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# *SANDAKANIA*

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***SANDAKANIA***

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*Racemobambos pairinii*  
(Gramineae : Bambusoideae),  
a new species of bamboo from Sabah,  
Malaysia

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**Summary.** *Racemobambos pairinii* is described as a new species, so far collected only from a few localities on ultramafic soil in the central and eastern parts of Sabah, Malaysia, in north Borneo. Notes on differences from other species of the genus, and on its flowering, distribution and conservation, are provided.

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The genus *Racemobambos* was established by Holttum (1956), and was typified by *R. gibbsiae* (Stapf) Holtt. which occurs on Mt Kinabalu, Sabah. Thus far, sixteen species have been recognized in the genus (Holttum 1956; Dransfield 1980, 1983, pers. comm. 1992). Nearly all the species have an elegant habit, with culms that are pencil-thin or only slightly thicker. The majority are highly localized and, thus, rare species, and mostly occur at upper altitudes on mountains.

Of the sixteen species that have been described, six occur in Borneo: *R. gibbsiae*, *R. glabra* Holtt., *R. hepburnii* Dransf., *R. hirsuta* Holtt., *R. kutaiensis* Dransf. and *R. rigidifolia* Holtt. Except for *R. kutaiensis*, recorded with only one collection from Kalimantan, these are also found in Sabah (Dransfield 1983; Kulip 1992). In her revision of the genus, Dransfield (1983) included three specimens (SD 779, SD 780, SD 786) under *R. hirsuta*. With more material from a recent collection of the taxon conspecific with these specimens, as well as of typical *R. hirsuta*, it is now possible to differentiate the two taxa as distinct species. The new species and *R. hirsuta* were both discovered on Mt. Nicola in the Danum Valley Conservation Area in the eastern part of Sabah, during an expedition there in February, 1992. Their occurrence at the same locality permitted easy comparison of the living plants and fresh flowering material.

## Distinguishing characters for the new species

The elegant new species, named *Racemobambos pairinii* below in honour of Sabah's Chief Minister, Datuk Sri Joseph Pairin Kitingan, belongs to a group of species characterized by spikelets with two glumes each: *R. hirsuta* and *R. rigidifolia* from Borneo, and *R. setifera* Holtt. from Peninsular Malaysia. *R. rigidifolia* and *R. setifera* have glabrous spikelets and are thus different from *R. hirsuta* and *R. pairinii*, which have hairy spikelets. The latter two can be rapidly distinguished in the field because *R. hirsuta* has bristly auricles on the culm and leaf sheaths, whereas *R. pairinii* has glabrous auricles on the sheaths. Table 1 lists the differences between *R. hirsuta* and *R. pairinii*.

**TABLE 1.** Morphological differences between *Racemobambos hirsuta* and *R. pairinii*.

<i>R. hirsuta</i>	<i>R. pairinii</i>
Culm-sheath auricles small, lobe-like and bristly	Culm-sheath auricles nil, glabrous
Leaf-sheath auricles small, bristly	Leaf-sheath auricles nil, glabrous
Leaf-sheath ligules inconspicuous	Leaf-sheath ligules elongate, obtuse
Spikelets held closely to the main inflorescence axis	Spikelets conspicuously curved away from the main inflorescence axis
Lemmas shorter (5-8 mm long), hardly overlapping along the spikelet	Lemmas longer (10-16 mm long), overlapping along the spikelet
Paleae longer than lemmas	Paleae as long as or shorter than lemmas
Palea 4-veined on the back between keels, and 4-veined on each wing	Palea 2-veined on the back between keels, and 3-veined on each wing
Cilia on the palea keels 0.2-0.3 mm long	Cilia on the palea keels hardly 0.1 mm long
Mature anthers only 4-5 mm long	Mature anthers 6-8 mm long

## The new species described

**Racemobambos pairinii**, sp. nov. *R. hirsuta* Holtt. affinis, sed lemmatibus longioribus (10-16 mm) palea aequantibus vel superantibus, antheris longioribus (6-8 mm), auriculis vaginae culmorum et foliorum nullis, ligulis foliorum longioribus obtusus differt. *Typus*: Wong et al. WKM 2106 (holotypus SAN).

Slender bamboo in clumps of open habit, with culms clambering or flopping over surrounding plants, to 4 m high. Rhizomes sympodial, slender with elongated necks 1-5 cm long. Culms 5-9 mm diameter, to 4-5 m long, green; internodes 30-40 cm long, glabrous, slightly white-waxy below the nodes. Branch complement with a dominant middle branch which grows reiteratively like the culm itself, and 1-2 smaller secondary branches from its base on each side.

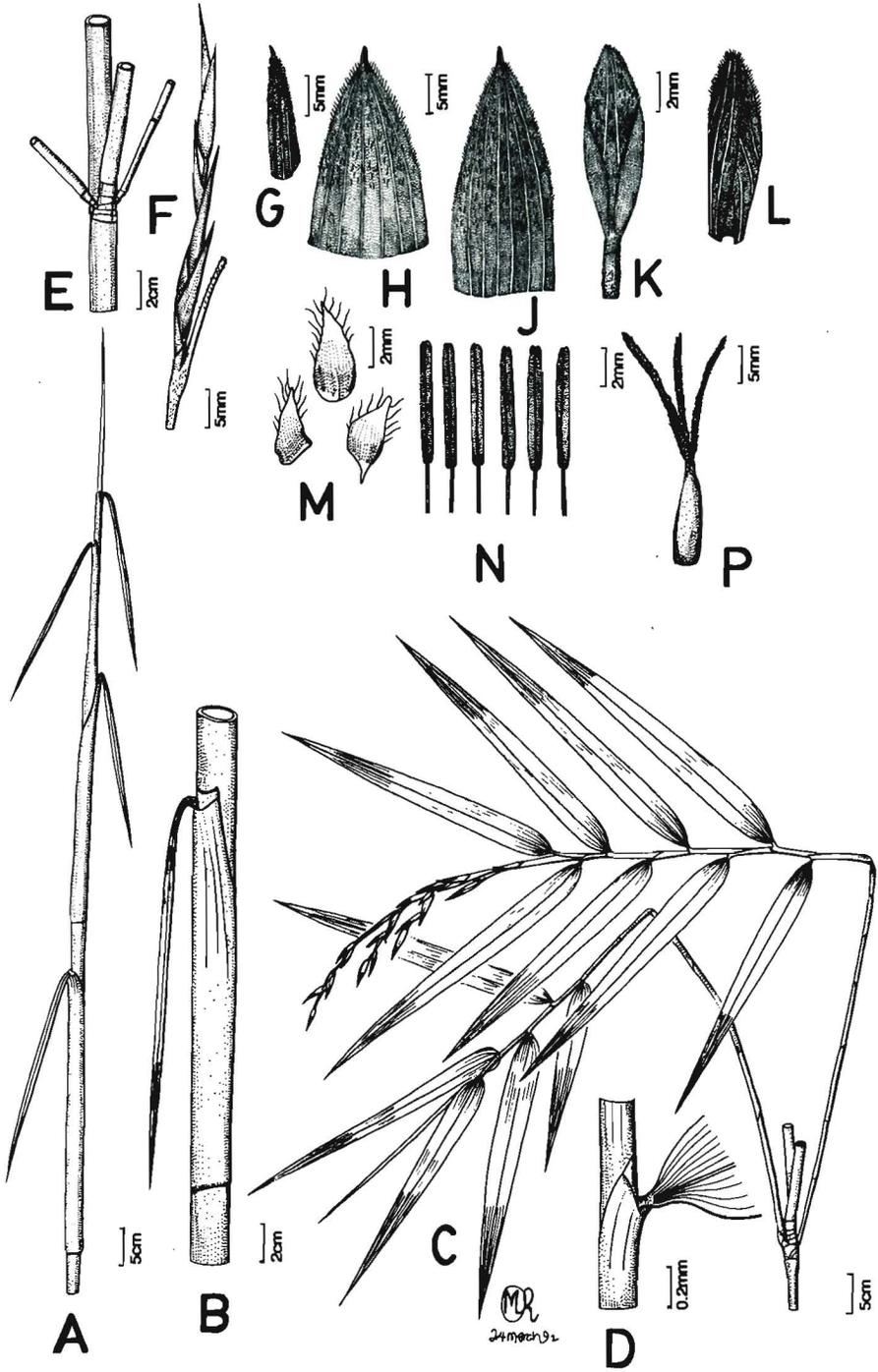
Culm-sheaths 5-16 cm long, green, glabrous, slightly white-waxy; auricles not developed; ligule a subentire rim 0.5-1 mm high; blades green, linear, 2-10 cm long, 2-4 mm wide, spreading to reflexed. Leaf blades 6-22(-30) cm long, 0.8-2.0(-3.4) cm wide; auricles not developed; ligule elongate and obtuse, 1-2(-4) mm long, glabrous.

Inflorescence semelauctant, 8-11 cm long when fully developed, the spikelets individually stalked and arranged alternately along the main axis terminating leafy branchlets; main axis short-hairy all over.

Spikelets 2.5-4.5 cm long when mature, conspicuously outcurved from the main inflorescence axis, with 2 glumes, 4-5 perfect flowers and a terminal vestigial flower (usually represented by a tightly rolled lemma), green to purplish green; rachilla internodes 3-6 mm long, shortest at the base of the spikelet, minutely hairy; lower glume narrow, small, 4-8 mm long, asymmetric, the broader wing thin and 1-veined, the narrower thick, short-hairy on the margin and median vein; upper glume 10-13 mm long, mucronate, chartaceous, short-hairy on the margin and back near the apex; lemmae 7-16 mm long, mucronate, coriaceous, longest at the base of the spikelet, overlapping along the spikelet, 6-7-veined, short-hairy on the margin and back; paleae 7-8 mm long, membranous, apex blunt, 2-keeled (keels closest at the base), 2-veined on the back, 3-veined on each wing, minutely ciliolate on the keels (cilia hardly 0.1 mm long), minutely hairy on the back; lodicules 3, basally thickened, apically membranous, ciliate on the margin, the anterior c. 3 mm long and 1.5-2 mm wide, the posterior two 1.5-2 mm long and c. 1 mm wide; stamens 6, filaments free, anthers 6-8 mm long when mature and fully extruded, connective not prolonged beyond apex; ovary narrowly cylindrical to narrowly ovoid, 0.5-1.5 mm long, glabrous; stigmas 3, 3-6 mm long.

The species is illustrated in Fig. 1.

**SPECIMENS EXAMINED – BORNEO. SABAH:** Telupid, road to Karamuak Valley, 50m, flowering, 24 Oct. 1979, S. Dransfield SD 779 (BO, K, KEP, SAN, SAR); vegetative, 24 Oct. 1979, SD 780 (K, SAN). Lahad Datu, Bukit Silam, 100 m, vegetative, 1 Nov. 1979, S. Dransfield SD 786 (K, SAN); Danum Valley Conservation Area, Mt Nicola, 530-800 m, flowering, 24 Feb. 1992, Wong, Kulip, Radin, Madani, Berhaman, Molubin and Tokilip WKM 2106 (holotype SAN; isotypes K, KEP, L, SAR, SING).



**Fig. 1.** *Racemobambos pairinii*. A, culm shoot; B, culm sheath; C, leafy and flowering branches; D, detail, leaf-sheath ligule; E, branch complement; F, spikelet; G, lower glume; H, upper glume; J, lemma; K, palea, back view; L, palea, front view; M, lodicule complement; N, stamens; P, gynoecium. All from WKM 2106.

## Flowering, distribution and prospects for conservation

At the end of February, 1992, many clumps of *R. pairinii* on Mt Nicola were beginning to flower, apparently following in the wake of the gregarious flowering of the entire *R. hirsuta* population around the summit at 870-910 m. Previously, only the species *R. gibbsiae* and *R. hepburnii* on Mt Kinabalu have been definitely documented as flowering gregariously (Wong, Chan and Phillipps 1988), a habit that intersperses several to many years in between flowering episodes. A general flowering of any *Racemobambos* population would appear to be a rare event. On Mt Nicola seedlings were observed in fully flowering stands of *R. hirsuta* at the summit, but apparently had not yet become common in stands of *R. pairinii* that were just coming into flower

*R. pairinii* appears to be restricted to small-crown forests on ultramafic substrates and highly localised in distribution. *R. pairinii* has been found only at 50-800 m, whereas *R. hirsuta* has been documented at 800-1600 m where they occur together in one locality, so there may be some kind of altitudinal segregation of the two species. This is reminiscent of *R. gibbsiae* and *R. hepburnii*, which show similar altitudinal segregation on Mt. Kinabalu (Dransfield 1983).

The survival of rare species localised on specialised substrates, such as *R. hirsuta* and *R. pairinii*, needs to be carefully considered in conservation terms. They epitomize many rare and unique plants of the rain forest which require an intact undisturbed forest framework to survive. As forest habitats become increasingly fragmented by timber harvesting it will be necessary to preserve sizeable tracts of rain forest, particular on specialised sites such as those on ultramafic substrates, to conserve these special facets of the flora.

## ACKNOWLEDGEMENTS

I thank S. Dransfield, Royal Botanic Gardens, Kew, for discussion and advice; J. Dransfield from the same institution for correcting the Latin diagnosis; C. Marsh and J. and E. Gasis of the Sabah Foundation for organizing the Mt Nicola expedition; and Datuk Miller Munang (Sabah's Director of Forestry) and Y.F. Lee (Head, Forest Research Centre, Sepilok) for encouragement in studies of bamboos. The drawing of the new species here is the work of Martin Molubin of the Herbarium, Forest Research Centre, Sepilok.

## REFERENCES

- Dransfield, S. (1980) Three new Malesian species of Gramineae. *Reinwardtia* 9(4): 385-392.
- Dransfield, S. (1983) The genus *Racemobambos* (Gramineae: Bambusoideae). *Kew Bulletin* 37 (4): 661-679.

- Holttum, R. E. (1956) *Racemobambos*, a new genus of bamboos. Gardens' Bulletin, Singapore 15: 267-273.
- Kulip, J. (1992) *Racemobambos glabra*, a new record for Sabah. Sandakania. 1: 7-9.
- Wong, K. M., C.L. Chan and A. Phillipps (1988) The gregarious flowering of Miss Gibbs' bamboo (*Racemobambos gibbsiae*) and Hepburn's bamboo (*R. hepburnii*) on Mount Kinabalu, Sabah. Sabah Society Journal 8(4): 466-474.

***Racemobambos glabra*,  
a new record for  
Sabah, Malaysia**

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**Summary.** The rare montane bamboo *Racemobambos glabra* Holtt., is recorded for the first time for Sabah with a collection from the Meligan Forest Reserve.

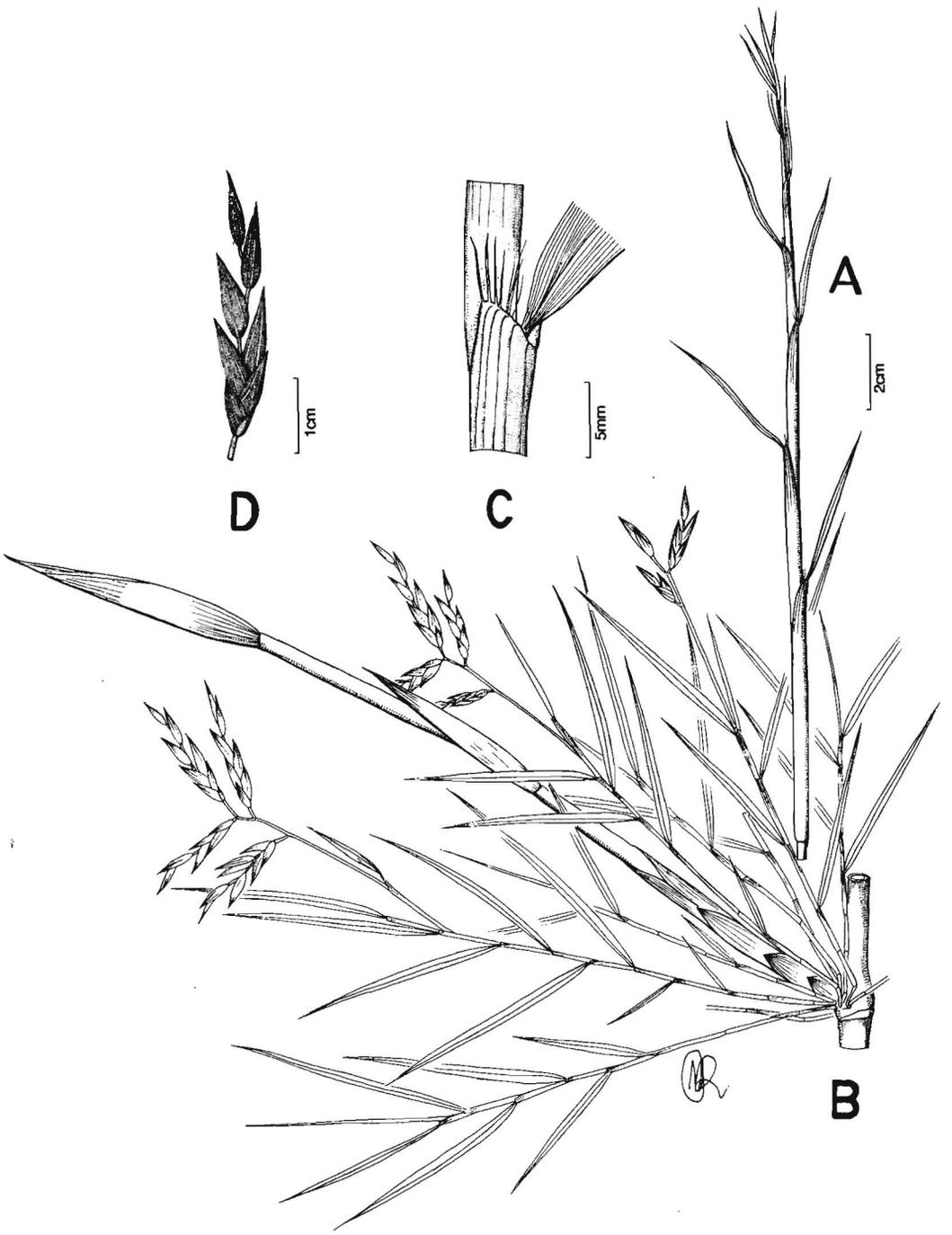
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*Racemobambos glabra* Holtt. is a rare species of bamboo, endemic to Borneo and previously known only from a few montane localities in Sarawak (Gunung Temabok on the upper Baram River, Gunung Mulu, the Melinau Paku area and the Dulit Ridge) and Brunei (the Pagon Periok ridge in the Ulu Temburung area) (Dransfield 1983). Two more specimens have been subsequently collected on the Retak ridge in the Ulu Temburung area of Brunei (Wong WKM 421 and 773) (BRUN, K, L, SAN, SING) in 1988 and 1989.

This species has now been found in Sabah (Kulip SAN 132701), collected in July, 1991 in the Meligan Forest Reserve (also a Virgin Jungle Reserve), Sipitang district, in the southwestern part of Sabah. The collection was made at an altitude of about 1500m, in montane forest on sandstone. The earlier collections were also made from montane forest sites on sandstone at 1300-2200m. At the Meligan Forest Reserve locality where this species was collected, the vegetation is much dominated by *Agathis* and *Lithocarpus* on a steep sandstone ridge. Here the forest is about 25m tall, with many large-crowned trees.

It appears that there has been very scanty description of this species so far (Holttum 1956; Dransfield 1983); especially, culm sheaths, which are often useful for identification of bamboos, have not been described. The inflorescence and flower have been described by Holttum (1956). Here I provide a description of the vegetative parts based on the Brunei and Meligan (Sabah) collections.

Culms 3-7 mm diameter, to 4-5 m long, light green; internodes 12-26 cm long, glabrous, white-waxy all over. Branch complement with a dominant middle branch which grows reiteratively like the culm itself and 15-52 smaller secondary branches from its base.



**Fig. 1.** *Racemobambos glabra*. A, young culm shoot; B, branch complement; C, detail, leaf sheath; D, spikelet. A,C from SAN 132701; B,D from WKM 773.

Culm-sheaths to 9.1 cm long, 1.5 cm wide, glabrous, light green; auricles not developed; ligule a subentire rim 0.5-1 mm high bearing whitish-brown bristles up to 2.5 mm tall; blades light green, linear, 4.2-4.6 cm long, 1.5-2.5 mm wide, erect. Leaf blades 4-12(-14.8) cm long, 0.2-0.3(-0.4) cm wide, glabrous; leaf sheaths 2-3.4(-4.2) cm long; auricles not developed; ligule a short rim 1-2 mm long with pale bristles up to 9 mm long.

The following specimens of *R. glabra* were examined:

BORNEO. SABAH: Meligan Forest Reserve, 10 July 1991, vegetative, *Kulip* SAN 132701 (SAN). BRUNEI: Temburung, north ridge of Bukit Retak, 17 Sept. 1988, flowering, *Wong* WKM 421 (BRUN, K, L, SAN, SING), 28 Jan. 1989, flowering, *Wong* WKM 773 (BRUN, K, L, SAN, SING).

The Meligan record represents the most northerly distribution of the species in Borneo thus far known.

### ACKNOWLEDGEMENTS

I would like to thank Mr K.M. Wong and Dr Soejatmi Dransfield who kindly confirmed the identification of the plants, Mr Leopold Madani and Mr Joseph Radin for assistance in collecting at the Meligan Forest Reserve, Sipitang.

### REFERENCES

- Dransfield, S. (1983). The genus *Racemobambos* (Gramineae-Bambusoideae). Kew Bulletin 37: 661-679.
- Holttum, R.E. (1956). *Racemobambos* a new genus of bamboos. Gardens' Bulletin, Sing. 15: 267-273.

## Two New Fern Records for Borneo

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**Summary.** *Lygodium japonicum* and *Sphenomeris retusa* are reported for the first time in Borneo.

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Subsequent to the revision of Malesian Schizaeaceae by Holttum (1959), *Lygodium japonicum* (Thunb.) Sw. was found in Sandakan, Sabah, Malaysian Borneo, in 1975. *Sphenomeris retusa* (Cav.) Maxon was noted by Kramer (1971) as having a distribution from the Philippines and Celebes, south-eastward to the Solomon Islands, but has since also been found in Sabah. Here, some notes are provided.

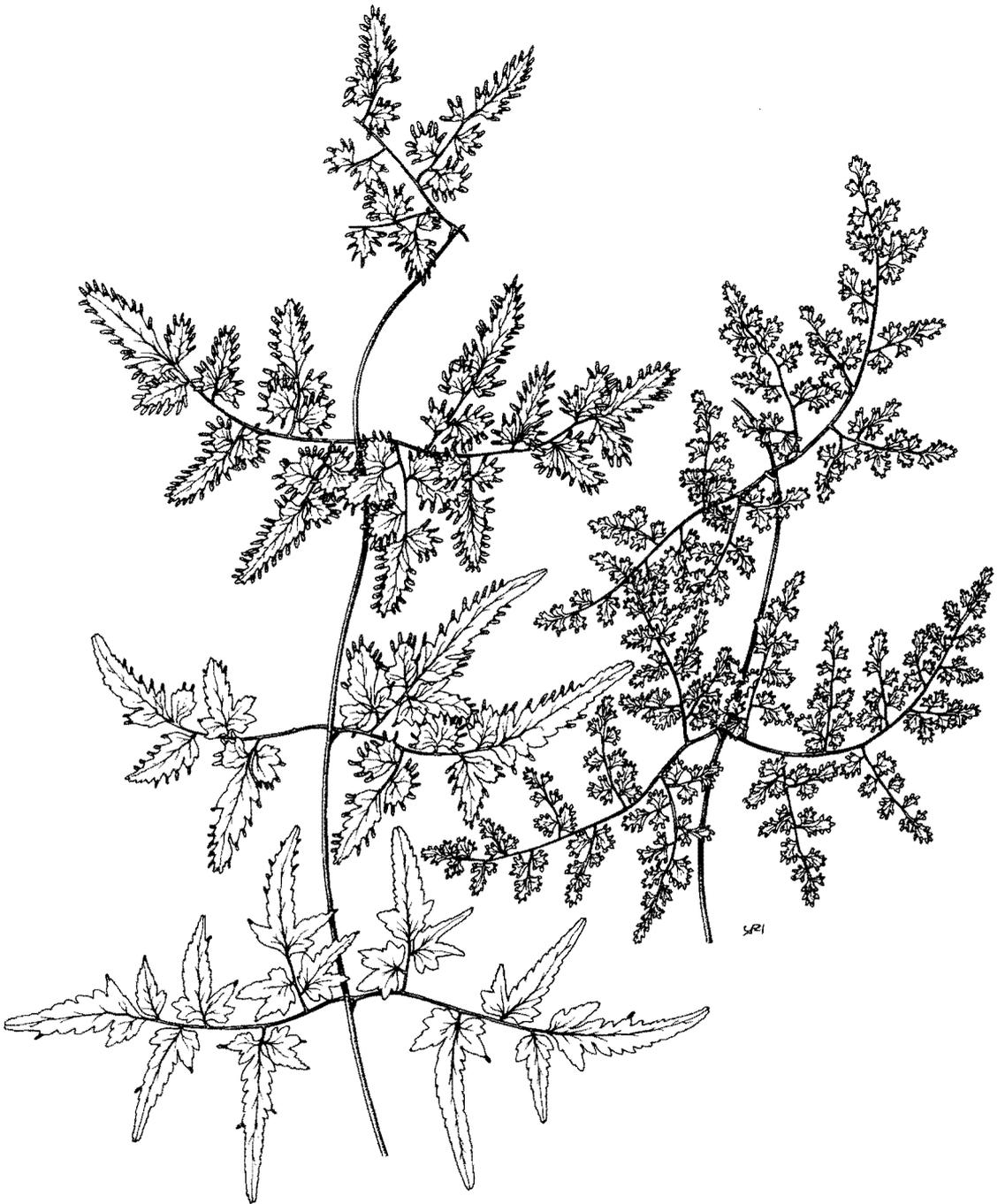
1. ***Lygodium japonicum*** (Thunb.) Sw. in Schrader, J. Bot. 1800, pt 2 (1801) 106. (Fig.1)

DISTRIBUTION. Sri Lanka, from the Himalayas to N. China, Korea, Japan and southwards to Thailand and Indochina; in Malesia: Banka, Java, Borneo, Sulawesi, Philippines, Moluccas, Lesser Sunda Islands and New Guinea.

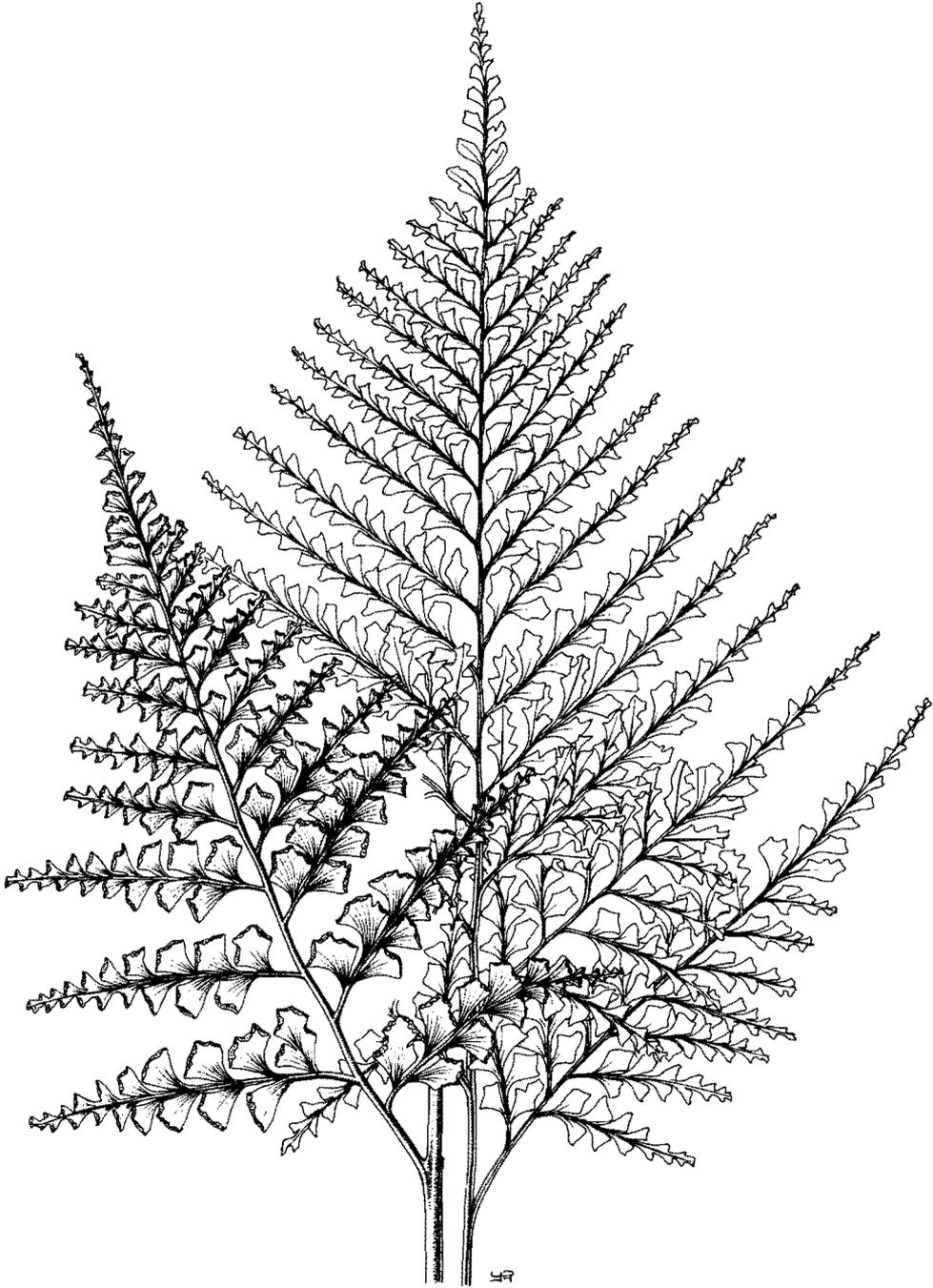
In Sabah, Borneo, it was first found only around the hill where the previous Forest Department headquarters was situated in Sandakan Town (*Shim* SAN 79622 & 81654) but appears to have spread to nearby Sim Sim in recent years. It was probably introduced by accident from the southern Philippines some time this century as it has not been found elsewhere in Sabah.

2. ***Sphenomeris retusa*** (Cav.) Maxon, J. Wash. Ac. Sc. 3(1913) 144. (Fig.2)

DISTRIBUTION. Malesia: Borneo, Sulawesi, Philippines, Moluccas, New Guinea, Admiralty Island, Bismarck Arch., Solomon Island. In Sabah, it was first collected (*Shim* SAN 75417) near Telupid. Subsequently, other collections have been made, in the Danum Valley Conservation Area, Ulu Segama (*Parris* 10770) and in the Ulu Sungai Lohan, Ranau (*Amin & Jarus* SAN 121444).



**Fig. 1.** *Lygodium japonicum*: fertile portions of leaves (from SAN 79622).



**Fig. 2.** *Sphenomeris retusa*: fertile leaves (from SAN 75417).

ECOLOGY. In Sabah, it is always found on ultrabasic rocks or soils derived from ultrabasic rocks. On road cuts, it is normally 0.5 to 1 m high but on stream banks where the soil is deeper, plants 2.5 m high have been observed.

#### ACKNOWLEDGEMENTS

The late Professor R.E. Holttum kindly confirmed the identity of *Lygodium japonicum*. Madam Yap Pak Hau drew Figs. 1 and 2.

#### REFERENCES

- Holttum, R.E. (1959) Schizaeaceae. Flora Malesiana, Ser. II Vol. I.1 : 37-61.
- Kramer, K.U. (1971) *Lindsaea*-group. Flora Malesiana, Ser. II Vol. I.3 : 177-254.

**The Poring Puzzle:  
*Gigantochloa levis* and a new species of  
*Gigantochloa* (Gramineae : Bambusoideae)  
from Peninsular Malaysia**

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**Summary.** Two distinct large bamboos, from Sabah and Peninsular Malaysia, have previously both been identified as *Gigantochloa levis* (Blanco) Merr., the type of which is from the Philippines. A comparison of flowering material against the type has revealed that the Sabah taxon, also cultivated elsewhere in Borneo, is correctly identified whereas the Peninsular Malaysian taxon is a new species, here named *G. thoi*.

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*Gigantochloa levis* is a name which has been applied to big bamboos, thought to represent one and the same species, from Peninsular Malaysia (Holttum 1958; Widjaja 1987), Borneo and the Philippines (Widjaja 1987), which yields good edible young shoots popular with local people in each area. The Peninsular Malaysian taxon is commonly called Buloh (bamboo) betung, in common with the other big bamboo popularly cultivated for its edible shoots, *Dendrocalamus asper* (Schantz) Backer ex Heyne. The Philippine taxon is commonly called Boho in the Philippines and the Bornean taxon, probably most widely encountered in Sabah, is popularly known as Poring (in the Dusun/Kadazan language) although in Brunei the same bamboo is called Buloh betung in the Brunei and Dusun languages.

When Poring was studied in the field in 1986 it became evident that this bamboo was in vegetative characters different from the Peninsular Malaysian taxon. The Peninsular Malaysian "G. levis" has white-waxy culms with only scattered dark hairs near the upper part of internodes, whereas the Poring bamboo from Sabah does not have any wax evident even on young culms, and the basal internodes have a dense covering of coarse dark brown hairs. Poring in Sabah is a common village bamboo, widely known for its edible shoots and useful large culms, and in many places there grows well, sometimes even dominating the landscape where there have been abandoned cultivated fields. The necessity of having an accurate name for the Poring bamboo is underscored by its being so much used in rural circles and the great potential attached to it for more systematic cultivation and exploitation. The identity of the Poring bamboo can only be firmly established by comparison with the type of *G. levis* from the Philippines, the taxon in Peninsular Malaysia and other related species of the genus.

## The identity of the Poring bamboo

The Poring bamboo from Sabah (and its conspecifics from Brunei and Sarawak) also has clear differences in floral morphology from the Peninsular Malaysian taxon identified by Holttum (1958) as "*G. levis*". Although the spikelets are superficially similar in both taxa (being similar in size, 4-5-flowered each and generally short-hairy); the Poring bamboo is distinct in having three lodicules in its flower, paleas with 4-5 veins on their back (between the keels) and 2 veins on each wing, and anther apical cusps with short-triangular spines (Fig. 1). The Peninsular Malaysian taxon has no lodicules in its flower, paleas with 2-4 veins on their back and 1-2 veins on each wing, and anther apical cusps with long spines (Fig. 2). The two taxa thus have a number of vegetative and floral differences and are distinct species (Table 1).

I have examined spikelets of the type of *G. levis* (Merrill: Species Blancoanae no. 310 : D.L. Topping, s. n., March 1914, Luzon, Tayabas Province) at Kew (holotype), Bogor and Leiden (isotypes), and find the spikelet and flower structure to be the same in these specimens as in the Poring bamboo (Fig.1). The Poring bamboo of Sabah is thus correctly identified as *G. levis* (Blanco) Merr.

**Table 1.** A comparison of two taxa previously identified as *G. levis*, from Sabah and Peninsular Malaysia.

Poring bamboo, Sabah (typical <i>G. levis</i> )	Peninsular Malaysian taxon (new species, <i>G. thoi</i> )
Culms not white-waxy	Culms white-waxy
Basal culm internodes densely dark-hairy all over	Basal culm internodes scantily dark-hairy at the upper part
Flowers with 3 lodicules	Lodicules absent
Palea 4-5 veined on back, 2-veined on each wing	Palea 2-4 veined on back, 1-2-veined on each wing
Anther apical cusps with short triangular spines hardly 0.05 mm long	Anther apical cusps with long spines c. 0.1 mm long

Merrill (1916) noted that *G. levis* is "apparently very closely allied to and possibly identical with *G. robusta* Kurz" but that species differs in having glumes and lemmas fringed with dark brown hairs, no lodicules and a notched palea apex. In *G. levis* the glumes and lemmas are fringed with pale hairs, there are three lodicules in the flower, and palea apices are acuminate. *G. achmadii* Widjaja, described from Sumatra (Widjaja 1987) and somewhat superficially similar, also differs from *G. levis* by its culm internodes which have

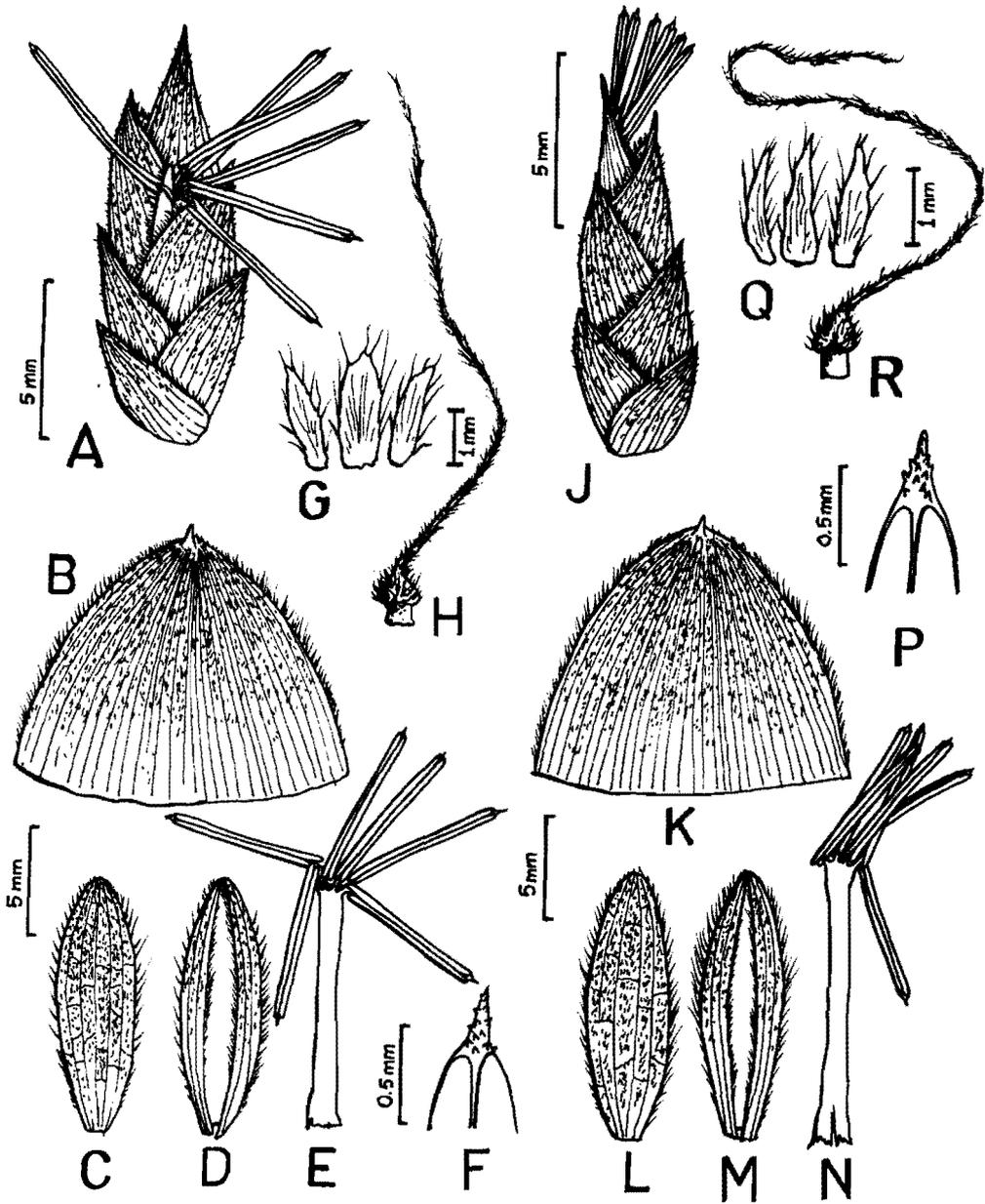


Fig. 1. Spikelets and flower parts of *Gigantochloa levis*, from Wong s.n. 27 Feb. 1986, Sabah, Ranau (A-H) and the type, Merrill: *Species Blancoanae* no. 310 from the Philippines (J-R). A, J, spikelets; B, K, lemmas; C, L, paleas (back view); D, M, paleas (front view); E, N, androecia; F, P, anther apices; G, Q, lodicule complements; H, R, gynoecia.

whitish hairs at the upper part, the culm-sheath auricles which are raised at the outer ends and slightly curved outward, and the dark-fringed glumes and lemmas. In *G. levis* the culm internode hairs are dark, the culm-sheath auricles are broad lobes which are not raised at the outer ends, and the glumes and lemmas are pale-fringed.

The following specimens of *G. levis* were examined:

**PHILIPPINES. LUZON** : Tayabas Province, March 1914, flowering, *D.L. Topping* (Merrill: Species Blancoanae No. 310) (holotype K; isotypes BO, L). Bulacan Province, Baliuag, 9 Jan. 1910, flowering, *Merrill & Robinson* 958 (L); Aug. 1910, flowering, *Robinson* Bureau of Science no. 11838 (L). Laguna Province, Mt Makiling, 11 Dec. 1955, flowering, *Sulit* Phil. Nat. Herb. no. 34084 (L).

**BORNEO. SABAH** : Ranau, Kiau Village, 27 Aug. 1979, flowering, *S. Dransfield* SD 717 (BO, K, SAN, SAR); Ranau Village, 29 Aug. 1979, vegetative, *S. Dransfield* SD 719 (BO, K, SAN); 27 Feb. 1986, flowering, *K.M. Wong* s.n. (SAN). Tambunan, 11 Sept. 1979, flowering, *S. Dransfield* SD 738 (K, SAN). Keningau, mile 8 Kimanis - Keningau road, 20 June 1978, flowering, *Tiong, Dewol and Nordin* SAN 85900 (SAN). Papar, Kampong Palawan, 28 May 1962, flowering, *Mikil* SAN 30300 (K, L, SAN). **SARAWAK** : 1st Division, road to Padawan, 11 Apr. 1981, flowering, *S. Dransfield* SD 792 (K, KEP, L, SAN, SAR, US). **BRUNEI** : Tutong, Lamunin, Biong Layong, 7 Apr. 1988, flowering, *K.M. Wong* WKM 348 (BRUN, K, L, SAN, SING).

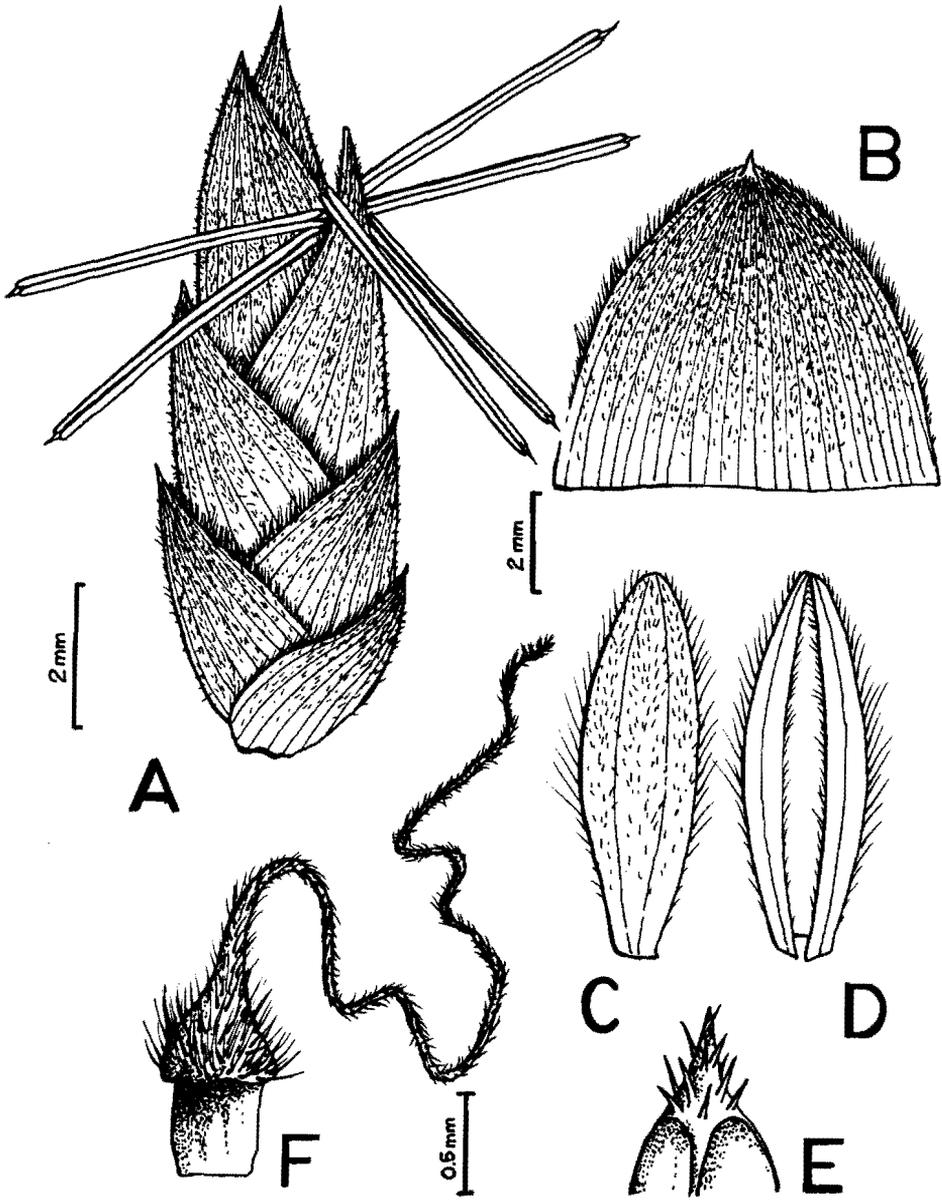
#### **A new species from Peninsular Malaysia**

The Peninsular Malaysian taxon has therefore been misidentified with *G. levis* by Holttum (1958) and Widjaja (1987). It is a distinct, as yet undescribed species which can be shown to differ from other *Gigantochloa* species which, like it, have large bristly culm-sheath auricles, flowers without lodicules and yellow anthers (in contrast to maroon anthers, also found in the genus). Thus *G. atter* (Hassk.) Kurz is different by its glabrous lower leaf surfaces, non-waxy culms and dark-fringed glumes and lemmas; *G. atrovioleacea* Widjaja by its glabrous lower leaf surfaces, purplish culms, short culm-sheath ligules (to only 2 mm high) and 4-veined palea backs; and *G. robusta* by its non-waxy culms, dark-fringed glumes and lemmas, and notched palea apices. The new species is distinct by its hairy lower leaf surfaces, white-waxy culms, long-bristly ligules to over 1 cm high, pale-fringed glumes and lemmas, and 2-4-veined palea backs (Fig. 2).

The species is here named *Gigantochloa thoi*, in memory of the late Dr. Tho Yow Pong, entomologist and conservationist, who had greatly encouraged me in my work.

***Gigantochloa thoi* K.M. Wong sp. nov.** *G. levis* (Blanco) Merr. affinis sed culmi internodiis ceraceis spicula lodiculis nullis paleis intra costulos 2-4-venosis extus 1-2-venosis antheris apice longe-spinosis differt. Typus : Wong FRI 28972, Selangor, opposite Templar Park, in compound of a stable (holotypus KEP; isotypus K, L, SING).

Big clumped bamboo, to 16 m tall; rhizomes thick, subfusiform and sympodial in growth. Culms to 12 cm diameter, green, white-waxy, scantily dark-brown hairy at the upper part of



**Fig. 2.** *Gigantochloa thoi*, spikelet and flower parts. A, spikelet with 3 glumes at the base; B, lemma; C, palea (back view); D, palea (front view); E, anther apex; F, gynoecium. From FRI 28973.

internodes. Branch complement of a dominant primary branch, with (usually) one subdominant secondary branch from its base on each side, and several lesser leafy branchlets from the base of the secondary branches.

Culm sheaths pale to medium green, with dark brown hairs on the back; auricles large lobes to 10 mm high with bristles 10-18 mm long on the margin; ligule 7-22 mm high bearing lacerations with bristle-like tips 5-18 mm long; blade dark purple on lower sheaths, green on upper ones, spreading to reflexed. Leaves softly pale-hairy on the lower surface, 2-6 cm wide, 8-32 cm long; auricles small lobes, fine-bristly on the margin (bristles to 4 mm long); ligules 0.5-1.5 mm long, shortly toothed on the margin.

Inflorescence main axis with pale short-hairy internodes. Pseudospikelets 10-15 mm long, each consisting of 2-3 gemmiferous bracts, 2-3 glumes, 4-5 flowers and a terminal vestigial flower usually represented by an empty lemma; glumes 3-5.5 mm long, acuminate, pale ciliate on the margin, pale short-hairy all over the back, many-veined; lemmas 6.5-10 mm long, shortly mucronate, pale ciliate on the margin, pale short-hairy all over the back, 23-27-veined; paleas as long as lemmas, apex acuminate, keels with cilia to 0.4 mm long, scantily short-hairy on the back between keels, glabrescent on the wings, 2-4-veined between keels, 1-2-veined on each wing; lodicules nil; staminal tube 7-8 mm long, anthers 5.5-6 mm long, yellow, apical cusp c. 0.5 mm long with long spines 0.1 mm long; ovary c. 1 mm long, subcylindric with a thickened dense-ciliate apex; style c. 7 mm long, hairy; stigma one.

**SPECIMENS EXAMINED. PENINSULAR MALAYSIA:** Selangor, opposite Templar Park, in compound of stable, 3 Oct. 1980, flowering, *K.M. Wong* FRI 28972 (holotype KEP, isotypes K, L, SING), beside stream, 3 Oct. 1980, flowering, *K.M. Wong* FRI 28973 (A, K, KEP, L, SING); Kepong, 28 Aug. 1930, flowering, *Symington* KEP 23138 (KEP, SING), on grounds of the FRI, 16 Oct. 1980, flowering, *K.M. Wong* FRI 28982 (K, KEP, SING), Bukit Lagong path behind house FD 15, 9 Sept. 1969, flowering, *Whitmore* FRI 12567 (KEP), Jalan Development, in compound of shop selling pet fishes, 6 Sept. 1980, flowering, *K.M. Wong* FRI 28958 (A, K, KEP, L, SING). Johore, Kota Tinggi, 5 Nov. 1948, flowering, *le Doux* s.n. (SING). Singapore, Pasir Panjang 6.5 mile, 9 Dec. 1934, flowering, *Holtum* s.n. (SING), cult. in Singapore Botanic Gardens, 26 Aug. 1937, flowering, *Pestana* s.n. (K, SING).

I have also observed this species in the states of Kedah, Kelantan, Penang, Perak, Pahang and Malacca in Peninsular Malaysia. It is known only as a cultivated species, of unknown origin. *G. thoi* is usually planted as solitary household clumps in villages and rural areas, and sometimes as small plots. In 1983 I visited a small holding of planted *G. thoi* in Kepong, along the road to the Forest Research Institute. The owner, who was tending about 4.5 ha of this species and marketing the fresh shoots to the Central Market in Kuala Lumpur, informed me that his lot dated back to before 1957. He observed peaks in shoot yield around July - August of each year, with a production of up to 1000 katties (c. 600 kg) per week; off-peak production was estimated at 200-400 katties (c. 1200-2400 kg) per week. He planted clumps at about 3.5 m spacing on undulating to flat ground but did not divulge his fertilizer application. The farm lot does not exist any more, as the site has been given over to housing development.

## ACKNOWLEDGEMENTS

I thank the curators and keepers of the Bogor, Kew, Kepong, Leiden, Sandakan and Singapore herbaria for facilitating consultation of specimens in their care. Dr. J. Dransfield kindly corrected the Latin diagnosis; he and Dr. S. Dransfield have been helpful with their comments on the work carried out.

## REFERENCES

- Holttum, R.E. (1958) The bamboos of the Malay Peninsula. Gardens' Bulletin, Singapore 16 : 1-135.
- Merrill, E.D. (1916) On the identity of Blanco's species of *Bambusa*. American Journal of Botany 3 : 58-64.
- Widjaja, E.A. (1987) A revision of Malesian *Gigantochloa* (Poaceae - Bambusoideae). Reinwardtia 10(3) : 291-380.

## The Sabah Forestry Department's Arboretum at Sepilok, Sandakan

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**Summary.** The Sabah Forestry Department's Arboretum at Sepilok, Sandakan was set up in 1971. It occupies a lowland site with remnant stands of naturally occurring forest species, which provide a matrix for introducing planted indigenous trees from other areas. Plans for developing the Arboretum for conservation, display, education and scientific purposes are outlined.

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The Sabah Forestry Department Arboretum at Sepilok, Sandakan, is a relatively new facility established only in 1971. The idea of having such an arboretum has its basis in that a scientifically documented, living collection of indigenous trees, established within an existing framework of identified spontaneous trees on site, will serve as a good ancillary facility for research. The phenological behaviour, in particular reproductive phenology, of species of forestry interest can be monitored for specimens of known identity and age, as can such growth attributes as height and diameter growth. An arboretum of planted trees allows regular periodic monitoring of these attributes for a large variety of selected species at one site, greatly facilitating the logistics of such work. In addition to being a living research facility at close proximity to the Forest Research Centre, it allows students of tropical trees and visitors in general to observe and learn more about Sabah's indigenous plant species.

The substantial area of the arboretum, with an undulating topography, and the support possible from its own nursery facilities as well as the main botanical research facilities nearby at the Research Centre, make it extremely feasible as an *ex situ* conservation facility for a large variety of lowland forest species. The special importance of this aspect is high-lighted when it is considered that lowland forest areas are increasingly being fragmented and disturbed by timber harvesting. In time, the living collections built up will serve as a unique set of trees which are either specially conserved in the Sepilok Arboretum, or are interesting comparisons with their conspecifics that can only be found scattered elsewhere.

These notes are provided to give more information about the development of the Arboretum and are partly based on an earlier information paper (Lee 1986).

## Locality and general description

The Sabah Forestry Department Arboretum is situated at Sepilok on the east coast of Sabah, 25 km by road west of Sandakan, at longitude 117° 57' East and latitude 5° 53' North. The arboretum site consists of an area of 106.7 ha, of which 35.7 ha is occupied by the Forest Research Centre complex, the Forestry Training School, the research nurseries and the staff quarters. It has an undulating terrain ranging from 15 to 45 m above sea level.

The North-east Monsoon brings heavy rain to the area during December and January, but the South-west Monsoon does not give much rain in June/July. The mean annual rainfall around Sandakan is 3,148 mm. The mean daily temperature is about 27° C, with a tendency for the driest month, April, to have a slightly higher mean value. The mean monthly relative humidity is usually over 80% and minimum daily means rarely go lower than the low 70's. The average daily sunshine is about 6-7 hours with the highest average in April and the lowest in January.

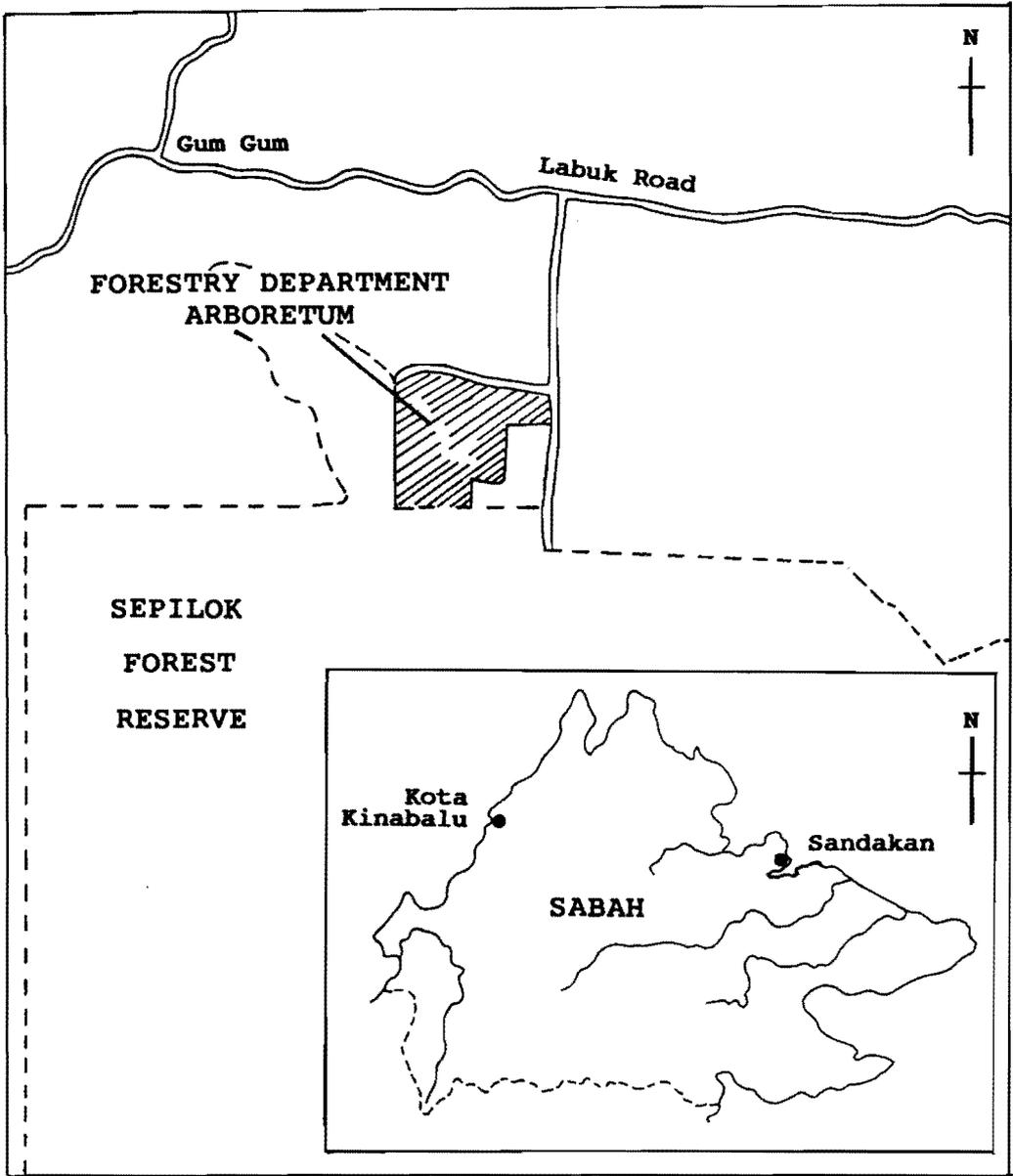
Geologically, the arboretum site has been mapped as the Sandakan Formation, which consists of mudstone, sandstone and some siltstone with rare thin coal seams (Lee 1967). The dominant soils are Orthic Acrisols and Luvisols in the Silabukan Association (Acres & Folland 1975).

The vegetation of the area consists of logged-over lowland dipterocarp forest that includes good regenerating stands in which can be found suitable conditions for raising planted forest tree species. The dominant dipterocarps naturally growing in the arboretum are *Shorea angustifolia*, *S. parvifolia*, *S. johorensis*, *S. mecistopteryx*, *S. smithiana*, *Dipterocarpus applanatus*, *D. caudiferus*, *Dryobalanops lanceolata*, *Parashorea malaanonan* and *P. tomentella*. Common non-dipterocarps which occur in the area are *Intsia palembanica* and *Sindora beccariana* (Leguminosae), *Eusideroxylon zwageri* and *Litsea* spp. (Lauraceae), *Knema laurina* (Myristicaceae), *Macaranga beccarianus* and *Glochidion* spp. (Euphorbiaceae), *Calophyllum* spp. (Guttiferae), *Artocarpus dadah* and *Ficus* spp. (Moraceae), *Scorodocarpus borneensis* (Olacaceae), *Palaquium* spp. (Sapotaceae), *Camptosperma auriculata* (Anacardiaceae), *Castanopsis* spp. and *Lithocarpus* spp. (Fagaceae), *Heritiera simplicifolia* (Sterculiaceae), *Euodia* spp. (Rutaceae), *Canarium* spp. (Burseraceae), *Diospyros* spp. (Ebenaceae), *Eugenia* spp. (Myrtaceae) and *Barringtonia* sp (Lecythidaceae). A full list of species which have been recorded in the logged-over forest of the arboretum is given in Appendix 1.

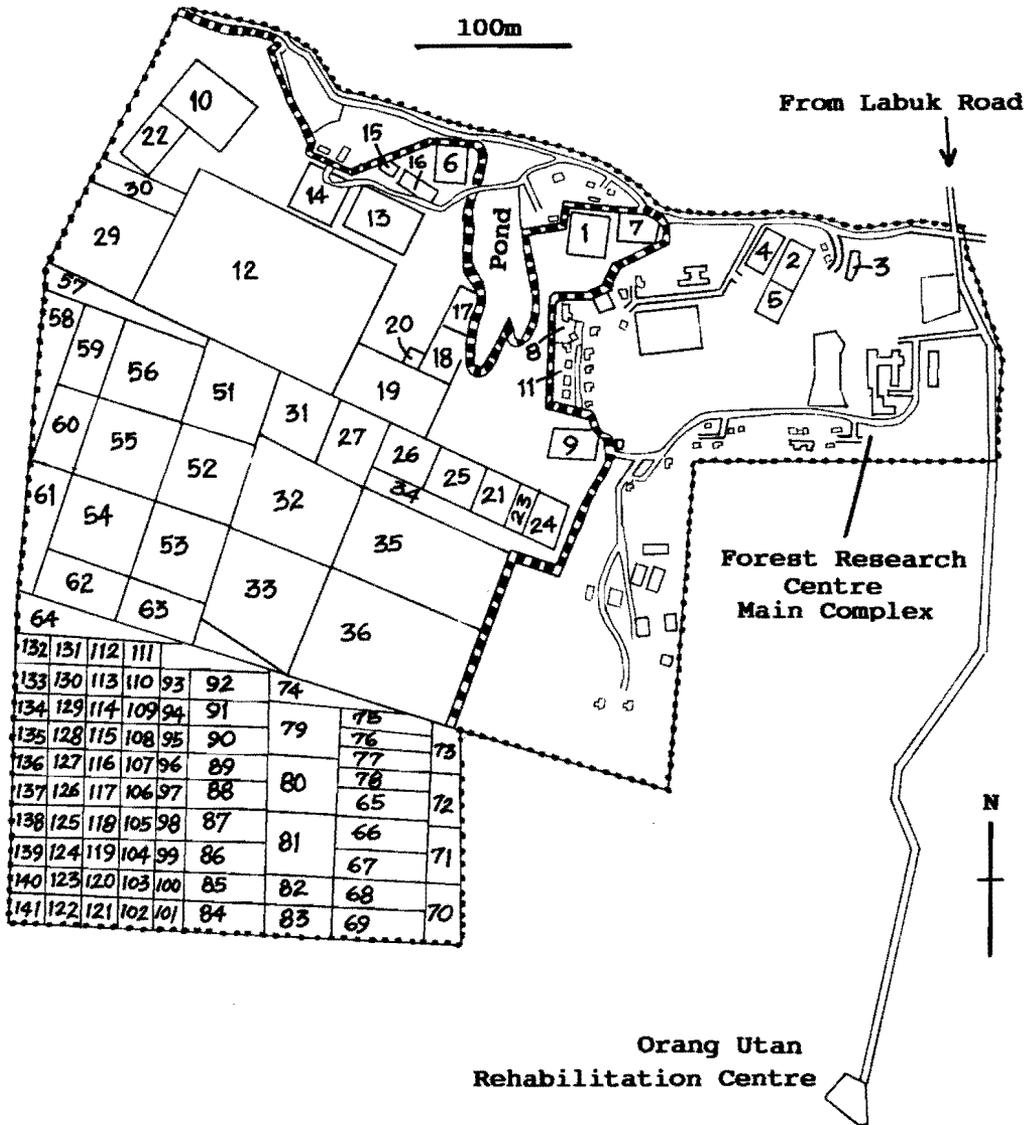
## History of establishment

The idea of a botanical garden in Sandakan was mooted in the early sixties, when the then Forest Botanist, Dr W. Meijer, proposed an area of about 121.4 hectares (300 acres) in Kebun Cina at km 6, Sibuga Road, as a forest park. Some trails were established in the forest and a botanical guide to the proposed botanical garden has been written. When the proposal was rejected in 1965 it was suggested that the botanical garden be located at Mt Walker Forest Reserve.





**Fig. 1.** Location of Sandakan (inset) and the Forestry Department Arboretum at Sepilok. Dashed line marks northern and western extent of the Sepilok Forest Reserve. Scale for larger map 1:50,000.



**Fig. 2.** Layout of the Arboretum at Sepilok. Dots mark boundary of the entire Arboretum area, including the main complex of the Forest Research Centre. Thick dashed bar marks eastern extent of the arboretum proper. Numbers indicate arboretum plots.

*Group B* Very few or no commercial species at present but there are some big trees which are potentially important timber species.

*Subgroup Ba* : Families with a large number of big trees.

*Subgroup Bb* : Families with few big trees.

*Group C* Virtually no potential timber species.

*Subgroup Ca* : Large families.

*Subgroup Cb* : Moderately large families.

*Subgroup Cc* : Small families.

A list of planted species which are now well established in Plots 1-36 is given in Appendix 2. Planted specimens in Plots 51-141 are still relatively young and are not listed here.

The canopy of a large part of the forest in the arboretum is dense. Before planting can be done, particularly for the light-demanding species, clearing is necessary. For the majority of timber species, spacing of 4-5 m between adjacent seedlings is suitable. Lines about 1 m wide and 4.5 m apart are cleared and seedlings are planted at intervals of 4.5 m along the lines. This technique is modified for the light-demanding species and small trees. The former may necessitate clearing a substantial area, and the latter can be planted at a narrower spacing of 3 m.

Gradual opening of the canopy of the logged-over forest is necessary as the young plants grow so that the planted trees will not be suppressed. Thinning is carried out subsequently and the optimum stocking is maintained at each stage of development of the plots.

### **Continuing development**

The development of longer term plans for the Arboretum will be carried out according to the following considerations:

- (a) The continuation of species procurement and specimen planting throughout the arboretum site, not neglecting the larger portion of the area (which may be called the "core scientific area") which as yet is accessible only for scientific work.
- (b) The special development of an attractive facade at the entrance (where also in the long term an interpretation centre may be sited), leading almost immediately onto a ridge walk through a varied matrix of pre-existing and planted forest tree species that are well labelled with name plaques and judiciously provided with information

boards for the benefit of visitors. This walk can be developed to link up near to the orchid garden situated next to the Forest Research Centre complex, and can be served by a creatively written trail guide. This portion of the Arboretum may be called the "general visitor area", which is advantageously set apart from the core scientific area.

- (c) The careful reorganisation of the Arboretum nursery along both functional and aesthetic lines. The nursery contains a large variety of natural forest tree seedlings, of great curiosity interest because of its adjacency to the entrance to the general visitor area. It will always carry a surplus of seedlings (because procurement requires that seeds in sufficiently large quantities are sown to ensure the germination of some, and final planting selects only a small number of seedlings, the rest being in excess and a potential liability in terms of storage space); these seedlings can form the basis of an exchange, sales or plant-donation programme with the public, with schools and with various agencies.

### **Scientific functions**

About 40 ha of the arboretum area have already been planted; another 30 ha or so will comprise sufficient area for receiving further planting. Over the next ten years, planting will continue alongside building up of the records of height and diameter measurements of the arboretum trees. These will be of ancillary value to the silvicultural knowledge of local trees, when continued over longer periods.

A phenological trail with 200 tagged trees of various species is being periodically monitored, and will yield patterns of leaf exchange and reproductive rhythm for a number of selected forest species. In addition, many of the adult trees in this collection will also be able to serve as seed trees with known seeding periodicities.

More than 80 species of trees are found naturally growing in the arboretum area; in addition, by 1990 another 200 species have been planted. In the years ahead, a minimum of 20 additional species a year can be procured for the arboretum, so that after ten years some 480 species of tree, minimally, would have been procured; if we allow a 10% loss, we would still have about 430 species in the living collection. This will be close to 10% of the entire tree flora of Sabah, an amazing feat and highly useful scientific and conservation facility.

### **Educational and recreational functions**

With sufficient funding and creative layout and development, the general visitor area can grow to be a highlight of the visitor's experience at Sepilok. The development of an informative trail system and guide, and possibly an interpretation centre, will ensure that students and general visitors learn something of the tree lore of Sabah's tropical rain forests. If developed and maintained conscientiously, this will indeed be a rare facility in the world.

The greater Sandakan area is fast shaping up as a region of great ecotourism interest; in relation to this a well-developed arboretum established so near to the already popular Orang Utan Rehabilitation Centre at Sepilok promises much attention from visitors and the general public. In an economic sense, the development of the arboretum along these lines is commensurate with the emergence of the greater Sandakan area as an important ecotourist destination, and so also contributes to the wealth represented by this growth.

### **ACKNOWLEDGEMENTS**

Mr K.M. Wong's comments, particularly on the development of the educational and recreational aspects of the Arboretum, are gratefully acknowledged.

### **REFERENCES**

- Acres, B.D. & C.J. Folland (1975) The soils of Sabah, Vol. 2. Sandakan and Kinabatangan districts. Land Resource Study 20. Surrey, England.
- Lamb, A. (1991) The conservation of orchids in Sabah (Malaysian Borneo). In : V.H. Heywood & P.S. Wyse Jackson (eds.), Tropical Botanic Gardens : their Role in Conservation and Development, pp. 307-327. London : Academic Press.
- Lee, D.T.C. (1967) The Sandakan Formation, East Sabah. Geological Papers, pp. 43-50. Geological Survey, Kuching.
- Lee, Y.F. (1986) The Sabah Forest Department Arboretum. Information paper, 9th Malaysian Forestry Conference, Kuching, Sarawak. 23 p.

**Appendix 1.** Species found naturally in the Arboretum site.

FAMILY	SPECIES
Anacardiaceae	<i>Camptosperma auriculata</i> <i>Dracontomelum puberulum</i> <i>Gluta</i> sp. <i>Koordersiodendron pinnatum</i>
Annonaceae	<i>Desmos</i> sp.
Apocynaceae	<i>Alstonia spatulata</i> <i>Dyera costulata</i>
Bombacaceae	<i>Durio</i> sp.
Datiscaceae	<i>Octomeles sumatrana</i>
Dilleniaceae	<i>Dillenia borneensis</i> <i>Dillenia excelsa</i>
Dipterocarpaceae	<i>Dipterocarpus caudiferus</i> <i>Dipterocarpus confertus</i> <i>Dipterocarpus grandiflorus</i> <i>Dryobalanops lanceolata</i> <i>Hopea nervosa</i> <i>Parashorea malaanonan</i> <i>Parashorea tomentella</i> <i>Shorea acuminatissima</i> <i>Shorea almon</i> <i>Shorea angustifolia</i> <i>Shorea fallax</i> <i>Shorea gibbosa</i> <i>Shorea inappendiculata</i> <i>Shorea johorensis</i> <i>Shorea leprosula</i> <i>Shorea macrophylla</i> <i>Shorea mecistopteryx</i> <i>Shorea parvifolia</i> <i>Shorea smithiana</i> <i>Shorea symingtonii</i> <i>Shorea xanthophylla</i> <i>Vatica</i> sp.
Ebenaceae	<i>Diospyros</i> sp.

**Appendix 1 (cont'd)**

Elaeocarpaceae	<i>Elaeocarpus stipularis</i> <i>Elaeocarpus</i> sp.
Euphorbiaceae	<i>Baccaurea bracteata</i> <i>Baccaurea lanceolata</i> <i>Baccaurea</i> sp. <i>Glochidion</i> sp. <i>Macaranga beccarianus</i>
Fagaceae	<i>Castanopsis motleyana</i> <i>Castanopsis</i> sp. <i>Lithocarpus</i> sp.
Flacourtiaceae	<i>Hydnocarpus woodii</i> <i>Pangium edule</i>
Guttiferae	<i>Calophyllum</i> sp. <i>Garcinia mangostana</i> <i>Garcinia parvifolia</i>
Lauraceae	<i>Eusideroxylon zwageri</i> <i>Litsea</i> sp.
Leguminosae	<i>Dialium</i> sp. <i>Intsia palembanica</i> <i>Sindora beccariana</i> <i>Sindora irpicina</i> <i>Sympetalandra borneensis</i>
Lecythidaceae	<i>Barringtonia</i> sp.
Melastomataceae	<i>Pternandra coerulescens</i>
Meliaceae	<i>Dysoxylum</i> sp. <i>Lansium domesticum</i>
Moraceae	<i>Artocarpus anisophyllus</i> <i>Artocarpus dadah</i> <i>Ficus</i> sp.
Myristicaceae	<i>Knema laurina</i>
Myrsinaceae	<i>Ardisia elliptica</i>
Myrtaceae	<i>Eugenia</i> sp.

**Appendix 1 (cont'd)**

Olacaceae	<i>Ochanostachys amentacea</i> <i>Scorodocarpus borneensis</i>
Oleaceae	<i>Linociera pluriflora</i>
Rubiaceae	<i>Neolamarckia cadamba</i> <i>Neonauclea bernardoi</i>
Rutaceae	<i>Euodia</i> sp.
Sapindaceae	<i>Nephelium ramboutan-ake</i> <i>Paranephelium nitidum</i> <i>Pometia pinnata</i>
Sapotaceae	<i>Mimusops elengi</i> <i>Palaquium</i> sp.
Sterculiaceae	<i>Heritiera simplicifolia</i> <i>Pterospermum</i> sp.
Thymelaeaceae	<i>Gonystylus bancanus</i>
Tiliaceae	<i>Microcos crassifolia</i> <i>Pentace</i> sp.
Verbenaceae	<i>Guensia pentandra</i>

**Appendix 2** List of planted trees in Plots 1-36 of the Arboretum.

FAMILY	SPECIES
Alangiaceae	<i>Alangium</i> sp.
Anacardiaceae	<i>Dracontomelum puberulum</i> <i>Gluta wallichii</i> <i>Koordersiodendron pinnatum</i> <i>Mangifera odorata</i> <i>Mangifera</i> spp.
Araucariaceae	<i>Agathis borneensis</i>
Bignoniaceae	<i>Spathodea campanulata</i>
Bombacaceae	<i>Durio zibethinus</i> <i>Durio</i> spp. <i>Neesia</i> sp.
Burseraceae	<i>Canarium</i> sp.
Casuarinaceae	<i>Casuarina nobile</i>
Chrysobalanaceae	<i>Parinari</i> sp.
Combretaceae	<i>Terminalia</i> sp.
Dilleniaceae	<i>Dillenia excelsa</i>
Dipterocarpaceae	<i>Anisoptera costata</i> <i>Dipterocarpus caudiferus</i> <i>D. exalatus</i> <i>D. grandiflorus</i> <i>Dipterocarpus</i> spp. <i>Dryobalanops lanceolata</i> <i>Parashorea malaanonan</i> <i>P. tomentella</i> <i>Shorea almon</i> <i>S. foxworthyii</i> <i>S. irpicina</i> <i>S. johorensis</i> <i>S. leprosula</i> <i>S. macrophylla</i> <i>S. mecistopteryx</i> <i>S. multiflora</i> <i>S. parvifolia</i>

Appendix 2 (cont'd)

*S. pauciflora*  
*S. seminis*  
*S. smithiana*  
*S. stenoptera*  
*S. venulosa*  
*S. waltonii*  
*S. xanthophylla*  
*Vatica sarawakensis*

Ebenaceae

*Diospyros discocalyx*  
*Diospyros* sp.

Euphorbiaceae

*Baccaurea macrocarpa*  
*B. motleyana*  
*B. puberulum*  
*Baccaurea* spp.  
*Elateriospermum tapos*  
*Mallotus* sp.  
*Ptychopyxis arborea*

Fagaceae

*Quercus argentata*  
*Q. gemelliflora*

Flacourtiaceae

*Hydnocarpus borneensis*  
*H. woodii*

Guttiferae

*Calophyllum* spp.  
*Garcinia mangostana*  
*Garcinia* sp.

Lauraceae

*Eusideroxylon zwageri*

Lecythidaceae

*Barringtonia* sp.  
*Planchonia valida*

Leguminosae

*Adenanthera pavonina*  
*Albizia lebbeck*  
*Albizia pedicellata*  
*Archidendron ellipticum*  
*Cassia fistula*  
*Cynometra mirabilis*  
*Intsia palembanica*  
*Intsia retusa*  
*Koompassia excelsa*  
*Parkia* sp.  
*Sindora* sp.

**Appendix 2 (cont'd)**

	<i>Sympetalandra borneensis</i>
Magnoliaceae	<i>Aromadendron nutans</i>
Meliaceae	<i>Aglaiia</i> sp. <i>Chisocheton</i> sp. <i>Melia azedarach</i> <i>Walsura villamilii</i>
Moraceae	<i>Artocarpus anisophyllus</i> <i>Artocarpus</i> sp. <i>Ficus callosa</i>
Myristicaceae	<i>Knema laurina</i> <i>Knema</i> sp. <i>Myristica</i> sp.
Myrtaceae	<i>Eugenia</i> spp. <i>Psidium guajava</i>
Nyctaginaceae	<i>Pisonia grandis</i>
Olacaceae	<i>Scorodocarpus borneensis</i>
Rubiaceae	<i>Neolamarckia cadamba</i>
Rutaceae	<i>Citrus macroptera</i> <i>Citrus</i> sp. <i>Murraya</i> sp.
Sapindaceae	<i>Dimocarpus longan</i> <i>Nephelium lappaceum</i> <i>N. ramboutan-ake</i>
Sapotaceae	<i>Palaquium</i> sp.
Sterculiaceae	<i>Sterculia macrophylla</i>
Thymelaeaceae	<i>Gonystylus</i> sp.
Tiliaceae	<i>Pentace</i> sp.
Verbenaceae	<i>Tectona grandis</i> <i>Teijsmanniodendron pteropodum</i>