13 June 1989. Vegetative and male plants were present in mud at +3.1 m at Lim Chu Kang on 16 June 1989. The Mandai isolate in culture has completed a Polysiphonia-type life history with self-compatible unisexual and bisexual gametophytes. The Lim Chu Kang isolate in culture is a male that is cross-fertile with the Mandai isolate.

The B. pinnata and B. simpliciuscula collected in Singapore and elsewhere contain D-dulcitol and D-sorbitol as compounds important in osmotic acclimation (Karsten, et al. 1992).

Rhodophyta, Ceramiales, Delesseriaceae

Caloglossa angustalata nom. prov.

Vegetative plants were collected in the upper turf areas at +2.0–3.0 m above chart datum at Mandai on 13 June 1989 and Lim Chu Kang on 16 June 1989 mixed with Caloglossa stipitata Post. Both isolates in culture have completed a Polysiphonia-type life history and remain uniform in morphology.

A careful survey of the literature and herbarium specimens indicate this species is undescribed. The narrow axes with wing cells often absent makes this most distinctive in comparison with other Caloglossa species. The final description of Caloglossa angustalata will be published in Botanica Marina (West, in preparation).

A similar species, C. ogasawaraensis Okamura, was isolated into culture from collections made from mud-covered Avicennia pneumatophores in Darwin, Northern Territory, Australia and from Rhizophora prop roots in Ilha do Cardoso, São Paulo, Brazil and Tumbes, Peru (West, 1991). Caloglossa ogasawaraensis produces 3–5 wing cells along each side of the midrib in the upper region of each internode whereas C. angustalata rarely forms more than 1–2 wing cells even at its widest. All Caloglossa species including C. angustalata produce mannitol for osmotic acclimation (Karsten, et al. 1992).

For all of the above-mentioned species, herbarium voucher specimens have been deposited at the University of California, Berkeley, Herbarium (UC). The culture isolates are deposited in The Culture Collection of Algae, Department of Botany, University of Texas, Austin, TX 78713-7640.
Acknowledgements

A travel grant from the University of California Committee on Research made this work possible. Tim Lowrey, Paddy Murphy, Shawn Lum, Johnny Wee and many other colleagues at the Departments of Botany and Zoology, National University of Singapore, generously provided facilities and assistance.

References


Notes on the Systematy of Malayan Phanerogams
XXXI Lauraceae

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EFFECTIVE PUBLICATION DATE: 23 MAR 1992

Abstract

Two new species, Cinnamomum pubescens and Endiandra scrobiculata, and two new varieties, Actinodaphne sesquipedalis var. glabra and Lindera concinna var. reticulata are described.

Introduction

Malayan Lauraceae was studied for incorporation in the 4th volume of Tree Flora of Malaya. On completion of this study, two new species, Cinnamomum pubescens and Endiandra scrobiculata and two new varieties, Actinodaphne sesquipedalis var. glabra and Lindera concinna var. reticulata were recognised which are described here.

Actinodaphne

Actinodaphne sesquipedalis Hook. f. var. glabra Kochummen var. nov.

A varietate typica in foliis glaberrimis differt.

This new variety has glabrous leaves with 4–6 cm long petioles and large 2–4 cm long glabrous bud scales. They are found in lowland and hill forests along the east coast of Malaya.

Cinnamomum

Cinnamomum pubescens Kochummen sp. nov.

Ramuli juveniles paulo angulosi flavo-brunnee pubescentes. Folia alterna vel opposita 3-nervata, petiolo 1–2 cm longo longe velutino. Lamina coriacea lanceolata 7.5–16 cm longa 2.5–6 cm lata viride-lutea, apice acuto, infra subtilliter pubescenti, supra costa nervis secundariisque planatis ad immersis, infra elevatis, nervis secundariis nervulis lateribus paulum ad marginem radiantis nervum ad marginem inconspicuum arcuatum formantibus, nervis tertiariis scalariformibus confertissimis, infra distinos, supra inconspicuis. Inflorescentia axillaris c. 10 longa, pubescentis. Alabastrum globosum c. 4 mm longum, pediculo c. 2 mm longo dense pubescentis, periantho subequali fere globoso utrique dense pubescentis. Stamina 9 in seriebus 3, seriebus primiti secundariisque extrasis tertii glandulis 2 magnis cordatis in medico filamenti affixis, filamentis dense pubescentibus, staminodiis stipitatis cordatis. Ovarium paulo rugosum, stigmatem decurrenti prominenti. Fructus immaturus in periantho infundibuliforme tube indurato rugoso lobis persistentibus pubescentibus sessilis, pedunculo c. 8 mm longo. (TYPUS FRI 35248 [KEPI]).

This is a small tree known only from 3 collections from the mountain forests at Cameron Highlands in Pahang at about 1500 m.
Fig. 1.  *Cinnamomum pubescens* Koch. FRI. 35248.
Endiandra

*Endiandra scrobiculata* Kostermans ex Kochummen *sp. nov.*

Arbor excelsa ad 33 m alta, caule 70 cm diam. cortex cinereo-brunnea laevis, intus rubra granulata suaveolens, ligno juvenali luteo. Ramuli atro-brunnei ad nigri, juvenales leviter angulosi. Laminae coriacea ellipticae ad lanceolatae 6.5-13 cm longa 2.5-5.5 cm latae, apice acuto, basi cuneata, costa supra applanata nigrescenti, secundariis 7-9 paribus utrinque inconspicuissime elevatis, reticulationibus inconspicue manifestis, petiolo 1-1.5 cm longo. Paniculae axillares. Flores ignoti. Fructus oblongi ca. 7 cm longi 4.5 cm lati laeves atro-brunnei in sicco. (TYPUS: KEP 45477, 93366 [KEP]).

This is a rare tree known only from mountain forests at Frasers Hill, Pahang at about 1200 m. Kostermans gave this name to the collections at Kepong years ago, however he did not publish it.

Lindera

*Lindera concinna* var. *reticulata* Kochummen *var. nov.*

A varietate typica in laminarium nervatura valde reticulata supra distincta quoque in ramulis dense velutinis differt. Differs from the type variety in the strongly reticulate venation which is distinct on the upper surface of the leaf and in the densely velvety hairy twigs. Locally common in mountain forests in Selangor and Pahang.
Acknowledgements

I wish to express my gratitude to Dr. J.F. Veldkamp of Rijksherbarium, Leiden for the latin descriptions.
Embryo Culture of *Howea* Palms

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EFFECTIVE PUBLICATION DATE: 23 MAR 1992

**Abstract**

This paper reports the findings of an experiment on embryo culture of *Howea belmoreana* and *Howea forsteriana*. It was demonstrated that growth regulators significantly affect the development of embryo culture. The medium containing 1 mg l⁻¹ of 2,4-D and 0.5 mg l⁻¹ of 2iP was found to give the best results for both of the *Howea* palms. Conventional germination of *Howea* palm seeds generally takes a year or more (Reynolds 1982). In our experiments, the embryo culture required only 12-20 weeks to develop fully rooted plantlets. This saving in time could be significant for commercial production.

**Introduction**

The *Howea* palms are ornamental plants which are arborescent monocotyledons with solitary vegetative shoots. They are relatively slow growing and consequently require much time and effort in production. Reynolds (1982) found that it normally took a year or more to germinate a *Howea* seed in a special germination bed. Because of its lack of a tendency to form branches, *Howea* palms cannot be multiplied by conventional methods of vegetative propagation. In 1986, the Department of Botany, National University of Singapore, and the Parks and Recreation Department, Ministry of National Development, undertook a joint research project on the tissue culture propagation of tropical trees, palms and shrubs. The Tissue Culture Laboratory of the Botanic Gardens was assigned the task of studying the tissue culture propagation of *Howea* palms.

The study proceeded in two stages. In the first stage, embryo culture was produced from imported seeds of *Howea* palms. In the second stage, the plantlets and callus derived from the embryo culture were used for tissue culture experiments. This paper summarises our findings and observations of the first stage of the project: the development of *Howea* palm embryo culture under the influence of different combinations of growth regulators.

**Materials and Methods**

(a) **Plant Materials**

One thousand seeds each of *Howea belmoreana* and *Howea forsteriana* were imported from Australia. These seeds were excised for the embryos. Before excision, the seeds were soaked in tap water for 24 hours and then surface-sterilised by soaking for 15 minutes in 1% (w/v) sodium hypochlorite solution. The seeds were then sliced open with an hand cutter and the exposed embryos were carefully removed with sharp-tipped
forceps. The excised embryos were then sterilised in a 5% chlorox solution for a few minutes, rinsed with distilled water, and cultured on various culture media.

(b) Nutrient Media

For germination of embryos, the basal medium used was the Murashige and Skoog salts (1962) supplemented with 170 mg/l NaH₂PO₄·2H₂O, 100 mg/l meso-inositol, 0.4 mg/l thiamine-HCl, 3% (w/v) sucrose, 40 mg/l adenine sulphate·2H₂O, 50 mg/l activated charcoal, and 0.8% agar. Three types of auxin; 2,4-dichlorophenoxyacetic acid (2,4-D), α-naphthaleneacetic acid (NAA), and Indole-3-acetic acid (IAA), and two types of cytokinin; N⁶-[Δ² isopentyl] adenine (2iP) and 6-benzylaminopurine (BAP), were used in the following combinations in our experiments:

(i) 1 mg 2,4-D and 0.5 mg 2iP;
(ii) 1 mg 2,4-D and 0.5 mg BAP;
(iii) 1 mg NAA and 0.5 mg 2iP;
(iv) 1 mg NAA and 0.5 mg BAP;
(v) 1 mg IAA and 0.5 mg 2iP;
(vi) 1 mg IAA and 0.5 mg BAP.

Three months after germination, the embryos were transferred onto an auxin/cytokinin-free medium which contained only the basal salts as described above, but at half the concentration.

The pH value of all the media was adjusted to 5.5 to 5.7. The media were dispensed into 25 mm × 150 mm culture tubes (10–20 ml of medium per tube) or 100 ml conical flasks (20–30 ml of medium per flask) and sterilised for 15 minutes at 120°C under 1.5 kg cm⁻² pressure.

(c) Cultural Conditions

The cultures were kept under 2–3 klx lighting provided by true-lite tube on a 16-hour photoperiod throughout the experiment. The environmental temperature was kept at 26±1°C.

(d) Experiments Conducted

One thousand embryos each of *Howea belmoreana* and *Howea forsteriana* were excised. For each of the two palms, 150 embryos were cultured in each of the six media described in Section II (b). The remaining 100 embryos were cultured in the basal medium without growth regulators. These last 100 embryos were used as controls for the other experiments.

After three months, the germinated embryos were transferred to the auxin/cytokinin-free medium. Thereafter, transfers at 4–6 week intervals were necessary to maintain embryo/plantlet growth until they developed their first true leaf.

**Results and Discussions**

During the first three months of the experiments, the embryos exhibited 10 growth patterns: no growth/contaminated; developed into swollen heads only (Fig. 1); developed into cotyledonary sheaths without roots (Fig. 2); developed into callus (Fig. 3); developed into cotyledonary sheaths with roots (Fig. 4); developed into callus with roots only (Fig. 5); developed into callus with shoots only (Fig. 6); developed into shoots only (Fig. 7); developed into callus with shoots and roots (Fig. 8); and developed directly into shoots and roots (Fig. 9). Some of these growth patterns had also been
Fig. 1 Embryos develop into swollen heads only.

Fig. 2 Embryo develops into cotyledonary sheaths without roots.

Fig. 3 Embryo develops into callus.

Fig. 4 Embryo develops into cotyledonary sheaths with root.
Fig. 5  Embryo develops into callus with roots only.

Fig. 6  Embryo develops into callus with shoot only.

Fig. 7  Embryo develops into shoot only.

Fig. 8  Embryo develops into callus with shoot and roots.
observed in date palm culture (Tisserat 1979, Tisserat 1982, Gabr and Tisserat 1985) and oil palm culture (Hodel 1977, Nwankwo and Krikorian 1986).

Table 1a lists the percentages of *Howea belmoreana* embryos that took on each of the growth patterns when cultured in the various media. Table 1b lists the corresponding figures for *Howea forsteriana*. Both of the tables show that growth regulators are important as the percentages of no-growth embryos for the control experiments are very much larger than those for the other experiments. For the various media except the control, the percentages of *Howea belmoreana* (*forsteriana*) embryos that showed no growth are close to each other, ranging from 46.00-49.33% (13.33-30.00%). There is a slight hint that the media with 2,4-D/2iP, 2,4-D/BAP, and NAA/BAP favour direct development into shoots and roots. However, at this stage, it is still not clear whether the differences in the growth regulators significantly affect the success of the embryo culture.

After the first three months, all the germinated embryos were transferred on the auxin/cytokinin-free medium. After repeated transfers, some of the embryos developed
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Table 1a
Initial developments of the embryos of *Howea belmoreana* in percentages
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<td>2.67</td>
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<td>4.00</td>
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<td>4.67</td>
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<td>20.00</td>
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<td>30.00</td>
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Table 1b
Initial developments of the embryos of *Howea forsteriana* in percentages
into normal plantlets, while others remained as roots, shoots, or callus only, or even browned off and died. There was however a strong dependence of this later development on the initial growth pattern of the embryo as shown in Table 2a, b. In general, only those embryos which initially developed both shoots and roots stood a good chance of developing into normal plantlets, and nearly all that initially developed into swollen heads, cotyledonary sheaths, or callus with shoots or roots only, had browned off and died.

**Table 2a**
Further developments of *Howea belmoreana* embryos in percentages

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<th>Embryos develop into</th>
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<th>Roots only</th>
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<th>Normal plantlets</th>
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<tr>
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<td>10</td>
<td></td>
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<td>callus</td>
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<td>10</td>
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<tr>
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<td>2</td>
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<td></td>
<td></td>
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<td>shoots only</td>
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<td></td>
<td></td>
<td>70</td>
<td>30</td>
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<td>callus with shoots and roots</td>
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<td></td>
<td>100</td>
</tr>
<tr>
<td>shoots and roots directly</td>
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**Table 2b**
Further developments of *Howea forsteriana* embryos in percentages

<table>
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<tr>
<th>Embryos develop into</th>
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<th>Roots only</th>
<th>Shoots only</th>
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<td></td>
<td>95</td>
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<tr>
<td>shoots and roots directly</td>
<td>5</td>
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<td>95</td>
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Considering only development into normal plantlets as success, we may work out the success rate figures for each culture medium by summing the products of the figures of the last column of Table 2a(b) and the corresponding figures of the columns of Table 1a(b). For instance, the success rate figure for *Howea belmoreana* in the medium IAA/BAP is given by

\[
(0 \times 8.67 + 0.1 \times 6.67 + 0.1 \times 5.33 + 0 \times 3.33 + 0 \times 4.00 \\
+ 0.02 \times 2.00 + 0.3 \times 8.00 + 1 \times 6.67 + 1 \times 6.67)\% = 16.98\%.
\]

The success rate figures for the various media are tabulated in Table 3 and the corresponding bar-chart is shown in Fig. 10. It is evident that the media 2,4-D/2iP and 2,4-D/BAP yielded the best results, especially for *Howea forsteriana*. *Howea belmoreana* appears to be not as sensitive to the media as *Howea forsteriana*. Our results agree with Tisserat (1981) and Gabr and Tisserat (1985) who observed increased germination rate and accelerated growth of date palms in 2,4-D/2iP medium, and also Nwankwo and Krikorian (1986) who made similar observations for oil palms. However, both of these previous studies used very much higher concentrations of 2,4-D (100 mg/l) and 2iP (3 mg/l). Fig. 11 shows the various stages of normal growth of a healthy embryo of *Howea forsteriana* over a period of eight weeks.

| Table 3 |
|---|---|---|---|---|---|---|
| | Control | 2,4-D/2iP | 2,4-D/BAP | NAA/2iP | NAA/BAP | IAA/2iP | IAA/BAP |
| *Howea belmoreana* | 2.82 | 23.90 | 28.30 | 16.31 | 21.43 | 20.83 | 16.98 |
| *Howea forsteriana* | 3.36 | 44.23 | 37.03 | 14.20 | 25.28 | 12.89 | 22.24 |

Our observations suggest that the size of the embryo could be a factor affecting its growth. Most of the embryos that died or showed no growth at all were very small in size. Those smaller embryos that survived generally took a long time to show any sign of growth, and they often developed into swollen heads, callus, or shoots or roots only. On the other hand, the large embryos in suitable media tended to grow within three months into normal plantlets. It is possible that the size of the embryos is an indication of the age of the embryos. The age of the embryo and the condition of the explant have been shown to have an effect on the growth pattern of date palm and oil palm culture (Jones 1974, Hodel 1977, Zaid and Tisserat 1983). Unfortunately, since the seeds were imported, we did not have information on the age and quality of the embryos used in our experiments. We therefore cannot draw a definite conclusion on this aspect about *Howea* palms.

**Conclusions**

This study demonstrates that growth regulators are important for embryo culture of *Howea belmoreana* and *Howea forsteriana*. Of the combinations tested, the medium containing 1 mg/l of 2,4-D and 0.5 mg/l of 2iP gave the best results for both *Howea* palms.
Fig. 10  Success rate of the media for the embryo culture of the two palms.
Fig. 11. The development of an excised embryo of *Howea forsteriana* in the presence of growth regulator over a 40-day period.

Germination of *Howea* palm seeds normally takes a year or more (Reynolds 1982). In our experiments, the embryo culture required only 12–20 weeks to develop fully rooted plantlets. This saving in time could be significant for commercial production. Similar results were obtained by Hodel (1977) for oil palm, which took 20–24 weeks to grow from seed to seedling, but only 10–12 weeks to achieve the same stage of development in embryo culture.

The age of the embryos may also affect the growth of the *Howea* embryos. This possibility is worth a further study. A better knowledge of the physiology and the biochemistry of the embryo will also be helpful in understanding the requirements of embryo growth in vitro.

**References**


**Schizostachyum terminale** Holtt., An Interesting New Bamboo Record for Borneo

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Forestry Research Centre
Forestry Department
P.O. Box 1407
90008 Sandakan, Sabah

EFFECTIVE PUBLICATION DATE: 23 MAR 1992

Abstract

The bamboo *Schizostachyum terminale* Holtt., first recorded and for more than 30 years known only from Peninsular Malaysia, has been documented for north Borneo. It has a clambering, thicket-forming growth habit and an unusual preference for seasonally inundated swampy riverbanks and alluvial flats.

Introduction

In 1956, Holttum described *Schizostachyum terminale*, known only from the type specimen *Nauen* SFN 35831 (K, SING), collected on the banks of the Krian River in Kedah state, Peninsular Malaysia. A second Malayan collection was made only in 1982 (*Wong* FRI 32399 — K, KEP, L, SING) from a damp logged-over patch of vegetation beside a stream at Rantau Panjang in Selangor state. Both collections were from the west coast of Peninsular Malaysia and the evidence then indicated a rather restricted distribution. Since 1982, searches along the Krian River and various other rivers near the Malayan west coast have ended in vain, suggesting the species was rare and that its survival was possibly threatened. In 1988, a third collection (*Saw* FRI 36283) was made from riverine swampy ground at 70 m above sea level, quite inland at the Krau Game Sanctuary near Kuala Lompat in Pahang state.

Recently this species has been discovered in north Borneo, and investigations of wild populations there in the East Malaysian state of Sabah (voucher: *Wong* FRI 35151 — K, KEP, SING) (Fig. 1) and in Brunei Darussalam (voucher: *Wong* WKM 2096 — BRUN, K, L, SING) have yielded more information on the growth habit, habitat requirements and general distribution which were hitherto poorly understood. These are discussed in the present paper.

Growth Habit

*S. terminale* is a small clambering bamboo occurring as clumps, each with 3–10 culms of 8–15 mm diameter. As in other species of the genus, the culms are white appressed-hairy on the internodes, slightly white-waxy, and arise from a sympodially constructed rhizome system. This species differs from other Malayan and Bornean *Schizostachyum* species in having culms which clamber over the surrounding vegetation. This clambering habit is possible through elongation of the primary branch at several nodes, which reiterates the original culm in morphology and habit, and which
in turn produces further such branches of a higher order. This system of reiterating branches allows the bamboo to clamber and entangle with nearby tree branches, a situation akin to that in *Dinochloa* bamboos (Wong, 1986), except that the culms do not twine.

Occasionally the base of the reiterating branch is thickened and produces roots as does a rhizome, and it is conceivable that when such parts come into contact with the ground, vegetative reproduction is facilitated. In other *Schizostachyum* species, the branch complement also arises from a single primary branch axis at the node, but when fully developed all branches at a node are of subequal size and a dominant is not easily distinguishable; however, development of “aerial rhizomes” (arising from the rooting of thickened branch bases) is also known in other species such as *S. latifolium* Gamble, especially when the culm tip is damaged (Wong, 1990). In *S. terminale*, the branch complement consists of a primary axis which frequently remains dormant initially but later develops to reiterate the culm, and several small leafy branches arising from the basal nodes of this primary axis. In addition, reiterative branch elongation

---

Fig. 1. Flowering leafy branch of *Schizostachyum terminale.*
occurs even without any damage to the original culm. In this way, thickets or curtains of this bamboo arise.

**Habitat Conditions**

In Sabah, *S. terminale* grows on the seasonally flooded banks of the Kinabatangan River near Tanjung Bulat, at about 15 m above sea level (Fig. 2). Thickets of it drape the vegetation in riverbank forest dominated by the trees *Octomeles sumatrana* and *Terminalia copelandii*. From the mud markings on the vegetation, this forest can be flooded some 2–3 m high. Inundation can last up to several weeks at a time (C.F. Tan, pers. comm.)

In Brunei, *S. terminale* is abundant along low wide stretches of the Belait River (Fig. 3) but above the mangrove or nipah (*Nypa fruticans*) zones, at 15–20 m above sea level. There it grows in the seasonally inundated swampy banks and alluvial flats together with *Syzygium spp.*, and the common riverbank rattan *Daemonorops fissa*. The waters can rise some 2 m higher during heavy rains, especially around May-June and September–November. The species is absent in forest away from such seasonally inundated riverine zones.

Bamboos are generally known to occur only away from swamp habitats, but *S. terminale* is a clear exception. Its distribution only in the habitats recorded above suggests its restriction to swampy ground and a tolerance of prolonged inundation. Elsewhere, *Chusquea paludicola* Clark is known to inhabit highland *Sphagnum* peat bogs above 2,000 m altitude in Costa Rica (X. Londono, pers. comm.; Clark, 1986), although in those situations such prolonged severe inundation does not occur.

Fig. 2. Undergrowth thickets of *Schizostachyum terminale* along the flood-prone bank of the Kinabatangan River, Sabah.
Fig. 3. Tangles of *Schizostachyum terminale* on the bank of the Belait River, Brunei.

**Acknowledgements**

This account is based on part of the research carried out for a Ph.D. programme under the supervision of A.L. Lim at the University of Malaya. I am grateful to the curators of the herbaria at Kepong and the Singapore Botanic Gardens for permission to consult the collections there, and to P.S. Shim and C.F. Tan for the opportunity to visit the Kinabatangan River in Sabah.

**References**


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*The Freshwater Swamp-Forest of S. Johore and Singapore* by E.J.H. Corner
(Gard. Bull. Sing. Suppl. 1) $35


3. A Revised Flora of Malaya.
   (c) Vol. 3, Grasses, by H.B. Gilliland, $30 (1971).


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