
SANDAKANIA

No. 22

November, 2016

Centenary of the Sandakan Herbarium 1916–2016



A journal of plant systematics, morphology and natural history

published by the Forest Research Centre, Sandakan, Sabah, Malaysia ISSN 0128-5939

SANDAKANIA

An occasional journal of plant systematics, morphology and natural history

published by the Forest Research Centre, Sandakan, Sabah, Malaysia

Editorial Committee

Chairman, Robert C. Ong

Editor, John B. Sugau

Assistant editors, Joan T. Pereira

Arthur Y.C. Chung

Production Manager, C.L. Chan

Advisors

Y.F. Lee (Forest Research Centre, Sandakan, Malaysia)

K.M. Wong (Botanic Gardens, Singapore)

Mohamed Abdul Majid, Haji (University of Brunei Darussalam, Brunei)

Todd J. Barkman (Western Michigan University, USA)

Communications addresses

Robert C. Ong, Forest Research Centre, Forestry Department, P.O. Box 1407, 90715 Sandakan, Sabah, Malaysia (Fax 6089-531068, *email* Robert.Ong@sabah.gov.my)

John B. Sugau, Forest Research Centre, Forestry Department, P.O. Box 1407, 90715 Sandakan, Sabah, Malaysia (Fax 6089-531068, *email* John.Sugau@sabah.gov.my)

Joan T. Pereira, Forest Research Centre, Forestry Department, P.O. Box 1407, 90715 Sandakan, Sabah, Malaysia (Fax 6089-531068, *email* Joan.Pereira@sabah.gov.my)

Date of publication

25 November 2016

Sandakania Vol. 22 is a project made possible through the kind interest of Mr Tan Jiew Hoe, Singapore.

Centenary of the Sandakan Herbarium 1916–2016

CONTENTS

	<i>Page</i>
K.M. Wong & Soejatmi Dransfield <i>Ruhooglandia</i> and <i>Widjajachloa</i> , two new genera of Malesian bamboos (Poaceae: Bambusoideae) and their distinction from <i>Nastus</i> and <i>Chloothamnus</i>	1
K.M. Wong, W.L. Goh, Hathairat Chokthaweeapanich, Lynn G. Clark, Sarawood Sungkaew, Elizabeth A. Widjaja & Nian-He Xia A subtribal classification of Malesian and Southwest Pacific woody bamboos (Poaceae: Bambusoideae: Bambuseae) informed by morphological and molecular studies	11
Elizabeth A. Widjaja & K.M. Wong New combinations in <i>Chloothamnus</i> (Poaceae: Bambusoideae), a genus of Malesian bamboos formerly confused with <i>Nastus</i>	37
A.S. Kamariah & K.M. Wong Novitates Bruneienses, 7. <i>Saurauia</i> (Actinidiaceae) in Brunei Darussalam	41
Peter Ashton Notes on northern Borneo Myrtaceae	55
Joan T. Pereira Four new species of <i>Ridsdalea</i> (Rubiaceae: Gardenieae) from Borneo, Wallacea and New Guinea	77

***Ruhooglandia* and *Widjajachloa*, two new genera
of Malesian bamboos (Poaceae: Bambusoideae)
and their distinction from *Nastus* and *Chloothamnus***

K.M. Wong¹ & Soejatmi Dransfield²

¹ Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, 259569 Singapore.
wkm2000@gmail.com

² Royal Botanic Gardens, Kew,
Richmond, Surrey, TW9 3AE, U.K.
S.Dransfield@kew.org

Summary. Two new genera of bamboos, *Ruhooglandia* S.Dransf. & K.M.Wong and *Widjajachloa* K.M.Wong & S.Dransf., are described for Malesia. They are distinguished from *Nastus* Juss. sensu stricto (based on *N. borbonicus* J.F.Gmel. from the Réunion) and *Chloothamnus* Buse, the correct genus for a related group of Malesian bamboos formerly confused with *Nastus*, in morphological as well as molecular characteristics.

Henrard (1936) has already identified *Chloothamnus* Buse as the correct name for the group of bamboos among which *C. chilianthus* Buse (1854) is the earliest named and therefore the type species. The name *C. chilianthus* however is a synonym of *C. elegantissimus* (Hassk.) Henrard (1936) because the latter is based on *Bambusa elegantissima* Hassk. (1844), an earlier published epithet.

The type specimen of *C. chilianthus* is a Junghuhn collection from NW Sumatra, as noted by Henrard (1936), although Dr Elizabeth Widjaja (Herbarium Bogoriense, BO) has expressed some doubt that this species of bamboo occurs in Sumatra because she has collected extensively in that general area and elsewhere in Sumatra and did not record the presence of this species (Widjaja, pers. comm. 2014).

In fact, it is not impossible that Junghuhn's material collected in Java before 1839 and after March 1842, and in Sumatra during 1840–1842 had been mixed up, because his job in Java

was not continued in 1839 and he had applied to go to another position in Sumatra, where he served during 1840–1842 (van Steenis-Kruseman 1950). His account (Junghuhn 1847) mentions interesting plants but in the case of bamboos, only as far as their use as fences and in other *ad hoc* ways. We are not able to definitely demonstrate this possible confusion in labelling, but even if it were true that the provenance (locality) of Junghuhn’s specimen was wrongly recorded (due to mismatching notes with materials), and Widjaja’s experience demonstrates so far that this Javan bamboo does not occur in Sumatra, we would still need to accept that the Junghuhn specimen is the type of *C. chilianthus*. In other words, whether or not this bamboo species occurs in Sumatra, and even if the Sumatra locality on the Junghuhn specimen is a mistake, that species is still valid. Consequently, the genus *Chloothamnus* is validly established with a type specimen.

This would mean that *Chloothamnus* is the correct name for the group of bamboos in Indonesia that includes *C. elegantissimus*, which until more recently (Dransfield & Widjaja 1995, BPG 2012) has been maintained in *Nastus* s.l. because of conventional placement and lack of clarifying investigation; but which (below) can be shown to be distinct from *Nastus* s.s. All of these bamboo taxa have true spikelets as the basic unit of the inflorescence. It should also be noted that *Oreiostrachys* Gamble (1908) is a synonym of *Chloothamnus*, as the original description of *Oreiostrachys* was based on *Junghuhn 143* (a leafy specimen that is also the type of *Bambusa elegantissima* = *Chloothamnus elegantissimus*) as well as *Pulle 3173* (inflorescences).

OTHER MALESIAN GENERA CONFUSED WITH *NASTUS*

The *Nastus* species from the Madagascar–Indian Ocean region are also in need of closer morphological studies, and it is as yet uncertain if they fall neatly into a single generic entity. For example, *Nastus borbonicus*, the type from Réunion, has an erect habit, whereas the Madagascan *N. elongatus* A.Camus is a clambering bamboo. Difference in habit seems also to be correlated to other morphological differences, such as the branch bud and branch complement dipping below the culm nodal level in *N. elongatus* but not *N. borbonicus*.

Recent molecular analyses (Clark et al. 2007, Chokthaweeapanich 2014) also indicate that typical *Nastus* (typified by *N. borbonicus* J.F.Gmel. from the Réunion) and another Madagascar species *N. elongatus* A.Camus belong to the same Hickeliinae clade, which is widely separated from another clade comprising the Malesian *N. elegantissimus* (= *Chloothamnus*) and *N. productus*. There seems to be at least two ways to easily distinguish the Malesian taxa concerned from the *Nastus* alliance in Réunion-Madagascar. One is that the midrib on the leaf upper surface is prominent in the *Nastus* alliance in Réunion-Madagascar but flat in the Malesian taxa (BPG 2012). Additionally, our recent studies have indicated that the flowering panicle in Réunion-Madagascar *Nastus* has branches either appressed to the

rachis (main axis) of the synflorescence, or ascending at a steep angle from it, whereas in the Malesian genera, the panicle branches diverge widely from the rachis.

The distinctive features of *Nastus hooglandii* that separate it from other Malesian ‘*Nastus*’ have been elucidated by Holttum (1967) in his New Guinea paper, but in addition, the presence of subtending bracts or sheaths in the inflorescence branching is a major difference from *Chloothamnus* or *Nastus productus*. Also, the hairy glumes are quite extraordinary. These could be adequately seen even in the images of the holotype in K or isotype in A available through JSTOR Global Plants [<https://plants.jstor.org>].

On the other hand, *Nastus productus* is quite different from the other so-called ‘*Nastus*’ and also merits a new genus. It has a bud and branch complement that ‘dips’ below the nodal line, the main (primary) axis of the branch complement is at first dormant (as in *Dinochloa*), and its higher-order axes typically develop first and do not rebranch (all of which are distinct from the rest of the so-called ‘*Nastus*’ constituting *Chloothamnus* in Malesia).

As such, the so-called *Nastus hooglandii* Holttum and *N. productus* (Pilg.) Holttum, which can be distinguished from *Chloothamnus* by rather distinctive sets of character-states, are here recognized as new genera because there are no available names for them.

KEY DISTINGUISHING *CHLOOTHAMNUS* AND TWO NEW GENERA FROM *NASTUS*

1A. Midrib of leaf adaxial surface prominent. Branches of flowering panicle appressed to the rachis (main axis) of the synflorescence or ascending at an acute angle from it
..... ***Nastus*** Juss. sensu stricto (type: *N. borbonicus*) [Réunion]

1B. Midrib of leaf adaxial surface flat or sunken. Branches of flowering panicle widely diverging (to more than 45 degrees to even perpendicularly) from the rachis (main axis) of the synflorescence [Malesia],

2A. Inflorescence bracteate at points of branching (segmented with the presence of subtending sheaths or bracts); glumes conspicuously brown-hairy
..... ***Ruhooglandia*** S.Dransfield & K.M. Wong (based on ‘*Nastus*’*hooglandii*)

2B. Inflorescence ebracteate (without subtending sheaths or bracts at points of branching); glumes glabrous or at most sparsely pale-hairy,

2A. Branch bud and branch complement above the culm nodal level. Rachilla extension absent or weakly developed and not consistently present and inconspicuous, never as long as the perfect flower below it. Palea of perfect flower not grooved down the back ***Chloothamnus*** Buse

2B. Branch bud and branch complement dipping below the culm nodal level. Rachilla extension bearing an imperfect terminal floret present, conspicuous, and as long as the perfect flower below it. Palea of perfect flower grooved down the back *Widjajachloa* K.M.Wong & S.Dransfield (based on '*Nastus productus*)

THE NEW GENERA

Ruhooglandia S.Dransfield & K.M.Wong, **gen. nov.**

This new Malesian genus is distinctive by its flowering panicle with branches widely diverging from the main synflorescence axis; bracteate inflorescences (with the presence of subtending sheaths or bracts at points of branching); determinate inflorescence units; and conspicuously hairy glumes.

(Fig. 1)

TYPE SPECIES: *Ruhooglandia hooglandii* S.Dransfield & K.M.Wong, **comb. nov.**

Basionym: *Nastus hooglandii* Holttum, Kew Bull. 21(2) (1967) 287.

TYPE: *Hoogland 9322*, Papua New Guinea, Huon Peninsula, Morobe District, summit area of Mt. Rawlinson, 3200 m, 30 Jun 1964 (holo K, iso A, BRI, CANB, L, LAE, US).

NOTES. The subtending inflorescence sheaths or bracts are 1–2-keeled structures often found at the base of the spikelets (prophyll-like and with their back appressed to the axis). These subtending bracts are usually glabrous or minutely hairy along their edge. In the type species, the uppermost ones are c. 3 mm long, ovate with a long tip; the middle ones are c. 6 mm long, ovate-lanceolate with pointed tip; and the lower ones are 10–20 mm long with modified blades 10–20 mm long, with linear tapering to long tips. They are all glabrous.

Holttum (1956) gives a good description and a detailed diagnostic figure, to which can be added the features highlighted in the diagnosis above. We name this genus after Dr Ruud ('Ru') D. Hoogland, Dutch botanist who collected the type specimen of this genus.

DISTRIBUTION: Known only in the Huon Peninsula and the Eastern Highlands of Papua New Guinea.

Widjajachloa K.M.Wong & S. Dransfield, **gen. nov.**

This new Malesian genus is distinguished by its solitary branch bud which dips below the culm nodal level; an initially dormant primary branch axis that later reiterates its parent axis in size and development and occurring together with usually many short and slender higher-order branches that do not typically rebranch away from their base; a flowering panicle with ebracteate branches widely diverging from the main synflorescence axis; determinate inflorescence units; and glabrous glumes.

(Fig. 2–3)

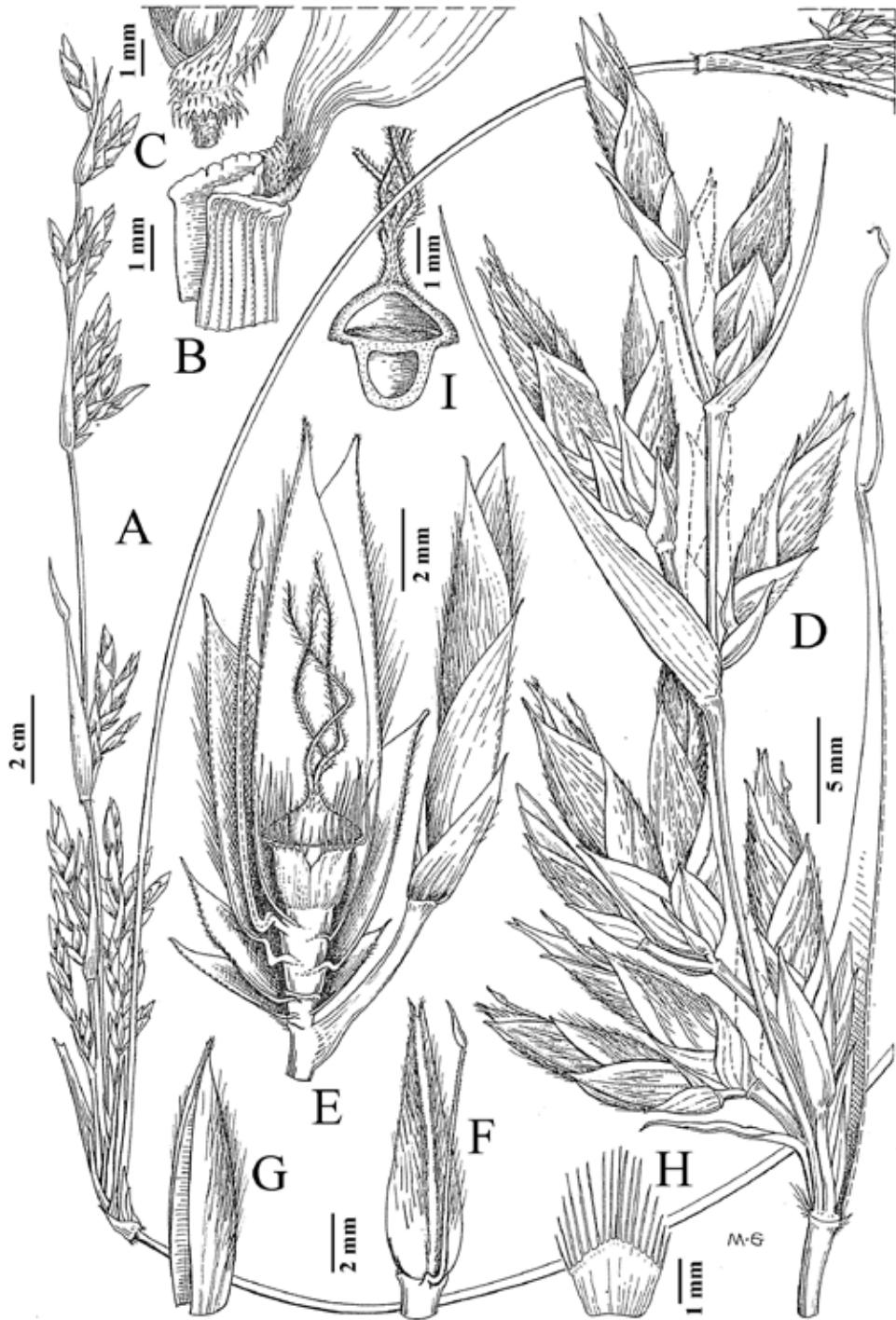


Fig. 1. *Ruhooglandia hooglandii*. A, inflorescence habit; B, top of leaf-sheath with ligule and base of blade; C, pulvinus and base of sheaths showing stiff reflexed hairs; D, part of panicle with half sheath removed to show base; E, spikelet in sectional view with no stamens present; F, palea, with extension of rachilla and rudimentary floret; G, lemma; H, lodicule; I, ovary, longitudinal section. All drawn from Hoogland 9322. Reproduced from *Kew Bulletin* 21(2), with permission.

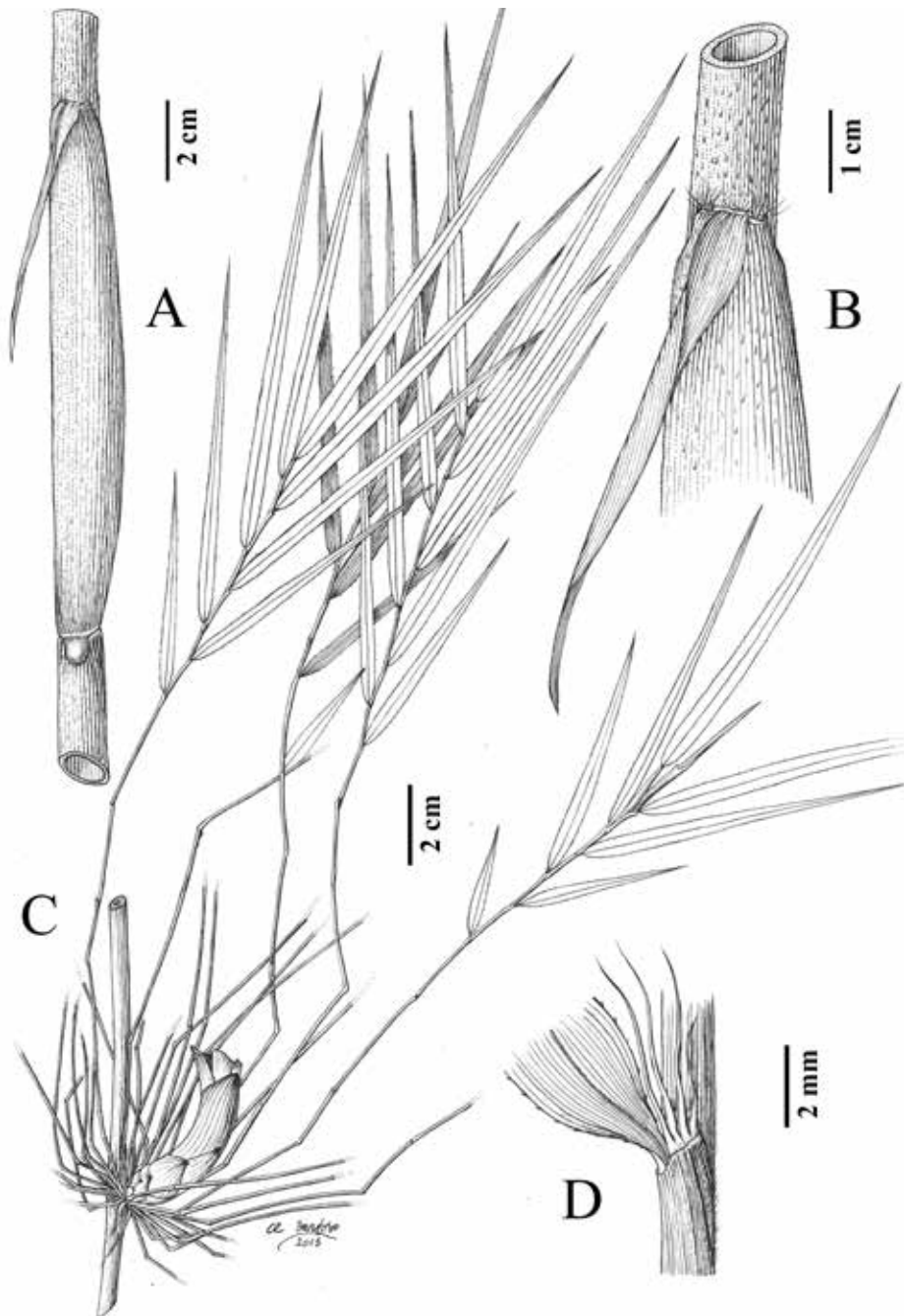


Fig. 2. *Widjajachloa producta*, vegetative parts. **A.** Portion of culm with intact sheath; note the nodal line and position of the primary branch bud ‘dipping’ below the general level of the node. **B.** Detail of culm sheath apex. **C.** Structure of branch complement, showing the dominant primary axis with a dense cluster of very slender higher-order leafy branches from its base. **D.** Detail of base of leaf blade and top of leaf sheath, showing long-bristly auricle on one side. All from *Widjaja EAW 6627* (BO). (Drawn by Wahyudi Santoso)

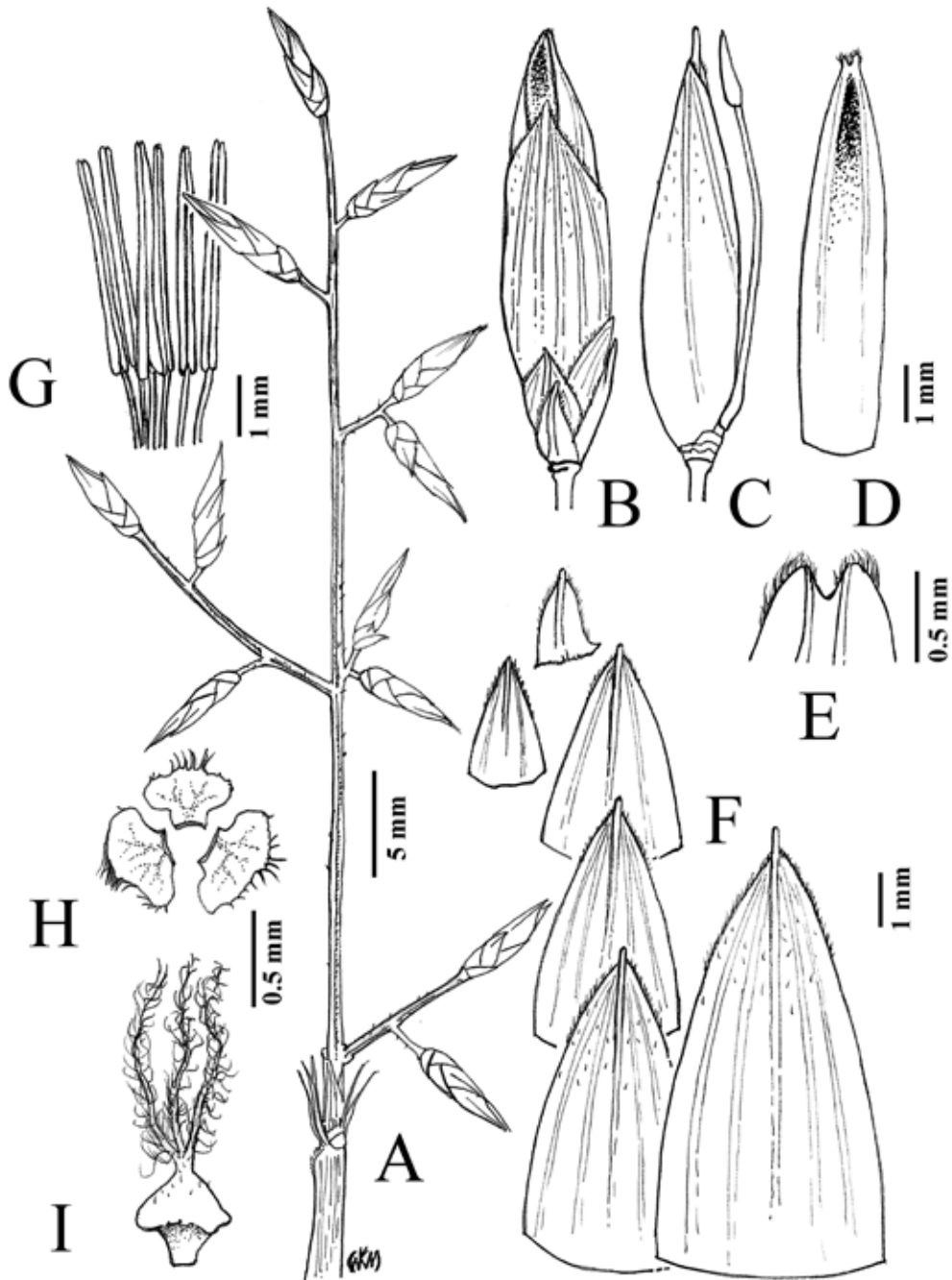


Fig. 3. *Widjajachloa producta*, inflorescence and floral parts. **A.** Structure of flowering branch. **B.** Spikelet. **C.** Spikelet with all glumes removed leaving the sole perfect floret and a long rachilla extension carrying a terminal vestigial flower (empty lemma). **D.** Palea, dorsal view, showing shallow groove down the back. **E.** Detail of cleft palea apex. **F.** Five glumes of increasing size from the base of the spikelet upwards and the lemma. **G.** Staminal complement. **H.** Lodicule complement. **I.** Gynoecium. All from *Womersley NGF 11340* (BO), except G, after van Royen (1979) based on *van Royen NGF 10904* (L). (Drawn by K.M. Wong)

TYPE SPECIES: *Widjajachloa producta* (Pilg.) K.M. Wong & S. Dransfield, **comb. nov.**

Basionym: *Oreiostachys producta* Pilg. in Engl. Bot. Jahrb. 62 (1929) 460.

Synonym: *Nastus productus* (Pilg.) Holttum, Kew Bull. 10(4) (1956) 594, 21(2) (1967) 289–291.

TYPE: *Keysser s.n.*, Papua New Guinea, Bolan Mountains, 2400–3000 m, 1913 (holo B, destroyed; iso BM).

NOTES. A good description is provided by Holttum (1956), to which the diagnostic features above may be added. This new genus is named after our colleague Dr Elizabeth Anita Widjaja, bamboo specialist at the Herbarium Bogoriense.

DISTRIBUTION: A rather common bamboo in mountains across New Guinea, at elevations around 1000–3000 m.

ACKNOWLEDGEMENTS

Dr John Dransfield and Dr Max van Balgooy helped with forming the genus name *Ruhooglandia*. We thank Prof David Simpson, Editor, Kew Bulletin, for permission to reproduce a figure from Volume 21(2). Prof Elizabeth Widjaja is thanked for an insightful discussion on Sumatran bamboos. Felix Merklinger kindly translated passages from Junghuhn (1847). The drawing of *Widjajachloa producta* vegetative features was made by Wahyudi Santoso (BO). Louise Neo assisted with the composition of figures used.

REFERENCES

- BPG (2012) An updated tribal and subtribal classification for the Bambusoideae (Poaceae). In: Gielis, J. and G. Potters (eds), *Proceedings of the 9th World Bamboo Congress, 10–12 April 2012*, Antwerp, Belgium. Pp. 3–27.
- Chokthaweeapanich, H. (2014) *Phylogenetics and Evolution of the Paleotropical Woody Bamboos (Poaceae: Bambusoideae: Bambuseae)*. Graduate Theses & Dissertations. Paper 13778. Iowa State University, Ames.
- Clark, L.G., S. Dransfield, J.K. Triplett & J.G. Sánchez-Ken (2007) Phylogenetic relationships among the one-flowered, determinate genera of Bambuseae (Poaceae: Bambusoideae). *Aliso* 23, 315–332.
- Dransfield, S. & E.A. Widjaja (1995) *Plant Resources of South-East Asia No. 7: Bamboos*. Backhuys Publishers, Leiden.

- Henrard, J.T. (1936) *Chloothamnus*, a neglected genus of Bambusaceae. *Blumea* 2(2): 60–73.
- Holttum, R.E. (1956) The bamboo-genera *Nastus* and *Chloothamnus*. *Kew Bull.* 10(4): 591–594.
- Holttum, R.E. (1967) The bamboos of New Guinea. *Kew Bull.* 21(2): 263–292.
- Junghuhn, F. (1847) *Die Battanländer auf Sumatra*. Druck und Verlag von G. Reimer, Berlin.
- Van Steenis-Kruseman, M.J. (1950) Malaysian Plant Collectors and Collections, being a Cyclopaedia of Botanical Exploration in Malaysia. In: C.G.G.J. van Steenis (ed), *Flora Malesiana* I, 1: 1–639. Noordhoff-Kolff N.V., Djakarta.

**A subtribal classification
of Malesian and Southwest Pacific woody bamboos
(Poaceae: Bambusoideae: Bambuseae)
informed by morphological and molecular studies**

**K.M. Wong¹, W.L. Goh², Hathairat Chokthaweeapanich^{3,4},
Lynn G. Clark³, Sarawood Sungkaew⁵,
Elizabeth A. Widjaja⁶ & Nian-He Xia⁷**

¹Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, Singapore 259569.
wkm2000@gmail.com

²Universiti Tunku Abdul Rahman, Jalan Universiti,
Bandar Barat, 31900 Kampar, Perak, Malaysia.
weilim_goh@yahoo.com

³Department of Ecology, Evolution, & Organismal Biology,
Iowa State University, Ames, IA 50011-1020, U.S.A.
lgclark@iastate.edu

⁴Department of Horticulture, Faculty of Agriculture,
Kasetsart University, Bangkok, Thailand 10900.
hathairat.ch@ku.th

⁵Department of Forest Biology, Faculty of Forestry,
& Center of Excellence for Bamboos,
Kasetsart University, Bangkok, Thailand 10900.
sungkaes@tcd.ie

⁶Herbarium Bogoriense, Puslitbang Biologi LIPI, Cibinong,
(Present address: Kp. Cimoboran, Ds. Sukawening, Dramaga, Bogor)
Indonesia.
eawidjaja3003@gmail.com

⁷South China Botanical Garden, Chinese Academy of Sciences,
Guangzhou 510650, Guangdong, China.
nhxia@scib.ac.cn

Summary. From the accruing indications of recent morphological and molecular studies, it is possible to recognize seven major lineages corresponding to distinct subtribes of woody bamboos for the Malesian–Southwest Pacific region. A key to the subtribes is presented, providing morphological distinctions to reflect synapomorphic or putatively synapomorphic character-states defining the lineages. Besides the Bambusinae and Melocanninae, four subtribes are newly recognized and the concept of Racemobambosinae is emended. The newly circumscribed subtribes include Dinochloinae, Greslaniinae, Holttumochloinae, and Temburongiinae. Notes are provided for a small number of taxa of uncertain subtribal position. With the exception of the Bambusinae, in which genera are known to form an introgressive complex, the constituent genera of the other subtribes in Malesia and the Southwest Pacific are also keyed out.

*This paper is dedicated to our colleague Dr Soejatmi Dransfield
for her insightful work on Malesian and Madagascan bamboos
on the occasion of her 77th birthday.*

BACKGROUND AND SCOPE OF THE PRESENT WORK

The most recent classifications of bamboos recognize three major lineages, the temperate woody bamboos (Arundinarieae), tropical woody bamboos (Bambuseae) and herbaceous bamboos (Olyreae) (Sungkaew et al. 2009, BPG 2012, Clark et al. 2015). The tropical woody bamboos, including 942 species (411 neotropical, 531 paleotropical) (Vorontsova et al., in press), currently appear to be the biggest tribe, within which two geographically distinct subgroups, the Paleotropical and Neotropical woody bamboos, are apparent (Sungkaew et al. 2009). Tropical woody bamboos are almost universally tetraploids or hexaploids, while temperate bamboos are characteristically tetraploids, and herbaceous bamboos diploids (Soderstrom 1981, Judziewicz et al. 1999, BPG 2012).

The Bamboo Phylogeny Group (BPG 2012) has reviewed the classification of tribes and subtribes, summarizing and discussing the morphological features that help define many of these groups, but it was recognized that refinements are still required in a number of cases. More recently completed work, such as the use of information from multiple chloroplast regions, is expected to further inform on these relationships, especially among both Paleotropical and Neotropical bamboos (Chokthaweeapanich 2014).

Meanwhile, the subtribal classification of Paleotropical bamboos remains highly unsatisfactory. Four subtribes are currently recognized: Bambusinae, Melocanninae, Hickeliinae, and Racemobambosinae (BPG 2012, Kellogg 2015). Of these, the Melocanninae have consistently been a well-supported monophyletic group in molecular analyses of moderate to large datasets (Yang et al. 2008, Sungkaew et al. 2009, Goh et al. 2013, Chokthaweeapanich

2014, Goh et al., unpublished), although some internal (generic) relationships still require clarification, but the other three subtribes have had uncertain delimitation.

The analyses of Sungkaew et al. (2009), Goh et al. (2010, 2013) and Chokthaweeapanich (2014) have individually demonstrated a number of clades and less well-supported clusters of genera external to the main Bambusinae using different combinations of molecular markers, without accomplishing totally conclusive resolution throughout. The main introgressing complex formed by *Bambusa* Schreber, *Dendrocalamus* Nees and *Gigantochloa* Kurz ex Munro and their allies such as *Maclurochloa* K.M.Wong, *Melocalamus* Benth., *Phuphanochloa* Sungkaew & Teerawat., *Soejatmia* K.M.Wong, and *Thyrsostachys* Gamble, referred to as the BDG complex of the Bambusinae by Goh et al. (2013), had a contentious relationship with a clade sister to it formed by *Holttumochloa* K.M.Wong and *Kinabaluchloa* K.M.Wong (Goh et al. 2010, 2013; Chokthaweeapanich 2014) and these were more phylogenetically distinct from other groups, including the Racemobambosinae. Sungkaew et al. (2009) also demonstrated the inclusion of *Vietnamosasa* Nguyen within the Bambusinae. There were, meanwhile, other consistently recovered isolated lineages such as *Temburongia* S.Dransf. & K.M.Wong, and a cluster comprising the climbing-scrambling genera *Dinochloa* Buse, *Mullerochloa* K.M.Wong and *Sphaerobambos* S.Dransf. together with the erect to clambering *Neololeba* Widjaja, or the ‘DMNS clade’ (Goh et al. 2013). Such studies (including Chokthaweeapanich 2014, Goh et al. unpublished), sampling even more taxa, have begun to reveal a rich diversity of associations external to the Bambusinae and excluded from the somewhat clearer definitions of Racemobambosinae and Hickeliinae.

The Hickeliinae were still considered to include not only *Hickelia* A.Camus and allies from the Madagascar–Réunion region, but also other taxa from Indonesia and Papua New Guinea in the Malesian region placed in *Nastus* Juss. (BPG 2012). However, more recent analyses (Chokthaweeapanich 2014, Goh et al. unpublished) have begun to affirm that the Malesian species of *Nastus* have been clearly misplaced in that genus. The species of *Nastus* from the Madagascar–Réunion region also need further clarification, as they are still very little understood (Dransfield, pers. comm.) but Wong & Dransfield (2016) have shown that the misplaced Malesian taxa form three distinct genera, *Chloothamnus* Buse, *Ruhooglandia* S.Dransf. & K.M.Wong and *Widjajachloa* K.M.Wong & S.Dransf.

It is an understatement to say that the classification of the Paletropical bamboos, or for that matter, all of the subfamily Bambusoideae, has been particularly problematic. It seems certain now that only with a great deal more effort in taxon sampling and a more comprehensive inclusion of gene regions, both plastid and nuclear, can unambiguous topologies of molecular phylogenetic analyses across the Paletropical bamboos be expected, and our understanding of relationships dramatically improve. Furthermore, the Malesian–Southwest Pacific region holds a rich diversity of genera of which many taxa are still incompletely represented in specimen material, so that an adequate summary of relationships can only benefit from better understanding the molecular relationships revealed in the various studies, advancing our survey and documentation of morphological attributes, and exploring the association

between these and morphological characteristics unique to individual groups and clusters of taxa. In this contribution based on such a collective approach, we outline a system of subtribal delimitation for Paleotropical bamboos in the Malesian–Southwest Pacific region, where clearly the continued retention of three existing subtribes (Bambusinae, Melocanninae, Racemobambosinae) and a misapplied subtribe (Hickeliinae) is highly unsatisfactory for indicating the most likely relationships.

We present first a key to the subtribes thought to be most feasible based on the available indications from various lines of evidence, both molecular and morphological. The genera within subtribes are also keyed out, except in the Bambusinae, which mainly includes an introgressive complex that needs greater taxonomic elucidation. Following this, the subtribes are enumerated and the attendant underlying premises for their recognition are discussed.

KEY TO MALESIAN–SOUTHWEST PACIFIC BAMBOO SUBTRIBES AND GENERA

1A. Ovary apex gradually narrowed into a stiff hollow style with a central tissue strand (**5. Subtribe MELOCANNINAE**) *Schizostachyum*

1B. Ovary apex abruptly narrowed into a soft flexuous, tissue-filled style, or without a conspicuous style,

2A. Auricles on culm leaf sheaths and foliage leaf sheaths horn-like (typically narrow and stiffly erect), patella present as a thin, plate-like extension around culm nodes (**7. Subtribe TEMBURONGIINAE**),

3A. Inflorescences indeterminate, with pseudospikelets in clear clusters of several to many (Luzon Is. in Philippines, South Sulawesi, East Java, Alor (Lesser Sunda Islands), New Guinea) *Fimbribambusa*

3B. Inflorescences ‘determinate’ (probably an extreme reduction of the indeterminate condition), with spikelets solitary or in sparse clusters (NW Borneo) *Temburongia*

2B. Auricles on culm leaf sheaths and foliage leaf sheaths indistinct or low, to lobe-like, but not horn-like; patella not present,

4A. Inflorescence indeterminate, with pseudospikelets,

5A. Midculm branch complement with a clearly dominant primary axis,

6A. Base of the culm leaf sheath smooth, not rugose or wrinkled (**1. Subtribe BAMBUSINAE**),

6B. Base of the culm leaf sheath transversely wrinkled (‘rugose’),

7A. Rudimentary florets (with only lemma and reduced palea developed) present, 1–2, between glumes and perfect (fertile) florets in the pseudospikelet (**1A**. Possibly introgressed member of Subtribe **BAMBUSINAE**) *Soejatmia*

7B. Rudimentary florets not occurring below perfect florets (**2**. Subtribe **DINCHLOINAE**),

8A. Only 1 perfect floret in the pseudospikelet; paleas not keeled,

9A. Culms twining; culm internodes basally distended; style glabrous *Dinchoa*

9B. Culms suberect-scrambling; culm internodes not basally distended; style hairy *Cyrtochoa*

8B. More than 1 perfect floret in the pseudospikelet; paleas 2-keeled,

10A. Lodicules present, culm internodes basally distended; stamens 4; filaments fused into a tube *Mullerochoa*

10B. Lodicules absent, culm internodes not basally distended; stamens 6, filaments free,

11A. Paleas longer than lemmas, the keels winged *Sphaerobambos*

11B. Paleas shorter than, or as long as, lemmas, the keels without wings,

12A. Pseudospikelets flat or compressed, the glumes and lemmas spreading outwards at the apices; lemma apices short-cuspidate *Neoleba*

12B. Pseudospikelets subterete, the glumes and lemmas closely appressed; lemma apices long-setiform,

13A. Pseudospikelets 25–52 mm long; culm leaf sheath margin papery *Parabambusa*

13B. Pseudospikelets 4–5 mm long; culm leaf sheath margin firm *Pinga*

5B. Midculm branch complement without a clearly dominant primary element, all branches subequal (**4. Subtribe HOLTUMOCHLOINAE**),

14A. Midculm branch complement developing from several to many distinct buds
..... *Holtumochloa*

14B. Midculm branch complement developing from a single bud
..... *Kinabaluchloa*

4B. Inflorescences determinate, with spikelets,

15A. Inflorescence branches subtended by well-developed prophylls or bracts

16A. Culms suberect to erect, unbranched or with solitary branches (these branched again away from their base); base of leaf sheaths and topmost part of branch internodes glabrous; glumes and lemma glabrous on the back (**3. Subtribe GRESLANIINAE**) *Greslania*

16B. Culms scrambling to climbing, with primary branches that rebranch to several orders at their base; base of leaf sheaths and topmost part of branch internodes with rigid retrorse hairs; glumes and lemma conspicuously brown-hairy all over the back *Ruhooglandia* (Subtribal position uncertain)

15B. Inflorescence without branches, or branches without prophylls or bracts,

17A. Spikelet with 2 glumes (Subtribal position uncertain: several Malaysian taxa currently named as *Racemobambos*; also *Temochloa* from Thailand)

17B. Spikelet with 3–5 glumes (**6. Subtribe RACEMOBAMBOSINAE**),

18A. Primary axis of branch complement elongating first or contemporaneously with the 2–several higher-order branches from its base, all similar in size and rebranching distally (Java, Wallacea, New Guinea)
..... *Chloothamnus*

18B. Primary axis of branch complement at lower and middle culm nodes initially dormant, much bigger than the short and slender higher-order branches developing first from its base, these higher-order branches not rebranching away from their base,

19A. Spikelet with 3–8 perfect florets; branch bud and branch complement at or above the culm nodal level *Racemobambos*

19B. Spikelet with 1 perfect floret; branch bud and branch complement dipping below the culm nodal level *Widjajachloa*

SYNOPTIC ENUMERATION OF SUBTRIBES IN THE MALESIAN–SOUTHWEST PACIFIC REGION

1. BAMBUSINAE J.S.Presl in K.B. Presl, Rel. Haenk. 1 (1830) 256.

TYPE: *Bambusa* Schreb.

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short to elongated. Culm nodes without patella. Aerial branching well-developed; mid-culm branch complement derived from a solitary primary bud, typically with the primary branch dominant in size and length, 1–few subdominants from its base, and smaller higher-order branches from these axes, rarely with reduction to just a solitary branch; the primary branch axis rarely (e.g., *Maclurochloa*, *Melocalamus*) elongating to reiterate the culm, rebranching distally; thorns absent or (in some *Bambusa*) present. Culm leaves well developed, often bearing fimbriae or fimbriate auricles or not (sometimes glabrous) at the sheath summit; oral setae present or absent; sheath base without transverse wrinkles (except in *Soejatmia*: see 1A below). Foliage leaf sheaths with fimbriae or fimbriate auricles or not at the summit. Synflorescences indeterminate (pseudospikelets), paniculate. Spikelets proper of the pseudospikelets consisting of (0) 1–several glumes, 1–10 or more perfect (fertile) florets, sometimes with 1–3 terminal rudimentary florets. Palea with wingless keels, rarely without keels. Stamens 6, filaments free or fused. Ovary glabrous with hairy apex, with a long slender, flexuous, tissue-filled style; stigmas 1, 2 or 3. Caryopsis basic or (in *Melocalamus*) baccate.

(Fig. 1–3)

Distribution: India to South China, across Indochina, Malesia to northern Australia and the Southwest Pacific.

Malesian genera: *Bambusa* Schreber, *Dendrocalamus* Nees, *Gigantochloa* Kurz ex Munro, *Maclurochloa* K.M.Wong

Extra-Malesian genera: *Melocalamus* Benth., *Oreobambos* K.Schumann, *Oxytenanthera* Munro, *Phuphanochloa* Sungkaew & Teerawat., *Pseudoxytenanthera* Soderstr. & Ellis, *Thyrsostachys* Gamble, *Vietnamosasa* Nguyen.

Comments: The BDG is now shown to be an introgressive complex by Goh et al. (2013), and the inclusion of the above genera in a well-supported Bambusinae clade is clear through the work of Sungkaew et al. (2009), Goh et al. (2011, 2013) and Chokthaweeapanich (2014). There will be a need to recognize further intermediate taxa (such as ×*Gigantocalamus* K.M.Wong) (Goh et al. 2011) as well as those that have outstandingly diagnostic morphological characters (such as *Maclurochloa*, *Phuphanochloa*) in this complex/subtribe.

1A. Possibly introgressed member of Subtribe Bambusinae (*Soejatmia*)

The position of *Soejatmia* K.M.Wong is clearly within the introgressive complex of the Bambusinae (Goh et al. 2013). Yet this remains the only ‘odd’ genus of the BDG complex



Fig. 1. In the Bambusinae, the primary branch is typically dominant in size and length, with 1–few subdominants from its base, and smaller higher-order branches from these axes (**A**, *Bambusa gurgandii*; **B**, *Dendrocalamus pendulus* with especially elongated primary branches). Sometimes the primary axis remains dormant at first with development of smaller higher-order branches from its base (**C**, *Melocalamus compactiflorus*; **D**, *Maclurochloa*, culm on right), but this later develops into a large branch that reiterates the parent culm in length and size (**D**, culm at top left), extending the shoot system and granting an effective clambering habit. The primary branch axes rebranch distally (shown only for **B**). (Photos: K.M. Wong)



Fig. 2. *Gigantochloa levis* and many other (but certainly not all) species of Bambusinae are large, even imposing, erect-suberect species. Among Southeast Asian bamboos, several taxa in the Melocanninae are also similarly large erect bamboos. (Photo: M. Sugumaran)



Fig. 3. Indeterminate inflorescence development with pseudospikelets that keep proliferating from buds at their base to produce higher-order pseudospikelets, resulting in the pseudospikelet tufts seen in the Bambusinae (A, unnamed member of the ‘BDG’ introgressive complex formed among *Bambusa*, *Dendrocalamus* and *Gigantochloa*), Dinochloinae, Holttumochloinae, Melocanninae (B, *Schizostachyum blumei*), and part of Temburongiinae. (Photos: K.M. Wong)

that has the transverse wrinkles at the culm leaf sheath base, which otherwise is a neat synapomorphy for the Dinochloinae. The possibility of inter-subtribal gene capture cannot be ruled out, as this has been demonstrated to occur among grass tribes (Mason-Gamer 2004). *Soejatmia* has rudimentary florets occurring below perfect florets, which is not known in the other SE Asian – Pacific bamboos here, except in *Temburongia* S.Dransf. & K.M.Wong; it is possible that this feature simply represents an uncommon peculiarity during complex evolution, as the inflorescence in *Temburongia* seems intermediate between the semelauctant and iterauctant conditions (see comments under Temburongiinae).

2. DINOCHLOINAE K.M.Wong & W.L.Goh, **subtribus novum**

The new subtribe Dinochloinae is distinctive among Paleotropical bamboos in having culm-sheath bases which are transversely wrinkled; culm nodes not developing a patella; a mid-culm branch complement with a clearly dominant axis; indeterminate inflorescences; no rudimentary florets below the perfect florets; and a flexuous tissue-filled style.

TYPE: *Dinochloa* Buse

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short to elongated. Culm nodes without patella. Aerial branching well-developed; mid-culm (or upper culm) branch complement derived from a solitary primary bud, typically with the primary branch dominant in size and length over smaller higher-order branches that may develop from its base; the primary branch axis sometimes dormant at first but elongating to reiterate the culm, rebranching distally (but sometimes not, as in some *Neololeba* and *Parabambusa*); thorns absent. Culm leaves well developed, bearing fimbriae or fimbriate auricles or not at the sheath summit; oral setae absent or present; sheath base with a distinctive zone of transverse wrinkles. Foliage leaf sheaths with fimbriae or fimbriate auricles or not at the sheath summit. Synflorescences indeterminate (pseudospikelets), paniculate. Spikelets consisting of 1–3 glumes, 1 (*Dinochloa*), 3–5 (*Sphaerobambos*), 3–12 (*Neololeba*, *Parabambusa*) perfect (fertile) florets, with a terminal rudimentary floret or (*Cyrtochloa*) without. Palea not keeled or keels winged (*Sphaerobambos*) or wingless. Stamens 4 or 6, filaments free. Ovary glabrous or hairy at summit, with a short or elongate flexuous and tissue-filled style; stigmas 1–3. Caryopsis basic or (in *Cyrtochloa*, *Dinochloa*, *Sphaerobambos*) baccate.

(Fig. 4–5)

Distribution: Andamans, South Thailand, Malesia, Queensland.

Malesian genera: *Cyrtochloa* S.Dransf., *Dinochoa* Buse, *Neololeba* Widjaja, *Parabambusa* Widjaja, *Pinga* Widjaja, *Sphaerobambos* S.Dransf.

Comments: *Dinochloa* was recovered as a distinct lineage removed from Bambusinae by Yang et al. (2007, 2008). Sungkaew et al. (2009) recovered *Dinochloa* and *Neololeba* in the same clade. The close association of *Dinochloa* and *Sphaerobambos* (Goh et al. 2010),

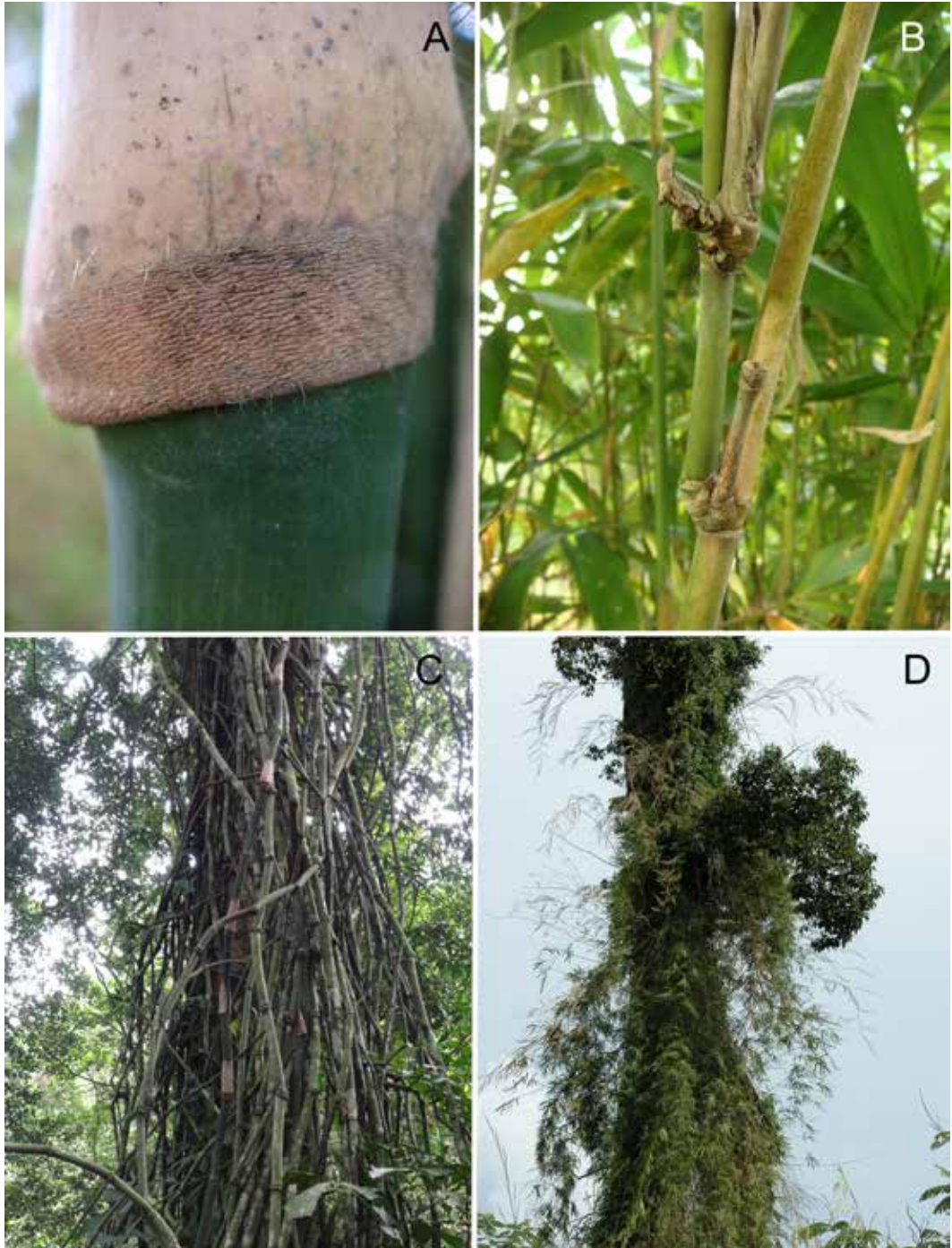


Fig. 4. Dinochloinae: the characteristic, transversely wrinkled culm leaf sheath base (**A**, *Neololeba atra*); typically well-developed aerial branching with the mid-culm (or upper culm) branch complement derived from a solitary primary bud that develops into a primary branch dominant in size and length over smaller higher-order branches from its base (**B**, *N. atra*); reiterative development of such primary branch axes contributes to a clambering or climbing habit (**C**, *Dinochloa scabrida*). In *Dinochloa*, the inflorescences consist of such primary (and initially dormant) branch buds that develop into long, branched flowering axes protruding into clear space away from the foliage thickets (**D**, *D. obclavata*). (Photos: K.M. Wong)

as well as with *Neololeba*, became clearer in molecular experiments reported by Goh et al. (2013). Kelchner et al. (2013) recovered *Neololeba* and *Cyrtochloa* in the same clade. Only in *Dinochloa* are the culms consistently twining. The extra-Malesian *Mullerochloa* has vegetative characteristics compatible with this subtribe, such as clambering and even occasionally twining culms, transverse wrinkles at the culm leaf sheath base, and spikelets with 4–9 glumes, but seems to differ in having stamens with fused filaments. Its inclusion in this subtribe is provisional in view of its consistent position within a clade with *Dinochloa* and allies only in chloroplast-based topologies (Goh et al. 2013, Chokthaweeapanich 2014) and not in topologies with nuclear data (Goh et al., unpublished). Only one other genus (*Soejatmia*) outside this tribe is known to have the transversely wrinkled culm leaf sheath base that is otherwise a clear unifying subtribal character for Dinochloinae; however, unlike in that genus, rudimentary florets do not occur below the perfect florets. See comments under *Soejatmia*.



Fig. 5. *Dinochloa scabrida*, cultivated at the Rimba Ilmu Botanical Garden, University of Malaya, showing the extending climbing-clambering shoot system possible through reiterative development of successively higher orders of primary branch axes. (Photo: K.M. Wong)

3. GRESLANIINAE K.M.Wong & W.L.Goh, **subtribus novum**

The new subtribe Greslaniinae is distinctive among Paleotropical bamboos in having erect to suberect culms that are unbranched or with a solitary branch at each branching node; culm nodes not developing a patella; inflorescence branches subtended by distinct prophylls or bracts; and a flexuous tissue-filled style.

TYPE: *Greslania* Balansa

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short. Culm nodes without patella. Aerial branching not developed (*Greslania circinata* Balansa) or just a single branch (*G. rivularis* Balansa) derived from a solitary primary bud, the primary branch not elongating to reiterate the culm, not or seldom rebranching distally; thorns absent. Culm leaves well developed, auricles not developed at the sheath summit; oral setae none; sheath base without a distinctive zone of transverse wrinkles. Foliage leaf sheaths with or without fimbriae at the sheath summit, auricles indistinct. Synflorescences determinate (spikelets), paniculate; inflorescences terminating leafy culms (*G. circinata*) or branches (*G. rivularis*), inflorescence branches subtended by well-developed prophylls or bracts. Spikelets consisting of 2 glumes, 1 perfect (fertile) floret, and a rachilla extension bearing a terminal rudimentary floret. Palea not keeled. Stamens 6, filaments free. Ovary glabrous with hairy summit, style inconspicuous; stigmas 3, arising directly from the ovary summit. Caryopsis basic.

(Fig. 6)

Distribution: Southwest Pacific: New Caledonia.

Extra-Malesian genera: *Greslania* Balansa.

Comments: Recent molecular analyses (Goh et al., unpublished) show *Greslania* as an independent clade. The molecular phylogeny by Chokthaweeapanich (2014) shows *Greslania* to be a distinct clade closer to the Dinochloinae than to the Racemobambosinae. The morphological analysis of two species by Dransfield (2002) adds to that by McClure (1966).

4. HOLTUMOCHLOINAE K.M.Wong & W.L.Goh, **subtribus novum**

The new subtribe Holttumochloinae is distinctive among Paleotropical bamboos in having culm nodes not developing a patella; mid-culm branching without any dominant axis and all branches subequal; indeterminate inflorescences; and a flexuous tissue-filled style.

TYPE: *Holttumochloa* K.M.Wong

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short. Culm nodes without patella. Aerial branching well-developed; mid-culm branch complement derived from a solitary primary bud or (in *Holttumochloa*) a complement of several to numerous small

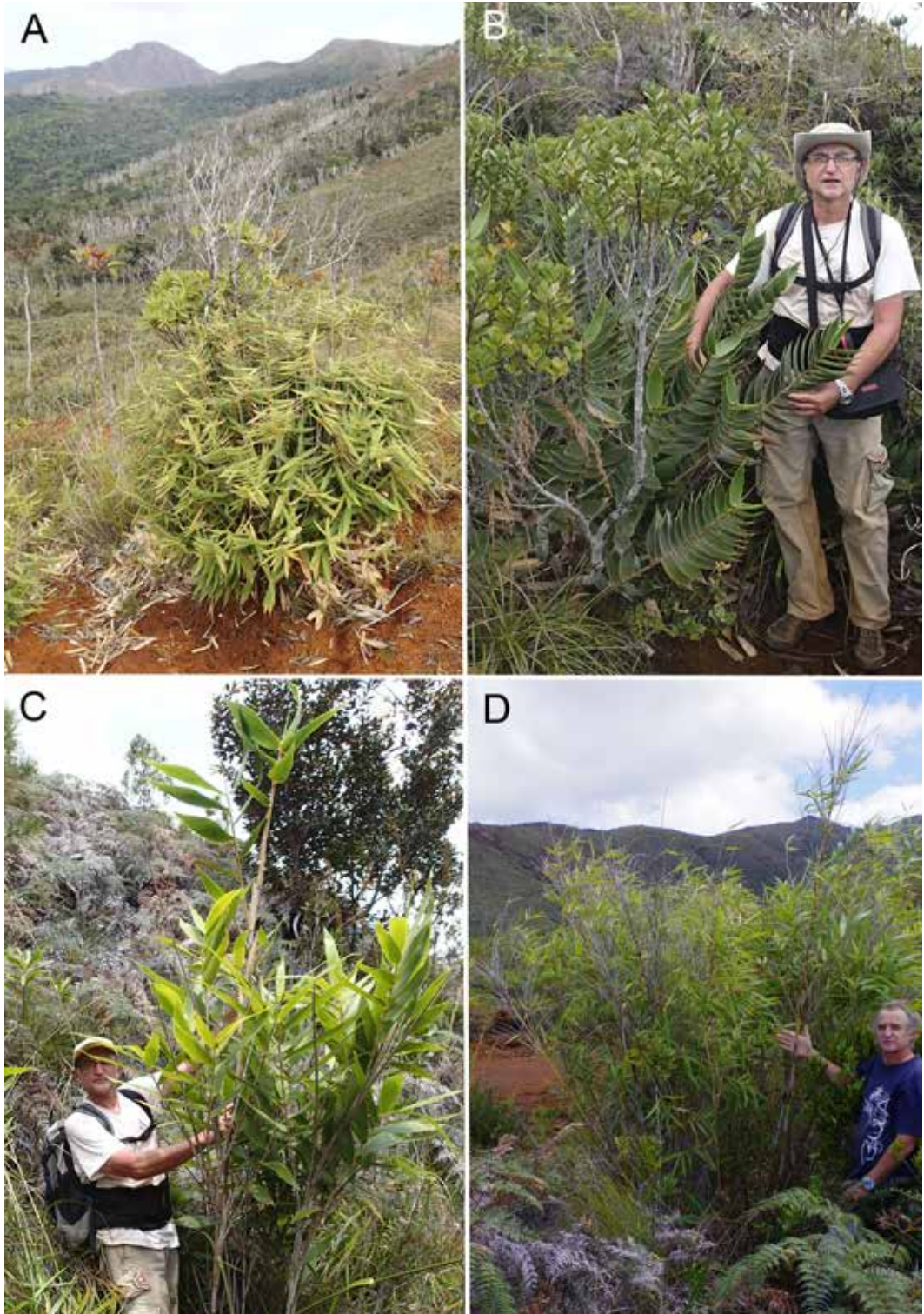


Fig. 6. Greslaniinae: unbranched culms in *Greslania circinata* (A) and *G. montana* (B, with Robert Kernin), or culms producing only solitary branches (C, *G. rivularis*), these sometimes repeatedly producing solitary branches sufficiently to give a bushy appearance (D). (Photos: Robert Kernin)

primary buds, all branches typically slender and subequal, the primary branch(es) none dominant and not elongating to reiterate the culm, not or seldom rebranching distally; thorns absent. Culm leaves well developed, bearing fimbriae or fimbriate auricles or not at the sheath summit; oral setae present or absent; sheath base without a distinctive zone of transverse wrinkles. Foliage leaf sheaths with fimbriae or fimbriate auricles or not at the sheath summit. Synflorescences indeterminate (pseudospikelets), with pseudospikelet clusters along a slender axis or only sparsely paniculately branched. Spikelets consisting of 1–3 glumes, 1–3 perfect (fertile) florets, and a terminal rudimentary floret. Palea not keeled or keels wingless. Stamens 6, filaments free. Ovary glabrous with hairy summit, style inconspicuous; stigmas 3, arising directly from ovary summit. Caryopsis basic.

(Fig. 7)

Distribution: Mainland SE Asia, Malay Peninsula, NW Borneo.

Malesian genera: *Holttumochloa* is known only in Thailand and the Malay Peninsula. *Kinabaluchloa* K.M.Wong straddles the South China Sea with two species, one in mainland SE Asia (Vietnam to north Malay Peninsula), the other in NW Borneo.

Extra-Malesian genera: *Nianhochloa* H.N.Nguyen & V.T.Tran is not known in Malesia, only in the highlands of Vietnam.

Comments: *Holttumochloa* and *Kinabaluchloa* have been recovered as a clade external to the main Bambusinae (BDG complex) by Goh et al. (2010, 2013) and Chokthaweeapanich (2014). Our analyses (Goh et al., unpublished) show *Nianhochloa* to cluster with *Kinabaluchloa* and *Holttumochloa*. As shown in the key, the morphology between *Holttumochloa* and *Kinabaluchloa* would seem rather contrasting. However, it would seem practical to keep them in a single subtribe, rather than have two or three, as suggested by their molecular relationship. In Yang et al. (2008) the extra-Malesian genera *Bonia* Balansa and *Neomicrocalamus* P.C.Keng from China also form a clade just outside Bambusinae. A species earlier misplaced with *Racemobambos* (which typically has determinate inflorescences) (Chao & Renvoize 1989) was later restored to *Neomicrocalamus* (*N. prainii* (Gamble) P.C.Keng, with indeterminate inflorescences) (Stapleton 1994, following Keng 1983). The relationship of these genera to either the Bambusinae or Holttumochloinae as here circumscribed is as yet uncertain.

5. MELOCANNINAE Benth., J. Linn. Soc. London 19 (1881) 31.

TYPE: *Melocanna* Trin.

Synonym: Schizostachyinae Soderstr. & R.P.Ellis in Soderstrom et al., Grass Syst. Evol. (1987) 238. TYPE: *Schizostachyum* Nees.

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short to elongated. Culm nodes without patella. Aerial branching well-developed; mid-culm branch complement derived from a solitary primary bud, typically a cluster of subequal branches of various orders



Fig. 7. Branching in Holttumochloinae is characterized by all branches in a complement being typically slender and subequal, which develop from multiple primary buds (A, *Holttumochloa magica*) or a solitary primary bud (B, C, *Kinabaluchloa wrayi*; D, *Nianhochloa*). The primary branch(es) are not dominant and do not elongate to reiterate the culm. (Photos: K.M. Wong)

from the base of the primary axis; the primary branch rarely dominant in size or length and elongating to reiterate the culm (e.g., *Schizostachyum terminale* Holttum), all branches rebranching distally; thorns absent. Culm leaves well developed, often bearing fimbriae or fimbriate auricles at the sheath summit; oral setae present or inconspicuous; sheath base without transverse wrinkles. Foliage leaf sheaths often with fimbriae or fimbriate auricles at the summit. Synflorescences indeterminate (pseudospikelets), paniculate or a capitate cluster terminal to branches. Spikelets proper of the pseudospikelets consisting of 0, 2 or 4 glumes, 1–3 perfect (fertile) florets, with or without rachilla extension bearing a rudimentary floret. Palea keels wingless or winged. Stamens 6 or (in *Ochlandra*) 15–numerous, filaments free or fused. Ovary glabrous, with a long slender, stiff, hollow style with a central tissue strand; stigmas 2 or 3. Caryopsis basic or (in *Melocanna*, *Ochlandra*, *Stapletonia*) baccate, or (in *Pseudostachyum*) nucoid (the pericarp crustaceous).

(Fig. 8)

Distribution: India through South and SE Asia into Malesia and the SW Pacific.

Malesian genera: *Schizostachyum* Nees is the only native Malesian genus of this subtribe.

Extra-Malesian genera: *Cephalostachyum* Munro, *Davidsea* Soderstr & R.P.Ellis, *Dendrochloa* C.E.Parkinson, *Melocanna* Trin., *Ochlandra* Thwaites, *Pseudostachyum* Munro, *Stapletonia* Singh, Dash & Kumari. The mainland SE Asian *Neohouzeaua* A.Camus, including its type species *N. mekongensis* A.Camus and the more recently described *N. fimbriata* S.Dransf., Pattan. & Sungkaew and *N. kerriana* S.Dransf., Pattan. & Sungkaew, have not been distinguishable in molecular analyses. The position of *Teinostachyum* Munro is still contentious, but possibly with *Schizostachyum*. *Annamocalamus* H.N.Nguyen, N.H.Xia & V.T.Tran, another mainland SE Asian genus, probably belongs in this subtribe and is very near *Schizostachyum*, except for its fleshy fruit.

Comments: The Melocanninae are a consistently demonstrable clade (Yang et al. 2007, 2008; Sungkaew et al. 2009, Goh et al. 2013), although *Davidsea*, *Dendrochloa* and *Stapletonia* have not been thus far included in molecular analyses. The occurrence of a conspicuous white-waxy zone or band just below the culm node, easily observed in fresh culms but occasionally sloughed off in very old culms, may also be a distinctive character of this subtribe, although its absence has not been thoroughly demonstrated for members of other Paleotropical woody bamboo subtribes (it also occurs in the neotropical *Chusquea* Kunth).

6. RACEMOBAMBOSINAE Stapleton, **emend.**

TYPE: *Racemobambos* Holttum

Racemobambosinae Stapleton, Edinburgh J. Bot. 51 (1994) 323–324, pro parte, quoad *Racemobambos*, excl. *Vietnamosasa* & *Neomicrocalamus*.

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short. Culm nodes without patella. Aerial branching well developed; mid-culm branch complement derived from a



Fig. 8. Melocanninae taxa typically have florets with a long slender, stiff, hollow style with a central tissue strand, which persists into the fruit stage (**A**, *Schizostachyum lengguanii*), and very frequently the mid-culm branch complement consists of subequal branches of different orders without a dominant axis present (**B**, *S. grande*). (Photos: K.M. Wong)

solitary primary bud, typically a cluster of subequal branches of various orders from the base of the primary axis; the primary branch initially dormant or not, elongating to reiterate the culm or not; all branches seldom or often rebranching distally; thorns absent. Culm leaves well developed, often bearing fimbriae or fimbriate auricles at the sheath summit or not; oral setae present or absent; sheath base without a distinctive zone of transverse wrinkles.

Foliage leaf sheaths often bearing fimbriae or fimbriate auricles or not at the sheath summit. Synflorescences determinate (spikelets), paniculate or not; inflorescence branches not subtended by well-developed prophylls or bracts. Spikelets consisting of 3–5 glumes, 1 (*Chloothamnus*, *Widjajachloa*) or 3–8 (*Racemobambos*) perfect (fertile) florets, with or without a rachilla extension bearing a terminal rudimentary floret. Palea not keeled or keeled and wingless. Stamens 6, filaments free. Ovary glabrous or hairy at summit, style inconspicuous to elongate, flexuous and tissue-filled; stigmas 3, sometimes arising directly from the ovary summit. Caryopsis basic.

(Fig. 9–10)

Distribution: Malesia: Borneo, Sulawesi, Moluccas (Seram Island), Java, Flores, Sumbawa, Sumba, across to New Guinea.

Malesian genera: *Chloothamnus* Buse, *Racemobambos* Holttum, *Widjajachloa* K.M.Wong & S.Dransf.

Comments: *Racemobambos* species allied to the type (*R. gibbsiae* (Stapf) Holttum) have been consistently recovered as a clade distinct from Bambusinae and other clades (Goh et al. 2013). The so-called *Nastus elegantissimus* (Hassk.) Holttum (= *Chloothamnus*) and *N. productus* (Pilg.) Holttum (= *Widjajachloa*) from Indonesia were recovered in the same clade as *Racemobambos* and far removed from *Nastus borbonicus* J.F.Gmel. and *N. elongatus* A.Camus in the Hickeliinae by Chokthaweeapanich (2014). The earlier definition of Racemobambosinae by Stapleton (1994) is polyphyletic and both *Vietnamosasa* and *Neomicrocalamus* need to be excluded.

7. TEMBURONGIINAE K.M.Wong, **subtribus novum**

The new subtribe Temburongiinae is distinctive among Paleotropical bamboos by its culm-nodes developing a patella; and its flexuous tissue-filled style.

TYPE: *Temburongia* S.Dransf. & K.M.Wong

Diagnostic characters:

Leptomorph rhizomes lacking. Culm bases sympodial, necks short to elongated. Culm nodes with patella present. Aerial branching well-developed; mid-culm branch complement derived from a solitary primary bud, typically with the primary branch dominant in size and length and smaller higher-order branches from its base; the primary branch bud sometimes dormant at first, then elongating into a dominant axis reiterating the culm in habit and structure, rebranching distally; thorns absent. Culm leaves well developed, often bearing narrow, stiff horn-like auricles, at the sheath summit; oral setae absent; sheath base without transverse



Fig. 9. The Racemobambosinae frequently (not always) have a clambering culm habit (A, *Racemobambos gibbsiae*) and are characterized by determinate inflorescences that are either unbranched or sparsely branched (B, *R. hepburnii*) or have ebracteate branches, i.e. not subtended by prophylls or bracts (C, *Chloothamnus*), and bearing spikelets. (Photos: A & B, Ubaldu Majawal; C, K.M. Wong)

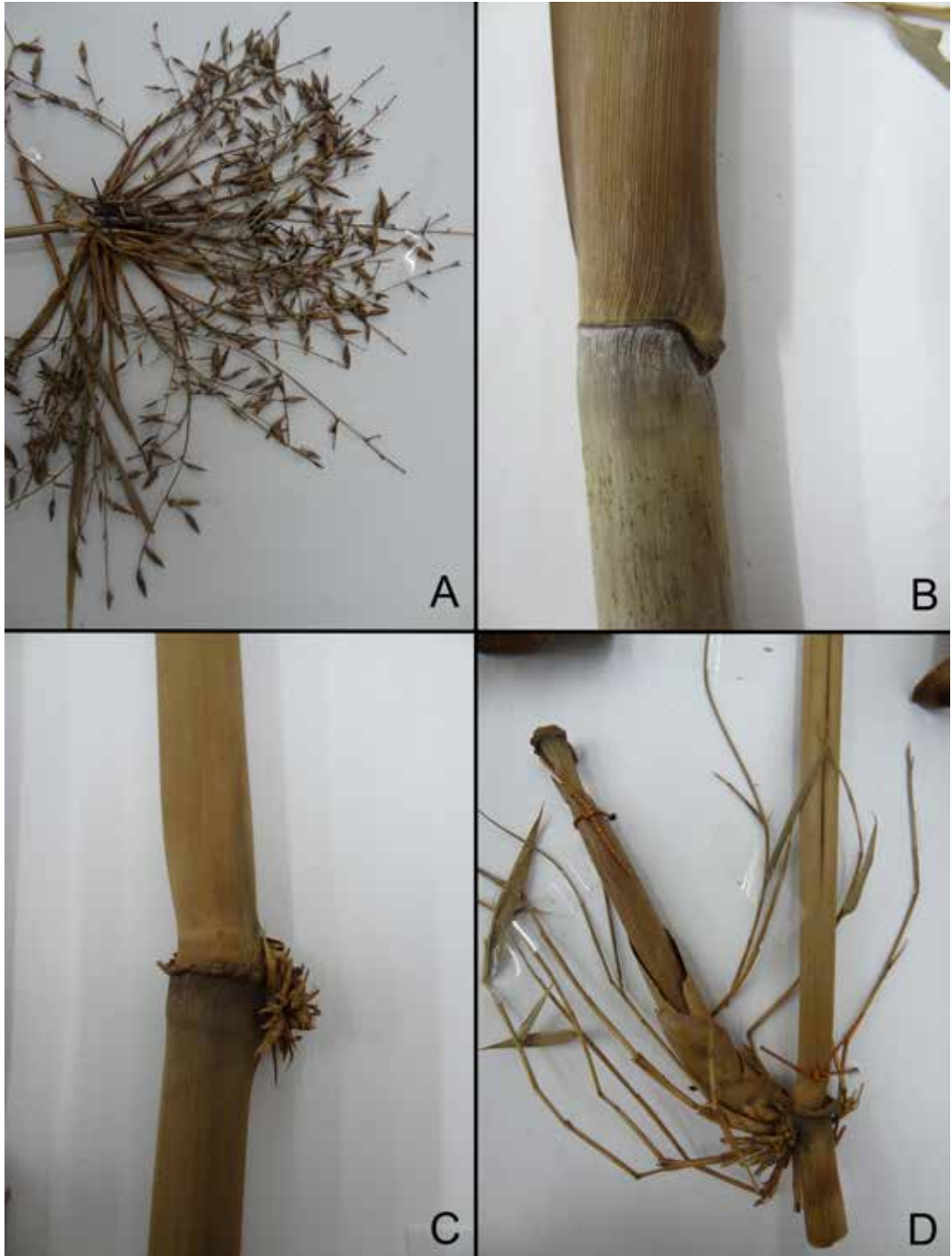


Fig. 10. *Widjajachloa* (Racemobambosinae) shows some typical characteristics of the subtribe: determinate inflorescences with ebracteate branches (**A**); a solitary culm bud (that, however, ‘dips’ below the nodal level compared to other genera of this subtribe) (**B**), development of a dominant primary branch axis that can be at first dormant and producing smaller, higher-order branches from its base (**C**), but later able to develop reiteratively (**D**) and replace or extend its parent axis. (Photos: K.M. Wong)

wrinkles. Foliage leaf sheaths with narrow and stiffly erect, horn-like auricles at the summit. Synflorescences in *Fimbribambusa* indeterminate (pseudospikelets), paniculate with very short branches, or in *Temburongia* ‘determinate’ or a reduced indeterminate condition (spikelets) (see comments below). Spikelets consisting of 1–3 glumes, 2–3 perfect (fertile) florets (in *Temburongia* only 1 rudimentary floret below the solitary perfect floret), and a rachilla extension bearing a terminal rudimentary floret. Palea keels wingless or very slightly winged. Stamens 6, filaments free. Ovary glabrous or hairy at the summit, with a short tissue-filled style; stigmas 3. Caryopsis basic.

(Fig. 11)

Distribution: Northwest Borneo, Philippines (Luzon Island), South Sulawesi, East Java, Lesser Sunda Islands (Alor), New Guinea.

Malesian genera: *Fimbribambusa* Widjaja, *Temburongia* S.Dransf. & K.M.Wong.

Comments: *Temburongia* has been consistently recovered as an independent lineage from Bambusinae and other clades (Goh et al. 2013). The molecular phylogenetic results of Chokthaweeapanich (2014) demonstrate consistent clustering of the above two genera. Dransfield & Wong (1996) provide a detailed analysis of the inflorescence structure in *Temburongia*, noting solitary spikelets as well as sparse clusters of spikelets on the main inflorescence axis; the condition is best described as semelauctant although this could also be an intermediate condition with, or extreme reduction of, the iterauctant condition. Given the close alliance with *Fimbribambusa*, in which the inflorescence can bear proliferating clusters of a few to numerous pseudospikelets and is clearly iterauctant, we may interpret the condition in *Temburongia* inflorescences to be an extreme reduction of the iterauctant state.

TAXA OF UNCERTAIN SUBTRIBAL POSITION

Although *Ruhooglandia* S.Dransf. & K.M.Wong is distinct as a genus from *Chloothamnus* and *Widjajachloa* (Wong & Dransfield 2016), it has characteristics found in *Greslania* (Greslaniinae) and *Widjajachloa* (Racemobambosinae). Like *Greslania*, its inflorescence branches are subtended by well-developed prophylls or bracts, which are absent in the Racemobambosinae. On the other hand, like *Widjajachloa*, the sole perfect floret in its spikelet also has a significant rachilla extension bearing a rudimentary floret. *Ruhooglandia* has not been included in any phylogenetic assessment to date.

Recent molecular experiments (Goh et al., unpublished) show a number of aberrant *Racemobambos* species (*R. hirsuta* Holttum, *R. pairinii* K.M.Wong, *R. rigidifolia* Holttum, *R. setifera* Holttum) forming a cluster separate from typical *Racemobambos* (represented by the type *R. gibbsiae* and the allied *R. hepburnii* S.Dransf.). This group has a different branch complement organization from typical *Racemobambos*. The position of the extra-Malesian *Temochloa liliana* S.Dransf. (so far known only in Thailand) has yet to be clearly demonstrated in molecular experiments. Sungkaew et al. (2009) recovered *Temochloa* as an independent lineage external to the Bambusinae but did not have representatives of typical *Racemobambos*. The results of Kelchner et al. (2013) indicated non-clustering of *Temochloa* with typical *Racemobambos*.



Fig. 11. *Temburongia simplex* with typical characteristics of the Temburongiinae: development of a shelf-like patella around culm nodes (A), raised horn-like culm-leaf sheath auricles (B) and foliage leaf sheath auricles (C). (Photos: K.M. Wong)

* * * * *

*I repeat my vow
in unchanging colors of
the ageless bamboo--
which still creates ten thousand
generations of shadows*

Waka from 18th century Edo Japan attributed to poetess Gion Yuri (1694–1764),
Stephen Addiss (1990)

ACKNOWLEDGEMENTS

The authors wish to acknowledge funding and facilities provided by the Singapore Botanic Gardens under the National Parks Board, Singapore; Universiti Tunku Abdul Rahman (UTAR, Malaysia); Iowa State University (U.S.A.); Kasetsart University (Thailand); Herbarium Bogoriense (Indonesia); and the Chinese Academy of Sciences and South China Botanical Garden for funding and facilities. Work by HC, EAW and LGC was supported by U.S. National Science Foundation Grant DEB-0515712 to LGC; further, HC was supported by a Ministry of Science and Technology scholarship from the Royal Thai Government. We thank Cliff Sussman (American Bamboo Society) and Robert Kernin (Association européenne du bambou Section France) for providing various samples for phylogenetic studies conducted thus far. Dr M. Sugumaran (University of Malaya), Robert Kernin and Ubaldu Majawal (Forest Research Centre, Sabah) are thanked for allowing the use of their images. Louise Neo kindly assisted with figure compositions.

REFERENCES

- Addiss, S. (1990) The three women of Gion. In: Marsha Smith Weidner (ed), *Flowering In The Shadows: Women in the History of Chinese and Japanese Painting*. University of Hawaii Press, Honolulu. Pp. 241–262.
- BPG (Bamboo Phylogeny Group) (2012) An updated tribal and subtribal classification for the Bambusoideae (Poaceae). In: Gielis, J. & G. Potters (eds), *Proceedings of the 9th World Bamboo Congress*, 10–12 April 2012, Antwerp, Belgium. Pp. 3–27.
- Chao, C.S. & S.A. Renvoize (1989) Revision of species described under *Arundinaria* (Gramineae) in South-East Asia and Africa. *Kew Bull.* 44: 349–367.
- Chokthaweeapanich, H. (2014) *Phylogenetics and Evolution of the Paleotropical Woody Bamboos (Poaceae: Bambusoideae: Bambuseae)*. Graduate Theses & Dissertations. Paper 13778. Iowa State University, Ames.

- Clark, L., X. Londoño & E. Ruiz-Sanchez (2015) Bamboo taxonomy and habitat. In: W. Liese & M. Köhl (eds.) *Bamboo. Tropical Forestry* 10: 1–30. Springer.
- Dransfield, S. (2002) *Greslania circinata* and *Greslania rivularis* (Poaceae-Bambusoideae) from New Caledonia. *J. Amer. Bamboo Soc.* 16(1): 1–8.
- Dransfield, S. & K.M. Wong (1996) *Temburongia*, a new genus of bamboo (Gramineae: Bambusoideae) from Brunei. *Sandakania* 7: 49–58.
- Goh, W.L., S. Chandran, D.C. Franklin, Y. Isagi, K.C. Koshy, S. Sungkaew, H.Q. Yang, N.H. Xia, & K.M. Wong (2013) Multi-gene region phylogenetic analyses suggest reticulate evolution and a clade of Australian origin among paleotropical woody bamboos (Poaceae: Bambusoideae: Bambuseae). *Plant Syst. Evol.* 299: 239–257. [DOI 10.1007/s00606-012-0718-1]
- Goh, W.L., S. Chandran, K. Kamiya, & K.M. Wong (2011) A natural hybrid between *Dendrocalamus pendulus* and *Gigantochloa scortechinii* (Poaceae: Bambusoideae: Bambuseae) in Peninsular Malaysia. *Gard. Bull. Singapore* 62: 223–238.
- Goh, W.L., S. Chandran, R.-S. Lin, N.-H. Xia & K.M. Wong (2010) Phylogenetic relationships among Southeast Asian climbing bamboos (Poaceae: Bambusoideae) and the *Bambusa* complex. *Biochem. Syst. Ecol.* 38: 764–773. [DOI 10.1016/j.bse.2010.07.006]
- Judziewich, E.J., L.G. Clark, X. Londoño & M.J. Stern (1999) *American Bamboos*. Smithsonian Institution Press, Washington.
- Kelchner, S.A. & Bamboo Phylogeny Group (2013) Higher level phylogenetic relationships within the bamboos (Poaceae: Bambusoideae) based on five plastid markers. *Mol. Phylogenet. Evol.* 67: 404–413.
- Kellogg, E.A. (2015) Poaceae. In: Kubitzki, K. (ed), *The Families and Genera of Vascular Plants, Vol. 13*. Springer, Heidelberg. Pp. i-xv, 1–416.
- Keng, P.C. (1983) A revision of genera of bamboos from the world. III. *J. Bamboo Res.* 2(1): 11–27.
- Mason-Gamer, R.J. (2004) Reticulate evolution, introgression, and intertribal gene capture in an allohexaploid grass. *Syst. Biol.* 53(1): 25–37.
- McClure, F.A. (1966) *The Bamboos: A Fresh Perspective*. Harvard University Press, Cambridge.
- Soderstrom, T.R. (1981) Some evolutionary trends in the Bambusoideae (Poaceae). *Ann. Missouri Bot. Gard.* 68: 15–47.

- Stapleton, C.M.A. (1994) The bamboos of Nepal and Bhutan Part III: *Drepanostachyum*, *Himalayacalamus*, *Ampelocalamus*, *Neomicrocalamus*, and *Chimonobambusa* (Gramineae: Poaceae, Bambusoideae). *Edinburgh J. Bot.* 51: 301–330.
- Sungkaew, S., C.M.A. Stapleton, N. Salamin & T.R. Hodkinson (2009) Non-monophyly of the woody bamboos (Bambuseae; Poaceae): a multi-gene region phylogenetic analysis of Bambusoideae s.s. *J. Plant Res.* 122: 95–108.
- Vorontsova, M.S., L.G. Clark, J. Dransfield, R. Govaerts & W.B. Baker (in press) *World Checklist of Bamboos and Rattans*. International Network of Bamboo and Rattan, Beijing.
- Wong, K.M. & S. Dransfield (2016) *Ruhooglandia* and *Widjajachloa*, two new genera of Malesian bamboos (Poaceae: Bambusoideae) and their distinction from *Nastus* and *Chloothamnus*. *Sandakania* 22: 1–9.
- Yang, H.Q., S. Peng & D.Z. Li (2007) Generic delimitations of *Schizostachyum* and its allies (Gramineae: Bambusoideae) inferred from GBSSI and trnL-F sequence phylogenies. *Taxon* 56: 45–54.
- Yang, H.Q., J.B. Yang, Z.H. Peng, J. Gao, Y.M. Yang, S. Peng & D.Z. Li (2008) A molecular phylogenetic and fruit evolutionary analysis of the major groups of the paleotropical woody bamboos (Gramineae: Bambusoideae) based on nuclear ITS, GBSSI gene and plastid trnL-F DNA sequences. *Mol. Phylogenet. Evol.* 48: 809–824.

**New combinations in *Chloothamnus*
(Poaceae: Bambusoideae), a genus of Malesian bamboos
formerly confused with *Nastus***

Elizabeth A. Widjaja¹ & K.M. Wong²

¹Herbarium Bogoriense, Botany Division,
Research Centre for Biology – LIPI, Cibinong,
(Present address: Kp. Cimoboran, Ds. Sukawening, Dramaga, Bogor)
Indonesia.
eawidjaja3003@gmail.com

²Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, Singapore 259569.
wkm2000@gmail.com

Summary. Nine species of Malesian woody bamboos, formerly named under *Nastus*, are here recombined into *Chloothamnus* Buse, following the molecular and morphological distinction between the latter genus and *Nastus* Juss.

Wong & Dransfield (2016) and Wong et al. (2016) have clarified the distinction of Malesian bamboo taxa that had been confused with *Nastus* Juss., which has been shown to be a different major lineage from the Malesian species by Chokthaweeapanich (2014). The Malesian taxa can be recognized morphologically as three distinct genera: *Chloothamnus* Buse, *Ruhooglandia* S.Dransf. & K.M.Wong and *Widjajachloa* K.M.Wong & S.Dransf.

Within *Chloothamnus*, so far only two species, *Chloothamnus elegantissimus* (Hassk.) Henrard (of which the type of the genus, *C. chilianthus* Buse, is a synonym) and *C. schlechteri* (Pilg.) Henrard, have been correctly placed nomenclaturally (Henrard 1936). Here we propose new combinations of another nine species that had been named as *Nastus*, which should be accommodated within *Chloothamnus*.

NEW COMBINATIONS IN *CHLOOTHAMNUS*

Chloothamnus elatoides (Widjaja) Widjaja, **comb. nov.**

Basionym: *Nastus elatoides* Widjaja, Reinwardtia 11(2) (1997) 108. LECTOTYPE (here chosen): *Widjaja 6648*, Irian Jaya, Paniai District, Kamu Subdistrict, Idadagi Village (BO: accessions BO-0098847 (culm shoots and sheaths) & BO-0098860 (leafy branch); isolectotypes BO: accessions BO-0098846, BO-0098848, BO-0098849, BO-0098850, BO-0098851; K, L, US).

Chloothamnus elatus (Holttum) Widjaja, **comb. nov.**

Basionym: *Nastus elatus* Holttum, Kew Bull. 21(2) (1967) 291. TYPE: *Millar & Holttum NGF 18538*, New Guinea, Western Highlands, Nondugl, near roadside, 1900 m (holotype K; isotypes A, BO, CANB, L, LAE).

Chloothamnus glaucus (Widjaja) Widjaja, **comb. nov.**

Basionym: *Nastus glaucus* Widjaja, Reinwardtia 11(2) (1997) 110. LECTOTYPE (here chosen): *Widjaja 6403*, Irian Jaya, Jayawijaya District, Kurulu Subdistrict, Uwosilimo Village (BO: accessions BO-1461377 (culm portions with leafy branches), BO-1461388 (culm internodes with sheaths) & BO-1461390 (young culm shoots); isolectotypes BO: accessions BO-1461683, BO-1461371, BO-1461372, BO-1461373, BO-1461374, BO-1461375, BO-1461376, BO-1461378, BO-1461379, BO-1461380, BO-1461381, BO-1461382, BO-1461383, BO-1461387, BO-1461389).

Chloothamnus holttumianus (Bor) Widjaja, **comb. nov.**

Basionym: *Nastus holttumianus* Bor, Österr. Bot. Z. 120(1-2) (1972) 90. LECTOTYPE (here chosen): *Gjellerup 144*, New Guinea, Bivah Hollandia (K: barcode K000290770 (leafy flowering branches)); isolectotypes K: barcode K000290771 (leafy flowering branches), L, U (in L)).

Chloothamnus longispiculus (Holttum) Widjaja, **comb. nov.**

Basionym: *Nastus longispicula* Holttum, Kew Bull. 21(2) (1967) 287. TYPE: *Darbyshire 1210*, Papua, N. District, Tufi Subdistrict, c. 6 miles N. of Moro, between Sisiworo and Dibau rivers (holotype L; isotypes A, BO, BRI, CANB, K, LAE, US).

Chloothamnus obtusus (Holttum) Widjaja, **comb. nov.**

Basionym: *Nastus obtusus* Holttum, Kew Bull. 10(4) (1956) ('1955') 594, 21(2) (1967) 288. TYPE: *Docters v. Leeuwen 10196*, W New Guinea, Rouffaer River, 200 m (holotype K, isotype BO, BRI, GH, L, NY, SING).

Chloothamnus reholttumianus (S.Soenarko) Widjaja, **comb. nov.**

Basionym: *Nastus reholttumianus* S. Soenarko, Gard. Bull. Singapore 30 (1977) 17, t. 1. LECTOTYPE (here chosen): *Iboet 443*, Sumba, Mangiliwari near Maomaru (BO: accession no. BO-1307803 (culm portion with leafy flowering branches); isolectotypes BO: accession nos. BO-1307802, BO-1307804, BO-1307805, BO-1307806).

Chloothamnus rudimentifer (Holttum) Widjaja, **comb. nov.**

Basionym: *Nastus rudimentifer* Holttum, Kew Bull. 21(2) (1967) 288. TYPE: *Brass 13020*, W New Guinea, Idenburg River, 6 km SW of Bernhard Camp, 1450 m (holotype L; isotypes A, BM, BO, US).

Chloothamnus schmutzii (S. Dransf.) Widjaja, **comb. nov.**

Basionym: *Nastus schmutzii* S. Dransf., Reinwardtia 9(4) (1980) 388. TYPE: *Schmutz 2789*, West Flores, Manggarai, Nunang, Todong Rancang, 850 m (holotype BO; isotype L).

ACKNOWLEDGEMENTS

We would like to thank the Director of the Herbarium Bogoriense who kindly gave permission to consult type specimens. Various digital images of type specimens were also consulted on the JSTOR Global Plants website [<https://plants.jstor.org>]. Dr J.-F. Veldkamp had earlier (2014) sent one of us (EAW) a working manuscript “Nomenclatural notes on *Chloothamnus* and *Nastus* (Gramineae, Hickeliinae)” that sought to provide a comprehensive nomenclatural history of the application of the name *Nastus*, but assuming that recombination into *Chloothamnus* should be effected for all remaining Indonesian species formerly ascribed to *Nastus*. In contrast, the work above is derived from a taxonomic perspective, which recognizes that two of the Indonesian taxa formerly placed in *Nastus* should in fact be distinct genera (see Wong & Dransfield 2016) and that the subtribal affinity of these genera is quite distinct from the Hickeliinae (Wong et al. 2016).

REFERENCES

- Chokthaweeapanich, H. (2014) *Phylogenetics and Evolution of the Paleotropical Woody Bamboos (Poaceae: Bambusoideae: Bambuseae)*. Graduate Theses & Dissertations. Paper 13778. Iowa State University, Ames.
- Henrard, J.T. (1936) *Chloothamnus*, a neglected genus of Bambusaceae. *Blumea* 2(2): 60–73.
- Wong, K.M. & S. Dransfield (2016) *Ruhooglandia* and *Widjajachloa*, two new genera of Malesian bamboos (Poaceae: Bambusoideae) and their distinction from *Nastus* and *Chloothamnus*. *Sandakania* 22: 1–9.
- Wong, K.M., W.L. Goh, H. Chokthaweeapanich, L.G. Clark, S. Sungkaew, E.A. Widjaja & N.-H. Xia (2016) A subtribal classification of Malesian and Southwest Pacific woody bamboos (Poaceae: Bambusoideae: Bambuseae) informed by morphological and molecular studies. *Sandakania* 22: 11–36.

Novitates Bruneienses, 7.
***Saurauia* (Actinidiaceae) in Brunei Darussalam**

A.S. Kamariah¹ & K.M. Wong²

¹Environmental and Life Sciences Department,
Faculty of Science, Universiti Brunei Darussalam,
Jalan Tungku Link, Bandar Seri Begawan BE 1410,
Brunei Darussalam
udhl_2003@yahoo.com

²Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, Singapore 259569
wkm2000@gmail.com

ABSTRACT. A synopsis of *Saurauia* (Actinidiaceae), a genus of small rainforest trees, is presented for Brunei Darussalam, as part of an ongoing revision of the genus for the island of Borneo. A key is given to the eleven species present in Brunei, which occupies less than 1 % of the land area of Borneo, where just over 70 species, including many novelties, have been sorted and diagnosed towards a forthcoming revision. *Saurauia bruneiensis* A.S.Kamariah, *S. lepidota* A.S.Kamariah and *S. temburongensis* K.M.Wong are newly described species. *Saurauia pavonii* K.M.Wong is a new name for *S. glabra* (Ruiz & Pav.) Soejarto (1980), non Merrill (1918).

Our interest in Bornean *Saurauia* broadened from a need to identify the species recorded through a first general inventory of the Brunei flora (Coode et al. 1996), in which one of us (ASK) provided a preliminary enumeration of 11 species. Since then, studies of material from across Borneo from the herbaria BO, BRUN, K, L, SAN, SAR and SING, as well as images from JSTOR [<https://plants.jstor.org>] of types held at A, BRI, CANB and NY (herbarium acronyms follow Thiers, continuously updated), in association with the literature, have brought us to a stage where we are able to recognize some 70 species of *Saurauia* in Borneo, including the Brunei taxa. The general account for Borneo will be presented subsequently.

In focussing on Brunei, it is of interest that, although its land area is only 1% of that of Borneo (Joffre et al. 2015), it has as many as 11 species of *Saurauia*. In our present enumeration, three new species are described and a new name is proposed for the Peruvian *Saurauia glabra* (Ruiz & Pav.) Soejarto, a later homonym of the Bornean *Saurauia glabra* Merr.

In the specimen listings, the following abbreviations are used:

For places: B N Borneo – British North Borneo; Bt – Bukit (= Hill); Cpt – Forest Compartment; Div – Division (main administrative unit in Sarawak); FR – Forest Reserve; G – Gunung (=Mount); Kg – Kampung (= Village); LP – Landing Point (helicopter); Mt – Mount; Prov – Province; R – River; Sg – Sungei (= Stream or River).

For elevation and direction: asl – above sea level; E – East; N – North; NE – Northeast; S – South; SW – Southwest; W – West.

For representation of reproductive material on specimens: FL – Flowers incl. buds; FRU – Fruits incl. young stages; ST – ‘Sterile’ (without flowers or fruits).

Months are abbreviated by first three letters only. ‘s.n.’ (*sine numero*) denotes unnumbered collections.

BRUNEI SAURAUIA

KEY TO SAURAUIA SPECIES & VARIETIES IN BRUNEI

1a. Sepals with a moderate to dense covering of suberect-patent to out-curved bristly scales appearing shaggy or tangled, or covered with much overlapping appressed bristly scales appearing densely villous-hairy,

2a. Flowers generally large; with sepals 10–15 mm long, very unequal and typically 2–3 broad-ovate and the others conspicuously narrower 1. *S. amoena*

2b. Flowers of various sizes, but sepals not exceeding 7–9 mm long, subequal in size and ovate to lanceolate,

3a. Midrib on lower leaf surface (and typically also distal twig portions and petioles) with appressed ovate to triangular-lanceolate or bristly scales 3. *S. ferox*

3b. Midrib on lower leaf surface (and typically also distal twig portions and petioles) with only suberect-patent bristly scales,

4a. Inflorescence axes with suberect-patent, long (1–3 mm or more), coarse (c. 0.2 mm diameter) and stiff (often spiky or curved) bristles
..... 9. *S. myrmecoidea* (in part)

4b. Inflorescence axes with appressed to suberect but shorter (< 3 mm), finer bristles
..... 11. *S. temburongensis*

1b. Sepals with a very sparse distribution of scales (the bare surface or minutely mealy or fine-hairy tomentum in between easily visible with a 10× lens), or subglabrous to glabrous, and the bristly scales when present generally appressed (often short) to ascending (and hairlike), straight or sinuous, but not tangled or shaggy,

5a. Scales along distal twig portions and petioles bristly or hairlike, suberect-patent (also typically so along midrib on lower leaf surface, with the exception of some *S. horrida*),

6a. Bristly scales along midrib on lower leaf surface mostly or entirely appressed (but those on petioles and young twig portions suberect-patent) 5. *S. horrida* (in part)

6b. Bristly scales along midrib on lower leaf surface (as well as petioles and young twig portions) suberect-patent,

7a. Scales along the midrib fine and hairlike, less than 0.5 mm long. Flowers big (sepals 10–14 mm long) 6. *S. kinabaluensis*

7b. Scales along the midrib coarse and bristle-like or conspicuously flattened basally (lanceolate-bristly scales), typically 1 mm long or more, sometimes in mixture with finer hair-like scales. Flowers smaller,

8a. Leaf midrib with stiff scales almost perpendicular to the surface. Bristly scales on sepals 2–3 mm long, mostly suberect to stiffly erect 9. *S. myrmecoidea* (mostly)

8b. Leaf midrib with curved-suberect scales. Bristly scales on sepals short, c. 1 mm long only, not stiffly erect 5. *S. horrida* (in part)

5b. Scales along distal twig portions and petioles slender bristly or not, but always appressed (also along midrib on lower leaf surface, which, sometimes subglabrous),

9a. Inflorescence a distinctly branched cyme or panicle,

10a. Flowers larger (sepals 4–5.5 mm long or more) 7. *S. lepidota*

10b. Flowers small (sepals to only 3–3.5 mm long) 2. *S. bruneiensis*

11a. Leaves sessile (petioles less than 1 cm long), subopposite; base cordate. Sepals with distinct tomentum over the surface, visible among bristly scales. [Brunei: Temburong] *S. bruneiensis* var. *bruneiensis*

11b. Leaves clearly petiolate (petioles (0.8–)1.5–2.5 cm long), subopposite to spirally arranged; base cordate to rounded. Sepals mostly without tomentum over the surface, quite bare among bristly scales. [Brunei (Brunei-Muara to Tutong & Belait) & NE Sarawak (Mulu-Baram-Miri area)]
..... *S. bruneiensis* var. *petiolata*

9b. Inflorescences 1-flowered or predominantly so (in some taxa like *S. subcordata*, few-flowered cymes may be occasionally produced as well as, or even among masses of 1-flowered inflorescences),

12a. Flowers small, mature sepals not exceeding 4–4.5 mm long
..... 8. *S. longipetiolata* (var. *melegritoi*)

12b. Flowers larger, mature sepals 5–7(–8) mm long,

13a. Inner sepals conspicuously elongating and longer than outer sepals at fruit stage, all ovate, 7–8 mm long; the calyx-enclosed fruit an ovoid structure
..... 10. *S. subcordata*

13b. Inner sepals larger than outer sepals and spreading outwards at fruit stage, all broad-ovate to rounded, 5–7 mm long; the calyx becoming a cup-shaped structure containing the fruit 4. *S. glabra*

1. *Saurauia amoena* Stapf

Trans. Linn. Soc. London, Bot. 4(2): 134. 1894 [1894–96 publ. Dec 1894]. TYPE: Borneo, Kinabalu, Garai, Kiau, 2500 ft asl, 25 Nov 1892, FL, *Haviland 1361* (holotype K; isotype SING: barcode SING0027264).

BRUNEI. **Temburong**: Amo, headwaters of the Temburong River to the NE of G Retak, 4°22'N, 115°17'E, 850 m asl, 12 Mar 1991, FL, *Sands, Johns, Kaya & Fikir 5345* (BRUN, K, SING).

DISTRIBUTION. Distributed in the highlands of west Sabah (including Kinabalu and the Crocker Range) and Sarawak's inner Baram region (including highlands in the Mulu National Park), Kelabit Highlands and Dulit Range.

2. *Saurauia bruneiensis* A.S.Kamariah, **sp. nov.**

Resembling *Saurauia actinidifolia* Stapf in having lanceolate to bristly scales along the midrib on the lower leaf surface and a sparse but conspicuous covering of bristly scales on

the sepals, but differing in the smaller flowers with sepals to only 3–3.5 mm long (compared to 4–9 mm long in *S. actinidifolia*).

TYPE: BRUNEI. Temburong: Bt Belalong, N ridge, 21 Jul 1989, FL, *Wong WKM 1459* (holotype BRUN, isotype SING).

var. *bruneiensis*

BRUNEI. **Temburong:** Amo, Bt Belalong, clay hillside by River Belalong, hill base, 250 ft asl, Nov 1958, FRU, *Ashton BRUN 5680* (BO, SAN, SAR, SING), NE spur-ridge of Bt Belalong, opposite Sg Tulan, 180–220 m asl, 16 Jul 1993, FRU, *Sands, Hayland, Eri, Mohidin MJS 5836* (BRUN); Kuala Belalong, Sg Belalong, 4°32'N, 115°09'E, 15 Feb 1992, FRU, *Dransfield, Salleh, Han & Suhaili JD 7082* (BRUN), Kuala Belalong Field Studies Centre, 16 Jun 1995, FL, Chen 107/95 (BRUN), 4°33'N, 115°09'E, 9 Mar 1991, FRU, *Nielsen, Balslev & Lasah 1049* (BRUN), Sg Belalong, 300 ft asl, 19 Mar 1957, FL, *Smythies, Wood & Ashton SAN 17373* (A, BO, BRI, BRUN, K, KEP, L, SAN, SING); Temburong National Park, Observation Point, 24 Apr 1998, FRU, *Kamariah 502* (BRUN); Temburong River, Sg Baki, N side of Temburong, 4°32'N, 115°11'E, 16 Jul 1993, FRU, *Atkins, Cowley, Ariffin & Hussain 485* (BRUN, K), Temburong river, tributary of Sg Tulan, N of Temburong river, 4°32' N, 115°11'E, 50 m asl, 15 Jul 1993, FRU, *Atkins, Cowley, Sands, Sharbini & Jang 477* (BRUN); Sg Temburong over 100m upriver from Sg Apan, 15 Jul 1993, FL, *Idris & Han Seng BRUN 15294* (A, AAU, BRUN, K, KEP, L, SAN, SAR, SING, WU), along Sg. Baki, 4°33' N, 115°09' E, 17 Nov 1991, FL FRU, *Hansen 1576* (BRUN), Sg Temburong, downstream from Kuala Belalong, 19 Jul 1988, FRU, *Wong WKM 239* (BRUN, SING), Sg Temburong at Kuala Belalong, 4°32'N, 115°9'E, 20 m asl, 20 Jun 1989, FL FRU, *Dransfield, Wong, Dransfield & Boyce JD 6623* (BRUN, K, SING), Kuala Belalong, on a ridge bounded by the Temburong River, 22 Jun 1989, FL, *Wong WKM 1199* (BRUN, SING).

DISTRIBUTION. Apparently restricted to the Temburong-Belalong catchment forests in Brunei's Temburong district, particularly common along streams.

Saurauia bruneiensis A.S.Kamariah var. *petiolata* A.S.Kamariah, **var. nov.**

Distinctive by the subopposite to spirally arranged, clearly petiolate leaves (petioles (0.8)1.5–2.5 cm long) with cordate to rounded base, and the sepals which are mostly without tomentum over the surface and quite bare among the bristly scales. In contrast, *Saurauia bruneiensis* var. *bruneiensis* has subopposite sessile leaves (petioles less than 1 cm long) with cordate base, and sepals with a distinctly visible tomentum over the surface and among the bristly scales.

TYPE: Brunei, Tutong, Kg Lamunin, 9 Apr 1988, FL, *Wong WKM 55* (holotype BRUN, isotype SING).

BRUNEI. **Belait:** Bt Sawat, Sg Malayan, 10 Jun 2003, FRU, *Ariffin, Watu, Jangarun, Talip & Azlan BRUN 20342* (BRUN); Labi, Kg Tenajor, 2 Nov 1994, FRU, *Niga, Ibrahim & Talip BRUN 15780* (BRUN), Rampayoh, Jalan Rampayoh Timur, trails to Wasai Telingan, 2°22'N, 114°27'E, 20 m asl, 8 Aug 1996, FL, *Joffre, Niga, Ismail, Suhaili & Jangarun BRUN 16582* (BRUN, SING), trail to Wasai Terawan, 22 Feb 1997, FRU, *Ogata, Ariffin, Ibrahim Clayton & Mahadi Og-B447* (BRUN), Rampayoh Hill, 60 m asl, 29 Jan 1997, FRU, *Ariffin, Niga, Ibrahim, Clayton & Watu BRUN 17968* (BRUN, SING), Sg Rampayoh, above waterfall No. 2, 60 m asl, 10 Jan 1994, FRU, *Coode 7792* (BRUN), Teraja, Ulu Sg Mendaram, 4°19'09.2"N, 114°26'16.8"E, 298 m asl, 30 Jul 2010, FRU, *Azlan BRUN 23337* (BRUN); Labi Hills FR, Bt Malayan Road, 19 Oct 1995, FL, *SATC students BRUN 17174* (BRUN, SING), Bt Telingan, Sg Perawan, 27 Aug 2005, FRU, *Azlan BRUN 21375* (BRUN), Cpt 12, Ulu Sg Bang Tajok, 7 Jun 2005, FRU, *Azlan BRUN 21352A* (BRUN), Cpt 49, Ulu Sg Rampayoh, 19 May 2009, FRU, *Yusup, Ariffin, Watu, Jangarun & Azlan BRUN 22638* (BRUN), Mendaram, Wong Kadir Waterfall, 4 May 2005, FL, *Ariffin BRUN 21267* (BRUN). **Temburong:** Peradayan FR, Jangut Waterfall, 5 May 2003, FRU, *Hisham BRUN 20136* (BRUN). **Tutong:** Kiudang-Mungkom, Bedanu Waterfall, 21 Jan 2013, FL, *Low LYW 482* (BRUN); Lamunin, Rambai, New Road Belaban to Belabau, few kilometer from Kg Belaban, 4°33'51"N, 114°43'58"E, 15 m asl, 29 Apr 1997, FL, *Joffre, Suhaili, Clayton & Han Sing BRUN 18305* (BRUN, SING), Ladan Hills FR, 12 Jan 2006, FL, *Ariffin BRUN 21562* (BRUN), Ladan Hills FR, Nyamokning W, N of LP-230, 4°24.45'N, 114°48.36'E, 50 m asl, 4 Jun 1996, FL, *Ariffin, Said, Niga, Joffre, Rosli & Ibrahim BRUN 17557* (BRUN, SING), W-NW of LP-230, along Sg Tutong, 4°24.45'N, 114°48.36'E, 35 m asl, 5 Jun 1996, FL, *Joffre, Said, Niga, Ariffin, Rosli, Ibrahim et al. BRUN 17517* (BRUN, SING); Ladan Hills FR, between Tutong and Bata Rivers, upstream from Belabau, 30 m asl, 4°26'N, 114°48'E, 29 Mar 1990, FL, *Coode 6396* (BRUN).

DISTRIBUTION. Generally in Brunei's Belait and Tutong districts and known only from the Temburong district at Peradayan; also in the adjacent Sarawak area of Baram, including the G Mulu National Park.

3. *Saurauia ferox* Korth.

Verh. Nat. Gesch. Ned. Bezitt., Bot. 132. 1842 [14 Feb 1842]. LECTOTYPE (here designated): Borneo, G Pamatton, no date, FL, *Korthals s.n.* (L: acc. no. 908.251-831).

Saurauia matthewsii Merr., Philipp. J. Sci., C 13: 90. 1918. TYPE: British North Borneo, May–Sep 1917, FL, *Villamil 386* (holotype PNH in A: barcode 00098181).

BRUNEI. **Temburong:** Labu, Ulu Senukoh, Cpt 22, Ulu Sg Senukoh, 89 m asl, 11 May 2010, FRU, *Ariffin, Joffre, Watu, Jangarun, Wafiuddin & Azlan BRUN 22488* (BRUN, K, SING).

DISTRIBUTION. Recorded for Brunei through a single collection, also distributed in Sabah, Sarawak and Kalimantan.

NOTES. In his protologue Korthals (1839–42) stated “*Crescit in monte Pamatton, prope riam Arinawe: BORNEO.*” The specimen *Borneo, riam Arinawe, Korthals s.n.* (L (L no. 908.251-872)) is a syntype. None of the Korthals specimens annotated by Merrill as type material in the herbaria at A, GH, and NY bear either of these two locality names on their labels. Korthals (1842) provides a clear representation of the main characteristics of this species in his Tab. 19.

Merrill (1918) gives the collecting date of *Villamil 386* as 13 Jul 1917.

4. *Saurauia glabra* Merr.

J. Straits Branch Roy. Asiat. Soc. 79: 31. 1918, *non* (Ruiz & Pavon) Soejarto, Fieldiana, Bot. n.s. 2: 32. 1980 (= *Saurauia pavonii* K.M.Wong). TYPE: Sarawak, Matang, Aug 1888, FRU, *Haviland s.n.* (holotype SING: barcode SING0027270); isotype PNH in NY: barcode 00428862).

BRUNEI. **Belait:** Andulau, no date, FRU, *Ashton BRUN 5522* (BRUN), Andulau FR, 24 July 1989, FL FRU, *Wong WKM 1542* (BRUN, SING), Andulau FR, left of logging road to Sg Lumut, 31 Jul 1963, FRU, *Fuchs & Muller 21162* (A, BO, CANB, G, K, L, SAR), Andulau FR, Cpt 7, 3 May 1988, FRU, *Wong WKM 80* (BRUN); River Ingei, upstream from the confluence with the Belait, 1 Jan 1989, FL FRU, *Wong WKM 612* (SAN, SING); Labi, trail to Bukit Teraja, 4°18'56.7"N, 114°26'29.3"E, 328 m asl, 28 Jul 2010, FRU, *Azlan BRUN 23110* (BRUN), Kg Teraja, near Teraja Waterfall, 8 Aug 1996, FL, *Ariffin, Ogata, Han, Janol & Yusof BRUN 17719* (BRUN, SING), Teraja Waterfall, 8 Aug 1996, FRU, *Ogata, Ariffin, Han, Clayton & Ahmad Og-B287* (BRUN); Labi Hills FR, Cpt 12, Ulu Sg Bang Tajok, 7 Jun 2005, FRU, *Azlan BRUN 21350* (BRUN), S of LP Ukur 16 (Nei GRD 333590), 150 m asl, 22 Aug 1997, FL, *Niga, Said, Ariffin, Ibrahim, Han, Clayton & Ismail BRUN 18693* (SING); Labi road, start of track to Andulau FR Compartment 7, 17 Aug 1988, FRU, *Niga NN 35* (BRUN, SING), along Sg Malayan road, 16 Oct 1995, FL FRU, *SATC Students BRUN 17148* (BRUN, SING); Sg Liang, Sg Lumut, 4°38'N 114°30'E, 8 Apr 1993, FL, *Coode, Niga, Awong, Jangarun & Ramlee 7741* (BRUN); Jalan Merangking-Buau, 10 Aug 1991, FRU, *Niga NN 260* (BRUN). **Brunei-Muara:** Bandar Seri Begawan, Kumbang Pasang, Jalan Tasik Lama, Taman Peranginan Tasik, 10 May 1997, FL, *Idris, Ariffin, Suhaili, Ibrahim & Clayton BRUN 18172* (BRUN, SING); Lumapas, Bt Saeh, 17 May 2005, FRU, *Ariffin BRUN 21284* (BRUN). **Temburong:** Amo, Ulu Temburong Nat. Park, KBFSC, 3 Mar 1998, FL, *Hemingway 187* (BRUN), 4 Apr 1998, FL, *Hemingway 249* (BRUN); beside Sg Baki, N side of Temburong, 4°32'N, 115°11'E, 17 Jul 1993, FRU, *Atkins, Hayland, Ariffin & Hussain 505* (BRUN); Ulu Belalong, LP 382, S-facing slope below campsite, 500 m asl, 4°23.310'N 115°11.195'E, FL FRU, *Dransfield, Coode, Kirkup,*

Idris, Jangarun, Han, Ibrahim & Ariffin 7426 (BRUN, K, SING). **Tutong:** Lamunin, Ladan Hills, top of steep slope at forest edge, 90 m asl, 4°38'N 114°46'E, 25 Mar 1993, FL FRU, *Coode & Ferguson 7361* (BRUN); *Medit*, 4°34'N, 114°43'E, 3 Nov 1991, FRU, *Simpson & Marsh 2549* (BRUN); Rambai, Kg Merimbun, Tasek Merimbun, Nature Park Centre, 24 Jun 1997, FL, *Idris, Joffre & Han Sing BRUN 18487* (BRUN, SING), in region of camp site at helicopter pad LP 239, 4°25'N 114°40'E, 150 m asl, 11 May 1992, FRU, *Johns, Niga, Shanang & Han 7630* (BRUN).

DISTRIBUTION. Widespread in Borneo, with most collections from the Brunei and Sarawak area.

5. *Saurauia horrida* Hook.f.

Trans. Linn. Soc. London 23(1): 162. 1860. LECTOTYPE (here designated): Borneo, Mt Barber, no date, FL, *Motley 393* (K: sheet no. H/216/95 22a; isolectotype K: sheet no. H/216/95 22b).

BRUNEI. **Brunei-Muara:** Lumapas, Bt Sa'eh, 3 May 1994, FL, *Joffre, Niga, Sharbini, Ibrahim & Jangarun BRUN 15390* (BRUN, K, SING), 10 Jun 1998, FRU, *Alimantar BRUN 18894* (BRUN), base of Bt. Sa'eh, 13 Oct 1974, FRU, *Davis 507* (BRUN, K). **Temburong:** S of Bangar, end of Temada road, 4°36'N, 115°4'E, 18 Oct 1989, FRU, *Forman 933* (BRUN, K); Bt. Tudal, 130 m from ridge top NW of landing point, 840–1160 m asl, 5 Oct 1994, FL, *Davis 485* (BRUN, K); above helicopter pad LP 286, 25 Apr 1992, FL, *Johns 7313* (BRUN, K), E of helicopter pad LP 286, along stream, 22 Apr 1992, FRU, *Johns 7139* (BRUN, K); Temburong headwaters NE of G Retak, 800 m asl, 12 Mar 1991, FL, *Sands 5350* (BRUN, K), 1150 m asl, 10 Mar 1991, FL, *Sands 5306* (BRUN, K). **Tutong:** Lamunin, Bt. Ladan FR, Ulu Sg Benutan, 4°35.4'N, 114°47.1'E, 10 Feb 2006, FRU, *Watu BRUN 21439* (BRUN); Tasik Merimbun, Bang Galan, 12 Jul 1993, FRU, *Bernstein 407* (BRUN, K).
MALAYSIA. **Sabah:** Tenom, near Pangi, 150 m asl, 23 Dec 1968, FL, *Kokawa & Hotta 2607* (KYO, L).

DISTRIBUTION. Scattered localities in Brunei, Sabah and Sarawak.

6. *Saurauia kinabaluensis* Merr.

Philipp. J. Sci., C 13: 88. 1918. TYPE: British North Borneo, Minitindok Gorge, Mt Kinabalu, 19 Nov 1915, FL, *M.S. Clemens 10458* (holotype PNH in A: barcode 00098175; isotypes A, GH, K).

BRUNEI. **Temburong:** headwaters of Temburong river to the NE of G Retak, 875 m asl, 4°22'N, 115°17'E, 12 Mar 1991, FRU, *Sands, Kaya & Fikir 5336* (BRUN, K, SING).

DISTRIBUTION. The type is from Mt Kinabalu but the species is also found in Tenom (Sabah) and Ulu Trusan (Lawas in Sarawak), as well as Brunei's Temburong highlands.

7. *Saurauia lepidota* A.S.Kamariah, sp. nov.

Resembling *Saurauia actinidifolia* Stapf in having triangular, ovate or linear inflorescence bracts with fine appressed to spreading scales, but differing in its typically few-many-flowered cymes with distinct peduncle typically longer than 2 cm (the inflorescence in *S. actinidifolia* being mostly 1-flowered, sometimes a few-branched cyme with a short peduncle 1–2(–3) cm long), and in the shorter petioles of 1.5(–2) cm long only (those in *S. actinidifolia* typically longer).

TYPE: Sabah, Beaufort, Mile 65 Saliwangan, 25 Jul 1977, FRU, *Talib SAN 84669* (holotype SAN).

BRUNEI. **Tutong:** Tasik Merimbun, Puk Lutong, 7 Oct 1992, FL, *Benstein JHB 212* (BRUN).

MALAYSIA. **Sabah:** without locality and date, FL, *Wood 1170* (K); Beaufort, Bt Bendira, 23 Aug 1975, FRU, *Dewol SAN 80184* (SAN), Lumat, 27 Mar 1948, FL, *Cuadra A 1310* (SING), G Lumaku FR, 6 Mar 1975, FL, *Dewol SAN 78460* (SAN), Halogilat, Padao Gorge, 21 Sep 1961, *Jaswir SAN 27405*, FL FRU (K), FRU (SAN, SAR, SING), Mantanior, 22 Oct 1979, FRU, *Talib & Marsal SAN 84783* (SAN, SAR), Rayoh, Landing area, W side, no date, FL, *Saikeh SAN 72242* (K, L, SAN, SING), Ulu Membakut, 8 Jul 1977, FRU, *Talib SAN 84641* (SAN).

DISTRIBUTION. Mainly in the Beaufort area of SW Sabah, recorded in Brunei only in Tutong.

8. *Saurauia longipetiolata* Merr. var. *melegritoi* (Merr.) A.S.Kamariah, comb. nov.

Basionym: *Saurauia melegritoi* Merr., Philipp. J. Sci. 29: 396. 1926. TYPE: British North Borneo, Banguay Island, Jul–Sep 1923, FRU, *Castro & Melegrito 1401* (holotype K; isotypes A: barcode 00098174, UC: barcode 241502).

Saurauia amplifolia Merr., J. Straits Branch Roy. Asiat. Soc. 86: 330. 1922 [Nov 1922], non Diels, Bot. Jahrb. Syst. 57(4): 452. 1922 [23 May 1922]. *Saurauia euryphylla* Airy Shaw, Bull. Misc. Inform. Kew 1940(6): 248. [10 Dec 1940]. TYPE: British North Borneo, Sandakan, 1 Dec 1920, FL, *Ramos 1245* (holotype PNH, destroyed; isotype GH: barcode 00098139).

BRUNEI. **Temburong**: Batu Apoi FR, Bt Gelaga, 4°34'N, 115°15'E, 28 Oct 1991, FL, *Simpson 2486* (BRUN), Kuala Belalong, along the Sg Sitam, a major tributary of the Sg Belalong, above the FSC, 4°33'N, 115°9'E, 11 Nov 1991, FL, *Hansen 1547* (BRUN), c. 1 km upstream from Sg. Tulan, on Belalong side, 4°32'N, 115°11'E, 17 Jul 1993, FL, *Sands, Cowley, Han & Sharbini 5851* (BRUN), Temburong River valley, in area of river bed near helicopter pad LAP 286, downstream from pad and up a small side stream and on associated ridge communities, c. 30–50 m asl, 24 Apr 1992, FL, *Johns, Niga, Salleh, Shanang, Han & Ramlee 7257* (BRUN); Sg Batu Apoi, tributary Sg Tongkat, 50 m asl, 29 Jan 1964, FRU, *Hotta 13750* (L). **Tutong**: Lamunin, Ladan Hills FR, 90 m asl, 4°38'N, 114°46'E, 25 Mar 1993, *Ferguson 7361* (K, SING), between Tutong & Bata rivers, upstream from Belabau, 4°26'N, 114°46'E, 30 m asl, 29 Mar 1990, FRU, *Coode et al. 6382* (BRUN); Layong-Gadong pipeline track, valley bottom near road, 4°22'N, 114°28'E, 20 m asl, 7 Nov 1990 FRU, *Dransfield 6816* (BRUN).

DISTRIBUTION. A frequent species throughout Borneo. *Saurauia longipetiolata* var. *longipetiolata* is apparently restricted to the Kinabalu area and is typified by *M.S. Clemens 10496*, British North Borneo, Mt Kinabalu, Minitindok Gorge, 19 Nov 1915, FL FRU (holotype PNH in A (barcode 00098176), isotype A).

NOTES. In his protologue, Merrill (1926) notes that *Castro & Melegrito 1401* was collected on June 8, 1923. *Saurauia amplifolia* Diels, non Merr., is from New Guinea.

9. *Saurauia myrmecoidea* Merr.

Philipp. J. Sci., C 13: 91. 1918. TYPE: Sarawak, Selungo, Nov 1914, FL, *Native collector 2838* (holotype PNH, probably destroyed). NEOTYPE (here designated): Borneo, Sarawak, Feb–Jun 1914, FL, *Native collector 2579* (K: 2 sheets clearly marked as Sheets I and II).

Saurauia spinuloso-setosa Merr., J. Straits Branch Roy. Asiat. Soc. 79: 32. 1918 [Sep 1918]. TYPE: Sarawak, Kalaka, 17 Apr 1893, FL, *Haviland s.n.* (holotype SING: barcode SING0052722; isotype PNH in A: barcode 00098251; photo in K).

BRUNEI. **Brunei-Muara**: Sengkurong, Kampong Kilanas, Jalan Dadap, trail to Dadap waterfall, 31 Dec 2007, FRU, *Zukrina BRUN 22259* (BRUN). **Temburong**: Amo, upstream of Kuala Belalong, 22 Jul 1988, FL, *Wong 268* (BRUN, SAR, SING), Ulu Belalong LP 382, north facing slopes below campsite, 4°32'N, 115°11'E, 450 m asl, 18 Jan 1994, FL, *Coode et al. 7841* (BRUN); headwaters of Temburong River to the NE of G Retak, 4°22' N, 115°17'E, 800 m asl, 12 Mar 1991, FL, *Sands et al. 5365* (BRUN), Wong Nguan rapids, 4°31'N, 115°15'E, 120 m asl, 8 Apr 1990, FL, *Coode et al. 6624* (BRUN).

DISTRIBUTION. Throughout Borneo, very common in Sarawak.

NOTES. In his protologue, Merrill (1918) clearly indicated *Native collector 2838* as type but simultaneously cited the numbers 2797 and 2579. Only 2579 can be located at Kew and this is here proposed as neotype, the other numbers likely without duplicate and destroyed in the PNH herbarium in World War 2.

10. *Saurauia subcordata* Korth.

Verh. Nat. Gesch. Ned. Bezitt., Bot. 124. 1842 [14 Feb 1842]. TYPE: Borneo, FL, *Korthals s.n.* (holotype L: acc. no. 908.251-501), ST, *Korthals s.n.* (isotype K: sheet no. H/216/95 35).

Saurauia heterosepala Merr., Philipp. J. Sci., C 13: 87. 1918. TYPE: British North Borneo, Mt Kinabalu, Khota Balud to Kibayo, 28 Oct 1915, FL, FRU, *M.S. Clemens 9812* (holotype PNH in A: barcode 00098179).

BRUNEI. **Belait:** Andulau FR, 150 ft asl, 15 Jul 1958, FRU, *Ashton BRUN 3251* (BRUN, SAR), Compartment 7, 3 May 1988, FL, *Wong WKM 80* (SING). **Brunei-Muara:** Brunei, Peradayan FR, 29 Jul 1954, FRU, *Sow KEP 80173* (BRUN). **Temburong:** 6 Km ESE of Batang Duri, 4°32'N, 115°10'E, 50 m asl, 31 Jul 1992, FRU, *Schatz et al. 3298* (BRUN); Bt Biang, base, 20 m asl, 4°41'N, 115°06'E, 17 Oct 1989, FL, *Forman & Blewett 893* (BRUN); Kg Sibatang, 8 km from Temada Bukuk, 4°36'N, 115°04'E, 18 Oct 1989, FL, FRU, *Forman 948* (BRUN, K, SING); Selapon, banks of Sg Batu Apoi, 4°40'N, 115°12'E, 15 m asl, 17 Nov 1990, FRU, *Dransfield 6906* (BRUN, K, SING); Sg Temburong at Kuala Belalong, 4°32'N, 115°9'E, 25 m asl, 22 Jun 1989, FL, *Dransfield 6660* (BRUN, K, SING), along the rivers Temburong and Belalong, near their junction, approx 4°30'N, 115°10'E, below 500 m asl, Sep 1930, FL, FRU, *Jacobs 5581* (BRUN), Belalong (plot voucher for K916), 1959, ST, *Ashton s.n.* (BRUN), Temburong river, just upstream from Wong Nguan rapids, 400 m asl, 10 Apr 1990, FL, *Coode 6731* (K, SING), Temburong river valley, in area of river bed above helicopter pad, LP 286, including collections along a major branch north towards Saraawk border, c 30–50 m asl, 25 Ap 1992, FL, *Johns et al. 7309* (BRUN), Temburong river valley, along stream to E of helicopter pad, LP 286, c. 30–50 m asl, 27 Ap 1992, FL, *Johns et al. 7380* (BRUN). **Tutong:** Rambai, Ladan Hills FR, Bt Bedawan, SW of LP 263, 4°29'33"N, 114°48'52"E, 270 m asl, 27 Mar 1997, FL, *Joffre et al. BRUN 18133* (BRUN, SING).

DISTRIBUTION. Throughout Borneo; also in Palawan.

11. *Saurauia temburongensis* K.M.Wong, **sp. nov.**

Resembling *Saurauia agamae* Merr. in having a glabrous upper leaf surface and sepals with suberect-patent and often overlapping or entangled bristles, but differing by its 1-flowered

unbranched inflorescences (those of *S. agamae* are branched cymes with few to many flowers).

TYPE: Brunei, Temburong, Amo, Apoi FR, Temburong river catchment, Apan, tributary of Sg Tulan, 4°32'N, 115°11'E, 120–130 m asl, 14 Jul 1993, FL, *Sands 5802* (holotype SING; isotypes BRUN, K).

BRUNEI. **Temburong:** Bt Biang, 20 m asl, 17 Oct 1989, FL, *Forman 913* (BRUN, K); Bt Gelagas, Sg Arur, 4.34°N, 115.15°E, 27 Oct 1991, FRU, *Simpson 2371* (BRUN, K); Bt Lutut, E of LP 297, 8 Apr 2004, FL, *Hisham BRUN 20915* (BRUN); Selapon, banks of the Sg Batu Apoi, 4°40'N, 115°12'E, 15 m asl, 17 Nov 1990, FL, *Dransfield 6908* (BRUN, K, SING); Sg Temburong, Sg Apan, 14 Jul 1993, FL, *Idris & Melinau BRUN 15288* (BRUN, SING), a few hundred meters upriver from Sg Apan, 15 Jul 1993, FL, *Idris & Han Seng BRUN 15602* (BRUN, SING), Apan, tributary of Sg Tulan, 4°32'N, 115°11'E, 120–130 m asl, 14 Jul 1993, FL, *Sands 5802* (BRUN, K, SING).

DISTRIBUTION. Apparently restricted to the Temburong district of Brunei.

NOTES. This is apparently a rheophytic species occurring along swift-flowing rocky streams.

SAURAUIA SPECIES NOT YET RECORDED FOR BRUNEI

The exploration and documentation of the rich Brunei flora is far from complete (Joffre et al. 2015). It is therefore still possible to expect further records of *Saurauia* species. Here we list a number of the more common ones that have not yet been recorded, or those that are known in the vicinity of Brunei but not yet collected there, which could turn up with continuing exploration.

Saurauria actinidifolia Stapf

Not recorded for Brunei although occurring in Sabah, Sarawak and Kalimantan.

Saurauia acuminata Merr.

Not recorded for Brunei although occurring in Sabah, Kalimantan and Lawas (Sarawak).

Saurauia hosei Merr.

Not recorded for Brunei, possibly just restricted to the Baram-Lambir-Bintulu area of Sarawak.

Saurauia nigrescens Korth.

Not recorded for Brunei but occurs sporadically across Sabah, Sarawak and Kalimantan.

Saurauia platyphylla Merr.

Not recorded for Brunei but occurs in highland areas of west Sabah (Kinabalu, Crocker Range) and adjacent Sarawak (Kelabit Highlands).

CORRECTED PAST RECORDS AND A NEW NAME

The checklist by Coode et al. (1996) was the first recent listing of all the seed plants of Brunei that were known until then. The enumeration of *Saurauia* at the time reflected a first contact with the genus before studies began for revising the Bornean taxa by the senior author (ASK) at Kew. The following entries in Coode et al. (1996) have now been reassessed as follows.

‘*Saurauia agamae* Merr.’ is mainly a Sabah species and does not occur in Brunei. *Coode 6396* is re-determined as *Saurauia bruneiensis* var. *petiolata* here.

‘*Saurauia hooglandii* A.S.Kamariah’ is an unpublished name, and is identifiable with *Saurauia glabra* Merr. See below, under *Saurauia pavonii*.

‘*Saurauia isosepala* A.S.Kamariah’ is an undescribed Sabah species; *Coode 6731* is *Saurauia subcordata*.

‘*Saurauia javanica* (Bl. ex Nees) Hoogl.’ is not in Borneo; *Sands 5345* has been re-identified as *Saurauia amoena* here.

‘*Saurauia longistyla* Merr.’, represented by *Ashton BRUN 3251*, etc. is *Saurauia subcordata*.

***Saurauia pavonii* K.M.Wong, nom. nov.**

Replaced name: *Saurauia glabra* (Ruiz & Pav.) Soejarto, Fieldiana, Bot. n.s., 2: 32 (1980). LECTOTYPE (Soejarto 1980): Peru, Huanuco, no date, FL, *Pavon s.n.* (G; photo in GH).

The basionym of the Peruvian species, *Palaua glabra* Ruiz & Pav., Syst. Veg. Fl. Peruv. Chil. 1: 182 (1798), when transferred to *Saurauia* as *Saurauia glabra* (Ruiz & Pav.) Soejarto (1980), is illegitimate because of the existence of the earlier combination *Saurauia glabra* Merr., J. Straits Branch Roy. Asiat. Soc. 79: 31 (1918), based on a different type. Our new name honours the collector of the type of the replaced name.

ACKNOWLEDGEMENTS

We wish to thank the various institutions and herbarium keepers and curators who have loaned material for study or facilitated visits for consulting material in their care, including especially the BO, BRUN, K, L, SAN, SAR and SING herbaria. ASK specially acknowledges Dr John Dransfield and Mark Coode of the Royal Botanic Gardens Kew for helping to initiate her studies in this genus and Dr David S. Edwards of the University of Brunei Darussalam for his encouragement. KMW wishes to acknowledge Dr M.M.J. van Balgooy and Dr J.-F. Veldkamp (Naturalis Biodiversity Centre, Leiden), Dr Joeni S. Rahajoe, Dr Elizabeth A.

Widjaja, Dr Marlina Ardiyani and Ridha Mahyuni (Bogor), Runi Anak Sylvester Pungga (Sarawak Forestry Department), Dr Y.F. Lee, John Sugau, Dr Joan Pereira and Eyan Khoo (Forest Research Centre, Sabah Forestry Department) for help and hospitality during working visits to their institutions. We thank Dr John Dransfield, Royal Botanic Gardens Kew, for nomenclatural discussions. Special thanks are due to the Brunei botanical team under Joffre Haji Ali Ahmad and Muhammad Ariffin A. Kalat for their efficient and consistent help throughout our studies.

REFERENCES

- Coode, M.J.E., J. Dransfield, L.L. Forman, D.W. Kirkup & I.M. Said (eds) (1996) *A Checklist of the Flowering Plants and Gymnosperms of Brunei Darussalam*. Ministry of Industry & Primary Resources, Brunei Darussalam.
- Joffre, A.A., A.K. Muhd-Arifin, Y.W. Low & K.M. Wong (2015) Novitates Bruneienses, 1. A background to the botanical survey of Brunei Darussalam, and a new species of *Jarandersonia* (Malvaceae). *Gard. Bull. Singapore* 67(1): 51–60.
- Soejarto, D.D. (1980) Revision of South American *Saurauia* (Actinidiaceae). *Fieldiana, Bot. N.s.* 2: 1–141.
- Thiers, B. (continuously updated). *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> (accessed on 31 May 2016).

Notes on northern Borneo Myrtaceae

Peter Ashton

Arnold Arboretum, Harvard University
22 Divinity Avenue, Cambridge, MA 02138, U.S.A.
pashton@oeb.harvard.edu

and

Herbarium, Library, Art & Archives
Royal Botanic Gardens, Kew
Richmond, Surrey TW9 3AE, U.K.

Summary. While preparing the account of Myrtaceae for the Tree Flora of Sabah and Sarawak, footnotes to species were added, either explaining reasons for nomenclatural changes, or highlighting my views on differences between similar species, especially in field characters. These were, with very few exceptions, not included in the Flora, so are presented here to assist, especially, field workers.

A leading reason why I volunteered a revision of northern Borneo Myrtaceae for the *Tree Flora of Sabah and Sarawak* was the challenge provided by *Syzygium* (Ashton 2011). The largest genus of Borneo trees, with one hundred and seventy eight there recognized by me in Sabah and Sarawak and a further twelve described from elsewhere in Borneo, its species are reputedly notoriously difficult to identify. Further, the second largest genus is *Shorea*, with which I have been familiar for many years. But whereas *Shorea* is subdivided into discrete sections that might justify generic status were visible characters discovered which would match phylogenetic relationships (Ashton 2004), natural groupings based on morphology are less distinct in *Syzygium*. Sections of *Shorea* are distinguished by characters of the androecium, and the flowers are visited either by honey bees (*Apis*) which are distant foragers, or small insects, notably *Trigona* bees, and thrips but probably others according to the section, which normally disperse only short distances; while fruit disperse by gyration, normally also a very short distance in closed forests. *Syzygium* flowers are visited, at least among large-

flowered species, by a variety of insects including bees and wasps, and butterflies; while their fruit are devoured and seeds dispersed by vertebrates, notably birds that may disperse them long distances. Most striking, although dipterocarps are known to freely hybridize, the seemingly trivial characters which distinguish sister species are remarkably constant, even among widespread species. One study has shown that hybrid mortality is high, but apparently rarely surviving beyond the F1 generation (Kamiya et al. 2011, Ashton 2015). Adventive embryony, which can lead to reduction in genetic variation in populations, commonly occurs in both genera (this was found with triploidy, which likewise prevents outcrossing, in one dipterocarp (Wickneswari et al. 1995)). This might explain the occurrence of consistently distinct allopatric forms that I have called subspecies in several *Shorea* and other dipterocarp taxa. But although adventive embryony is well known in *Syzygium* (Tiwary 1926, Kaur et al. 1978), interspecific and intraspecific morphological variability is very different in *Syzygium*, and the major cause of difficulty in species definition and diagnosis.

I have always adhered to the broad species view, inspired by that adopted in the *Flora Indica*, and later *Flora of British India*, and advocated by van Steenis for *Flora Malesiana*. Both Hooker and van Steenis accepted a broad concept in part because it yields a simple and accessible account of a flora when patterns of local and regional variation are still poorly known owing to paucity of collections. As a field ecologist, I have marvelled at their foresight. It will always be easier to distinguish new taxa later, when hypothesis can be tested by adequate observation and collection; but it is frustrating indeed, during field observation and especially the close examination of population samples imposed by plot census, when it proves necessary to disentangle rival names where no discontinuity exists. Importantly, with this broad species concept I have found it possible to identify all but a very few of the almost two hundred northern Borneo *Syzygium* on the basis of leaf and twig characters.

Putative natural species groupings in Borneo *Syzygium* are defined in my key to species in Sabah and Sarawak. Although some were formerly awarded generic status, this has not been substantiated by further collections and molecular genetic research (references in Craven et al. 2006). Variability within widespread species appears to be continuous, and local rather than geographical as in *Shorea*. It seems at least in part ecological, in relation to soils. This applies also to apparent sympatric speciation, good examples of which occur in Sabah, both at higher elevations on Mount Kinabalu, and on ultramafics and their adjacent peridotite-derived loams. These are the two themes of the following notes, which also discuss nomenclatural decisions made in the Tree Flora account.

In the notes below I frequently use the abbreviation TFSS 7 to refer to the volume in which my account has been published as Ashton (2011).

SPECIES GROUPS AND PAIRS

Is *Cleistocalyx* a natural group?

Cleistocalyx Bl. was recognized by Merrill & Perry (1937) 322 for that growing number of species which differ from *Syzygium* in their fused sepals, forming an accute snuffer-like bud. Two of the species had a *Syzygium* sister differing consistently solely in this one character, but the discovery of an entity which clearly represents the closed-calyx form of a distinctive *Syzygium*, sharing its habitat and locality, has cast doubt on the validity of the genus. This doubt has been confirmed by molecular genetic evidence (Craven et al. 2006), indicating that cliestocalycine species are scattered among *Syzygium* groupings. Bornean species thus affected are the following:

Syzygium barringtonioides (Ridl.) Masam. var. *quadrisepalum* P.S.Ashton, Kew Bull. 61 (2006) 113, TFSS 7: 177. Differing from the type solely in that the flower sepal lobes are distinct, 4, to 3×3 mm, ovate, acute, papery and reflexed at anthesis. Apparently uncommon, on the banks of muddy rivers in the lowlands, which is the same habitat as the type.

Syzygium calyptrocalyx P.S.Ashton. (TFSS 7: 183). Described as *Cleistocalyx leuocladus* Merr. & L.M.Perry. A new name was required because *Syzygium leuocladum* Merr. & L.M.Perry has precedence. This species shares the habitat of *Syzygium havilandii* (Merr.) Merr. & L.M.Perry whose distinctive leaf, frequently with veins narrowly furrowed above, can be indistinguishable from that of *S. calyptrocalyx*. Other than the calyx, the white corky twigs of *Syzygium calyptrocalyx* appear to distinguish it, but this requires more field confirmation.

Syzygium cleistocalyx (Merr.) P.S.Ashton. (TFSS 7: 193). Apparently uncommon, on floodplains and river banks, including behind the mangrove in the tidal reaches; also recorded in the lower facies of upper montane forest on Bt Sempandai, at 1600 m. This extraordinary ecological distribution may imply that the species merely encompasses variants of *Syzygium barringtonioides*. More field observation is required.

Syzygium nervosum DC. (TFSS 7: 248). The most widespread *Syzygium*: from South Asia, Indo-Burma and South China to Australia. Uncommon in Borneo, scattered in evergreen forest, especially in flood plains including shallow peat, and on moist undulating land on fertile clay soils in mixed dipterocarp forest. Apparently more common in Sabah than Sarawak. A light demander, often riparian. Curiously, *Syzygium nervosum* in India, still recognized by many foresters there as *S. operculatum*, is best known as a subcanopy tree in moist deciduous forest, and in semi-evergreen forest, while it recurs as a streamside subcanopy species in SW Sri Lanka.

Syzygium perspicuinervium (Merr.) Masam. (TFSS 7:262). *SAN 54612*, which otherwise matches the type, has 4 unequal flower sepals only partially hiding the incrassate corolla dome. The only known flower buds are young. We predict that, as in *Syzygium barringtonioides*, the buds will be larger and more slender at maturity.

Syzygium soepadmoi P.S.Ashton (TFSS 7:285). Endemic to the Bukit Tavai ultramafics, Sabah. Apparently allied to the Philippine cleistocalycine *Syzygium arcuatinervis* (*Cleistocalyx arcuatinervis* (Merr.) Merr. & L.M.Perry, of unknown ecology; but differing in its smaller more coriaceous leaf with obscure venation and, notably, its calyx which, although with united lobes, opens in an apical pore.

Groups whose species are geographically and/or ecologically distinct

These groups represent, in my understanding and with exception of the first, species series that have diversified so far that they no longer form natural series of sisters, albeit differing mostly only in seemingly trivial characters.

The Aphanomyrtus Group

Aphanomyrtus Miquel is based on the Sumatran *A. rostrata* Miq. which shares, with *Syzygium caudatum* (Merr.) Airy-Shaw, *S. skiophilum* (Duthie) Airy-Shaw and *S. biniflorum* (Ridl.) P.S. Ashton, a short inflorescence and small flowers with few stamens. Although a field description of *A. rostrata* is unavailable, all appear to be small slender trees of understorey shade. They are thus analogous to the species groups in several other rainforest genera in which the understorey habit is associated with reduction in flower size and, particularly, the number of stamens, a view supported by the many staminodes of *Syzygium biniflorum*. To them might be added the upper montane forest canopy species *Syzygium quadricostatum*, with 10 stamens. *Syzygium biniflorum*, *S. olivaceum* and *S. skiophilum* do appear to be sister species, but the others more likely evolved independently. Study of their breeding systems is merited.

Syzygium skiophilum Airy Shaw. (TFSS 7: 284). Sister species to *Syzygium biniflorum*. Merrill and Perry described the stamens of *S. filicaudum* (holotype: *Endert 3680*, Kong Kemul, E. Kalimantan, BO) which I consider a synonym, as ‘many’. I failed to find evidence of this in the type specimen at A, or of other Borneo material now available, where they all prove to number 8.

A seemingly natural group: the Attenuatum Group (TFSS key, p. 137)

The following species are united by their distinctive clove-shaped flower buds, and by their small to medium sized ovate to elliptic more or less coriaceous leaves, black dotted beneath and drying ochreous to rust-brown. They appear to form a natural series of sisters, mostly

differing in trivial characters of leaf and twig.

Syzygium adenophyllum Merr. & L.M.Perry. (TFSS 7: 165). Easily confused with *Syzygium napiforme* whose carrot-shaped fruit is distinctive, and its wartiness visible in the flower bud. The twig in that species is grey-brown, not distinctive whitish as in *Syzygium adenophyllum*. Further collection may yet prove the two synonymous.

Syzygium attenuatum (Miq.) Merr. & L.M.Perry. (TFSS 7: 172). Our form differs from that general in Peninsular Malaysia and Sumatra in its shorter, few-flowered panicle, larger fruit and obscure leaf venation; but in the following collections the panicles are much branched and floriferous, the fruit to 7×5 mm, and the venation (*Sugau JBS 70*, *S 67512* excepted) distinctly raised beneath with the tertiary venation forming a fine net, in these respects resembling the Sumatran type form: Sabah: *SAN 32362* Sosopodon Ranau, *JBS 70* route to G. Alab Tambunan, *SAN 35054* S. Liwagu Ranau, *SAN 62202* M.38 Ranau road; Sarawak: *S 22190* Bt Meninga, *S 25673* Bt. Mabong Melinau, *S 67512* Bt. Lanjak Ulu Ai; Brunei: *Schatz et al. 3303*, Bt. Belalong; W. Kalimantan: *Laman et al. s.n.*, G. Palung. With the exception of the last, these were collected from upper dipterocarp forest at 800–1400 m. A distinct variety is found on Kinabalu (e.g. *SAN 57802*, Power Station) in which the leaves are more leathery, drying red-brown.

Syzygium flagrimonte P.S.Ashton. (TFSS 7: 207). A distinctive upper montane apparent point endemic distinguished from *Syzygium napiforme*, which appears to be its sister species, by its habit and smaller subacute to obtuse leaves with 8 pairs of veins, and unusually slender floral pseudostalk.

Syzygium fusticuliferum (Ridl.) Merr. & L.M.Perry. (TFSS 7: 210). Difficult to distinguish from *Syzygium oligomyrum* juveniles when not in flower, though in that species the leaf dries distinctly rust- to buff brown, rather than chocolate-brown. When in flower, the prominent sepal lobes, almost enveloping the corolla, distinguish it.

Syzygium napiforme (Koord. & Valetton) Merr. & L.M.Perry. (TFSS 7: 247. This species still requires comparison with *Syzygium rynchophylla* Miq. of Java, whose type I have not seen.

Syzygium oligomyrum Diels. (TFSS 7: 254). Easy to confuse with *Syzygium fusticuliferum*, and *S. monticolum* of the Chloranthum Group, when an immature tree. The type represents the immature leaf form but the flowers, venation and pits on the blade above are characteristic. *Syzygium ochneocarpum* (holotype *Elmer 21522*, Tawau, Sabah, UC, iso: A, NY), which represents the mature form, is reduced here.

The Chloranthum Group (TFSS key, p. 138)

This is a small group of apparent sister species, *Syzygium chloranthum* (Duthie) Merr. & L.M.Perry and two others:

Syzygium caryophylliflorum (Ridl.) Merr. & L.M.Perry. (TFSS 7: 184). Doubtfully distinct from *Syzygium chloranthum*. The strongly ascending venation somewhat more distinct beneath, with more and longer intermediates distinguish it.

Syzygium monticolum Merr. & L.M.Perry. (TFSS 7: 242). Closely resembling *Syzygium chloranthum* also, but the pimpled thickly leathery leaf blade and more slender flower pseudostalk distinguish it.

The Zeylanicum Group (TFSS key, p. 135)

This is the most easily distinguishable natural group within Borneo *Syzygium*, recognized by their generally square or narrowly winged twigs, milky bloom, persistent bracteoles, and cylindrical calyx. Again with a few exceptions, the species are specialists of *kerangas*, upper montane forest, and other forests on humult soils.

Syzygium antisepticum (Bl.) Merr. & L.M. Perry. (TFSS 7: 168). The species complex that includes *Syzygium antisepticum*, *S. gratum*, *S. ovatifolium* and also *S. zeylanicum* requires further study in the field, and throughout Asia. All but one are species of lowland and hill dipterocarp forest on humult soils. Herbarium material alone leads me to suspect a single variable species, but there seem to be entities with distinct ecologies. *Syzygium antisepticum*, there formerly called *S. gratum*, is a sea-shore plant in Peninsular Malaysia. This species around Kinabalu was formerly recognized as *Syzygium ovatifolium*, holotype: *Clemens 28478* Mt Kinabalu (iso A, BO, L, NY).

Syzygium zeylanicum (Bl.) Merr. & L.M.Perry (TFSS 7: 302) therefore remains as one variable species in my understanding, several forms having been described as separate species which I doubt. *Syzygium gratum* was one, which was reduced here by Kochummen (1978, 217, as *E. spicata*), as also was *S.antisepticum*.

Syzygium bankense (Hassk.) Merr. & L.M.Perry. (TFSS 7: 174). This is the core lowland species of a group characterised by their tiny leaves and quadrangular distinctly albeit narrowly winged twigs. All are recognized as *ubah ribu*. Those that have been decribed from Borneo mountains are: *Syzygium gaultherioides* (Ridl.) Merr. & L.M.Perry in west to north-east Sarawak and Brunei, *S. perparvifolium* (Merr.) Merr. & L.M.Perry in West Kalimantan and West Sarawak, *S. nummularium* Airey-Shaw from north-east Sarawak and Brunei (see there), and *S. kinabaluense* (Stapf) Merr. & L.M.Perry, *S. exiguiifolium* Merr. & L.M.Perry and *S. polycladum* Merr. & L.M.Perry from Mount Kinabalu and sometimes on the north-east Sarawak summits. We here recognize three species two of which, *Syzygium bankense*, *S. kinabaluense*, have more or less distinct forms (see TFSS keys). The Bangka type has larger leaves than is general in Borneo, in this resembling the Peninsular sister entity, *Syzygium nitidulum* (Ridl.) I.M.Turner.

Syzygium bankense subspecies *perparvifolium* (Merr.) P.S.Ashton (TFSS 7: 175). The holotype was formerly at the Manila herbarium, now destroyed. Differing from the type subspecies in its more densely congested inflorescence at most 1.5 cm long clustered at the first 2(–3) twig nodes, much branched twigs, and ovate-lanceolate or obovate 5–7 × 4–6 mm leaf blade with evident veins. We here reduce *Syzygium gaultherioides*, holotype: *Haviland 2057* Mt. Bungoh, W. Sarawak, which is within the range of variation of current collections of this subspecies.

The Jambos Group (TFSS key p. 132)

This, the largest apparently natural species series in Sabah and Sarawak, is united around a core easily distinguished by their large flowers with urn-shaped calyx tube, hardly swollen hypanthium, calyx lobes distinctly hyaline-translucent towards their margins and becoming reflexed, and leaf blades frequently cordate and with prominent unequal lateral veins, furrowed above. It includes all the comestible *jambu* excepting *Syzygium cumini* which does not naturally occur and is not cultivated in our area.

Syzygium jambos (L.) Alston. (TFSS 7: 227). The wild form found in Sabah and Sarawak is the native tree formerly known as *Syzygium monanthum* (Merr.) Merr. & L.M.Perry, holotype: *Haviland 2146*, Belaga, Rejang, Sarawak (SING, iso K, reduced here by me (TFSS 7: 227)). It differs from the cultivated, albeit not consistently, in the more persistently 4-angled twig, leaf wrinkling on drying, smaller flower with more leathery sepal lobes and, of course, its smaller fruit.

Syzygium medium (Korth.) Merr. & L.M.Perry. (TFSS 7: 241). Further field study may reveal this entity to be a rheophytic juvenile ecotype of *Syzygium jambos*.

The Claviflorum Group (TFSS key p. 137; sub.gen. *Perikion* Craven & Biffin, *Blumea* 55, 2010: *Syzygium claviflorum* and its sisters)

Syzygium claviflorum Wall. ex Steudel (TFSS 7: 192) is variable in the size of its parts, including flowers with torch-shaped calyx, but this variation appears continuous

Syzygium cornuflorum P.S.Ashton (TFSS 7: 195) is distinguished from it by its small leaves, and smaller flowers with striking cornet-shaped calyx.

Syzygium viridifolium (Elmer) Merr. & L.M.Perry. (TFSS 7: 301). I do not accept Henderson's view (Gard. Bull. Singapore 12 (1949) 253) that this entity is synonymous with *Syzygium claviflorum*. Although the flowers are similar, the parts are smaller and the leaf elliptic not elliptic-lanceolate, and dark dotted beneath.

***Syzygium castaneum* (Merr.) Merr. & L.M.Perry and its sisters**

Syzygium castaneum is a common and variable species of humult yellow and white sandy soils, in primary and secondary dipterocarp forest, *kerangas*, karst, and upper montane forest.

Syzygium georgei P.S.Ashton (TFSS 7: 212), known only from the type locality, where it is common along a stony occasionally flooded river bank on ultramafic substrate. Clearly related to *Syzygium castaneum*, I only recognize it from that variable species owing to its conspicuously different leaf shape with its venation distinctly furrowed on its upper surface. This is a candidate for sympatric speciation.

Syzygium paludosum P.S.Ashton (TFSS 7: 257), is locally frequent in mixed peat swamp forest, also rare in mixed dipterocarp forest on deep yellow humic sands on coastal hills. Also closely related to *Syzygium castaneum* and with its slender dark quadrangular twigs with distinct upcurling flakes, it differs in its larger parts, elongate bud, and dull leaf blade.

Syzygium longiflorum*, *S. rostratum* and *S. pyriformum

Three similar small leaved species of Java and widespread throughout the Sunda dipterocarp forests.

Syzygium pyriformum (Bl.) DC. (TFSS 7: 271). Henderson provides a useful table indicating the differences from *Syzygium longiflorum*. He cites broad shallow caducous *versus* deep oblong persistent sepal lobes, pseudostalk with distinct medial constriction, and larger spherical to depressed-spherical apically rimmed fruit ripening brownish green *versus* oblong-ovoid fruit with prominent sepal lobes, ripening white. The following collections, from *kerangas*, mixed peat swamp forest and the lower facies of upper montane forest along ridges at c.1000 m, differ in their more leathery chocolate-brown drying leaf blade and shorter panicle, but in other characters including flower and fruit appear to be this species: Sarawak: S 33872 Bt Peninjau Lanjak-Entimau P.F. Lubok Antu, S 45033, 45084 Bt Sadok. Sabah: SAN 86228 Sipitang. Brunei: BRUN 178, K. Ingei Belait.

Syzygium racemosum (Bl.) DC. (TFSS 7: 273) differs in the field in its somewhat larger leaf blade with more distinctly raised venation beneath, and round young twigs.

Syzygium rostratum (Bl.) DC. (TFSS 7: 279). Difficult to distinguish from *Syzygium longiflorum*. The shorter to vestigial flower sepal lobes, relatively broader smaller prominently caudate leaf blade, and fruit shape mentioned in the literature for this species sometimes overlap with *Syzygium longiflorum* in Borneo where there may be hybridization, but less so in Java and Sumatra. The generally larger sepal lobes of *Syzygium longiflorum* become apparent only at anthesis and especially when flared outwards on a prominent rim in the young fruit; but I find that the lobes may become prominent in the young fruit of *S. rostratum* also (e.g. Wong WKM 140 S. Liang arboretum, Brunei). However, in *Syzygium longiflorum*

the panicle is consistently more branched, whereas in *S. rostratum* the fruit becomes borne on long rigid rachises. Also in *Syzygium longiflorum*, the intermediate and tertiary veins typically are less dense, and the tertiaries more overall parallel with the veins are generally minutely impressed above in the dry mature leaf; while the gland dots beneath are scattered not dense.

Syzygium rugosum Korth. (TFSS 7: 280), a further small leaved species of Peninsular Malaysia, South and West Borneo of dipterocarp forests on siliceous soils, differs in its short flower bud and leaden-drying leaves with shagreened undersurface.

Other species pairs

Syzygium pterophorum Merr. & L.M.Perry. (TFSS 7: 267). *Syzygium pterophorum* is sister to *Eugenia pseudotetraptera* King, which occurs widespread in the same habitat as in Peninsular Malaysia. It was reduced to a variety of the exclusively lowland *Syzygium tetraptera* Miq. by Henderson (Gard. Bull. Singapore 12 (1949) 220). King's plant differs from the present only in its smooth (drying wrinkled) flower calyx, shorter pseudostalk and apparently earlier caduceous bracts; it and possibly also *Syzygium tetraptera* may prove to be synonymous.

Syzygium steenisii Merr. & L.M.Perry and *Syzygium subcrenatum* Merr. & L.M.Perry (TFSS key, p. 141). *Syzygium steenisii* differs from *S. subcrenatum* in its distinct flower sepal lobes, also in its leaf with less prominent venation, no marginal teeth and smaller size. It is distinguished from *Syzygium punctilimum* by its terete twig and elliptic cuneate-based leaf blade with tertiary veins clearly elevated on both surfaces; and from *S. confertum* by its dull blade with dense subequal venation and short acumen. *Syzygium subsessilifolium* (Merr.) Merr. & L.M. Perry. (TFSS 7: 289), represented by a collection from Lake Toba, Sumatra, *Rutner 182*, may prove to be this rare Bornean species of sluggish lowland river banks.

Syzygium nemestrinum (Henderson) I.M.Turner and *S. prasiniflorum* (Ridl.) Merr. & L.M.Perry. These two entities require more field observation. *Syzygium nemestrinum* differs from *S. prasiniflorum* in its dull leaf blade somewhat yellow-brown pale beneath, and generally, its densely dotted and pimpled blade beneath, also its larger flower. Overall though, I have found *Syzygium nemestrinum* difficult to define owing to its overall lack of diagnostic characters. The leaf dots are variably prominent below and sometimes obscure, but the undersurface is always dull and usually somewhat milky. The sepals may be distinct and shallowly hemispherical in young bud but become stretched and more or less obscure at or following anthesis. I finally concluded that it should be considered a synonym of *Syzygium subcrenatum* Merr. & L.M.Perry, in which the dentate margin appears to be sometimes absent (TFSS 7: 288). *Syzygium prasiniflorum* (TFSS 7: 266) is also a poorly known species without clear diagnostic characters. The leaf recalls that of *Syzygium punctilimum* but for its base. Easily confused also with *Syzygium havilandii*, which differs in the round twig and dull not glistening leaf with veins minutely furrowed above, and by its abundant stilt roots.

From *Syzygium nemestrina* it differs in its generally slightly glistening leaf blade above and usual absence of dots beneath, besides its much smaller flower.

Syzygium elliptilimum and *S. maingayi*: *Syzygium elliptilimum* (Merr.) Merr. & L.M.Perry. (TFSS 7: 201). This large-leaved species is distinguished by its thinly leathery leaf with slender venation, but prominent beneath, not furrowed above, the tertiaries beneath an open lattice, drying rich crimson-brown beneath with the venation the same colour. The panicle is slender and much branched, with many small flowers. It is apparently allied to *Syzygium maingayi* (see there). Merrill & Perry (Philip. J. Sc. 79 (1950) 388) recorded this species from Mindanao and the Sulu Archipelago, reducing *S. suluensis* Merr. here; but the type of that species has a much larger flower and short hardly branched rachis. *Syzygium maingayi* Chantar. & J.Parn. (TFSS 7: 240) differs from *S. elliptilimum* only in the broader larger darker drying thinner textured leaf with somewhat shorter stalk. Further collections may prove them synonymous.

Syzygium houttuyniifolium P.S.Ashton. (TFSS 7: 220) Known with certainty only from the Usun Apau, Ulu Baram-Rejang divide, Sarawak (the type; *S. 68937*, Ulu Kelayan). *Syzygium houttuynii* Merr. & L.M.Perry (TFSS 7: 220) differs in its quadrangular twig, smaller leaf with intramarginal vein close to the margin and hardly looped, and in its hardly branched panicle and large flower. Two further collections resemble *Syzygium houttuyniifolium* but differ as follows: *SAN 100132*, *Amin G. et al.*, SW Segindai across S. Liwagu, Ranau, ultrabasic substrate, has a glistening leaf and somewhat larger flower bud; *Arbainsyah SA 1944*, G. Kedamuk posko 235 km 11, has a thickly leathery leaf blade with short stout stalk.

Sister species with apparent sympatric speciation

The following are entities that I have recognized as natural species series. They share a set of diagnostic characters, of flower, leaf, and twig, but may differ in the size of their parts, and seemingly more trivial characters of inflorescence, leaf thickness, margin or venation prominence, indumentum and other parts; but they are at best only partly diversified by habitat, geography, or both. Further studies of populations in the field are required before their status can be confirmed.

Syzygium fastigiatum (Bl.) Merr. & L.M. Perry, *S. cuneiforme* Merr. & L.M.Perry, *S. odoardo* Merr. & L.M.Perry, and *S. neriifolium* Becc. (TFSS key, p. 136). *Syzygium cuneiforme* is at once distinguishable by its substantially larger parts, but the other three are debatable. *Syzygium fastigiatum* bears a similar relationship with *S. odoardo* that *S. jambos* does with *S. medium*. *Syzygium fastigiatum*, very variable in both leaf shape and colour and panicle size, has a wide ecological range if that variation is accepted as intraspecific. *S. odoardo* and *S. neriifolium* are both principally riparian. A hill form of *Syzygium odoardo*, as defined by me, comes close to *S. fastigiatum*, which differs in the less branched panicle with fewer

flowers and generally narrower leaves. The two species nevertheless merit more detailed field study of their variation and ecology. Further, more collections are needed to decide whether *Syzygium odoardo* is truly distinct from *S. nerifolium*.

Syzygium pycnanthum Merr. & L.M.Perry (TFSS 7: 269). This very variable and common riparian species was formerly called *Eugenia densiflora* (Blume) A. de Candolle. I have reduced *Syzygium foxworthianum* (Ridl.) Merr. & L.M.Perry here as I have concluded that it represents the rheophytic phenotype on open shingle banks, or a juvenile form, again recalling the relationship between *S. jambos* and *S. medium*.

Syzygium beccarii (Ridl.) Merr. & L.M.Perry and *S. gladiatum* (Ridl.) Merr. & L.M.Perry (TFSS key, p. 138). Large-leaved forms of *Syzygium beccarii* cannot consistently be distinguished from *S. gladiatum* which may eventually prove synonymous. Small-leaved forms resemble *Syzygium punctilimum*, which can be distinguished by its quadrangular twigs. SAN 49332, Bt Madai, Mostyn, Sabah was from 'mossy forest' on limestone at 400 m; it bears unusually large flowers on short congested terminal rachises, but otherwise shares the characters of this species. S 41764, Ulu Kana, Anap, shares the long panicle of *S. gladiatum*, but the flowers are intermediate with *Syzygium beccarii*, which is indistinguishable on vegetative characters. Further collections may reveal these two entities to be forms of the same species.

WIDESPREAD SPECIES WITH COMPLEX VARIABILITY

In these taxa, variation is substantial but I have failed to find those necessary discontinuities that could separate distinct species from the complexity.

Syzygium urceolatum Merr. & L.M.Perry and allied species (TFSS keys, pp. 145, 164)

I interpret this species as the most variable, morphologically and ecologically, of the lowland forest *Syzygium*.

Subspecies *urceolatum* (TFSS 7: 296). The type differs from ssp. *kuchingense* in its chartaceous blade with depressed veins above. I have interpreted it as the plant of *kerangas* and its ecotone with mixed dipterocarp forest. It generally has smaller thickly leathery leaves than the ssp. *kuchingense*; the depressed main and intermediate veins above are the defining character. Merrill & Perry compared this entity with *Eugenia hemsleyana* King, and Henderson (Gard. Bull. Sing. 12 (1949) 129) considered it synonymous, but the leaf of that species is much larger and not milky beneath and Kocummen kept it separate (1978, 196).

Subspecies *palembanicum* (Miq.) P.S.Ashton (TFSS 7: 296) most resembles *Syzygium hemsleyana* (King) I.M.Turner, and is the form in mixed dipterocarp forest on loam soils. It is distinguished notably by the absence of milkiness on the twig, and the leaf which is often shiny. Subspecies *palembanicum* differs from *Syzygium grande* (Wight) Walp., besides the ribbed calyx in flower and fruit, in the less prominent venation, hardly raised or occasionally shallowly sunken above, and somewhat smaller flower bud with subequal sepal lobes.

I recognize the following as distinct sister species:

Syzygium borneense Miq. (TFSS 7: 179). This variable species was previously often called by its synonym *Syzygium litseaefolium* in Borneo, and *Eugenia pseudosubtilis* King and *E. microcalyx* Duthie in Peninsular Malaysia. Lowland and montane varieties are formally recognized in continental Asia, but are not clearly distinguishable in Borneo where the species apparently does not reach above 800 m. In Thailand, Parnell & Chantaranothai recognize *Syzygium borneense* with *S. microcalyx* a synonym, and *S. cinereum* (Kurz) Parnell & Chantaranothai with *S. pseudosubtilis* a synonym (*Fl. Thailand* 7, 4 (2002) 838); but they differentiate the two in their key on a subtle difference in twig colour. I have not had the opportunity of examining the Thai material in sufficient detail to form an opinion on their decision in context of the variation observed in Borneo. I also reduce here *Syzygium hackenbergii* Diels, based on *Hackenberg 17*, Sampit, W. Kalimantan (holotype B, destroyed, fragment in A), a specimen with smaller than average leaves distinctly dotted above.

Syzygium korthalsianum Miq. (TFSS 7: 306), a Sumatran species, was noted from Indonesian Borneo by Merrill and Perry (*ibid.* (1939) 191). Those collections I have examined seem not to be this species. *Eugenia embelioides* Ridl., (*Syzygium embelioides* (Ridl.) Masam.), based on *Beccari 3354*, Danau Lamadjan (close to the Sarawak border), which was reduced to *S. korthalsianum* by Merrill and Perry, appears to represent a form of *S. borneense*.

Syzygium creaghii (Ridl.) Merr. & L.M.Perry. (TFSS 7: 197). NE Borneo, in mixed dipterocarp forest on moist slopes. Based on *Creagh 7* and *Burbidge s.n.*, Sabah (K). The Bukit Mersing collection has leaves with c. 30 pairs of main veins, and internodes prominently ribbed distally. The typical form occurs in the Lambir N.P. tree demography plot.

Syzygium griffithii (Duthie) Merr. & L.M.Perry (TFSS 7: 217) generally has a distinctly narrower leaf with deeply impressed veins above. The rigid racemose inflorescence with branches subterminal, and the flower pseudostalk as long as the receptacle are diagnostic. It differs from *Syzygium confertum* (Korth.) Merr. & L.M.Perry, when not in flower, mainly by its larger generally narrowly oblong thickly leathery leaf with spreading veins furrowed above.

Syzygium kunstleri (King) Bahadur & R.C.Gaur. (TFSS 7: 233). Though generally easy to identify owing to its cream twigs and bright red-brown drying somewhat obovate leaf blade, this species is very variable in leaf size and shape; the blade may dry grey-green though the dense fine generally dark pimples beneath are indicative; the twig is also sometimes grey-brown. I reduced here *Syzygium albidirameum* (Merr.) Merr. & L.M.Perry (holotype: *Elmer 21762*, Tawau, Sabah, UC; iso: A, NY), *S. chrysanthum* Merr. & L.M.Perry (holotype: *Maiden, SAN 1746*, Kinabatangan, Sabah, A), and *S. stictophyllum* Merr. & L.M.Perry (holotype: *Clemens 50344*, Penibukan, Kinabalu, A) which come within the range of variation of the present species.

Syzygium oblanceolatum (C.B.Rob.) Merr. (TFSS 7: 251). Eastern Philippines and Borneo. In mixed dipterocarp forest on clay loam. *Syzygium kihamense* Merr. & L.M.Perry (holotype: *Endert 2341*, Batu Bong, near Kiham, W. Kutei, Kalimantan, BO, iso:K) and *S. petakense* Merr. & L.M.Perry (holotype: *Endert 4063*, near Long Petak, W. Kutei, BO, iso: K) differ in no consistent way from this Philippine species though the leaf base is more frequently narrowly obtuse, the intermediate veins few or absent, in the latter. Some Kinabalu collections differ in their smaller leaf with as few as 7 pairs of veins, but the variation with the type appears to be continuous. Related to *S. papillosum* (Duthie) Merr. & L.M.Perry of Peninsular Malaysia and southern Kalimantan, in which the twig is round leaf is more leathery, the base deeply cordate.

Syzygium palawanense (C.B.Rob.) Merr. & L.M.Perry. (TFSS 7:256). Eastern Borneo and Palawan. The narrow leaf with few veins and densely finely pimpled upper surface are distinctive and distinguish this species from e.g. *Syzygium remotifolium*. Collections from lower montane forests on Kinabalu differ in their generally fewer, 6–9 pairs, of veins.

Syzygium scortechinii (King) P.Chantar. & J.Parn. (TFSS 7: 282). The many collections now available show continuous variation between the forms described as species by Merrill and Perry (*Syzygium heterocladum* (Merr.) Merr. & L.M.Perry, holotype formerly PNH, iso: K; *S. kingii* (Merr.) Merr. & L.M.Perry, holotype *Ridley 9071*, Bongaya, Sabah, SING, iso: K) and between them and the peninsular species *S. scortechinii*. Related to *Syzygium panzeri*, which differs in its distinctly smaller subsessile flowers, and more conspicuously and continuously narrowly 4-winged white twigs; nevertheless not reliably distinguishable when not in flower; and to *S. insigne* (Bl.) Merr. & L.M.Perry of South Kalimantan, which differs in its smaller more prominently dotted leaf and quadrangular twigs. Some Sabah collections (e.g. *SAN 38235*, Sekong Kecil, *SFN 19064a*, Bettotan, Sandakan) differ in their leaves drying pale beneath, with slender tapering base and hardly shouldered twigs, but their flowers and fruits are typical.

Syzygium tawahense (Korth.) Merr. & L.M.Perry (TFSS 7: 291) is similar in field characters to *S. urceolatum* ssp. *palembanicum* and *kuchingense*, but with leaf veins more prominent especially above, longer more slender flower bud with smaller calyx lobes than ssp. *palembanicum*, and more prominently ribbed more or less warty fruit. Thorough examination of variation throughout Borneo is needed to assess whether reduction of this species is warranted.

Syzygium valdecoriaceum P.S.Ashton (TFSS 7: 297) differs from *S. griffithii* in its yet more thickly leathery leaves drying pale yellowish brown, with less prominent veins and tertiaries obscure beneath.

Leptospermum javanicum Bl. (TFSS 7: 103). Widespread from southern Burma throughout Sunda to the Philippines and Java. On the high mountains of Sabah and Sarawak in rocky places in upper montane forest, between 1200–2400 m, to 3000 m on Kinabalu and adjacent

mountains including in scrub on ultramafics. Also on exposed coastal hilltops near Kota Kinabalu and Sandakan, Sabah. Trees from lower altitudes do generally bear larger thinner leaves, but their size is very variable.

Diversification on the Sabah ultramafics and Borneo karst: A special case

The Sabah ultramafic oolites, as in other regions and climates, support distinct forms of many, and in the case of Myrtaceae most, of the taxa able to survive on their soils, potentially toxic with nickel and chromium ions. Some forms I have recognized as distinct locally endemic sister species. In several cases, sympatric speciation with adjacent widespread sister entities is possible, meriting investigation.

Leptospermum javanicum Blume (TFSS 7: 103) and *L. recurvum* Hook.f. (TFSS 7: 105): *L. recurvum* occurs from c. 2600 m to the summit on Kinabalu, especially on ultramafics at its lower altitudes. Abundant at high altitudes. Also occurring near the Trus Madi summit, 2650 m, and from Sulawesi. Recognized by smaller more thickly coriaceous leaves, glossy above, with consistently narrowly revolute margin, and its hypanthium lacking minute warts. Although Thompson (*Telopea* 3 (1989) 391) questions the distinctness of this taxon as a species from *L. javanicum*, naturalists familiar with it are convinced and I accept their verdict. D.W. Lee. & J.B. Lowry (Bot. J. Linn. Soc. 80 (1980) 223-242), compared the ontogeny and morphology of the two species in the field on Mount Kinabalu. Though convinced of their separate identity, they found isozymal evidence that *L. recurvum* juveniles have limited genetic variability and suggested a sympatric origin. The putative existence of this same species on Sulawesi makes this unlikely. Nevertheless, molecular examinations of both species on Kinabalu and *Leptospermum recurvum* populations on Sulawesi could be rewarding.

Syzygium acuminatissimum DC. (TFSS 7: 164). An exceptionally widespread variable species, from India to South China and New Guinea, as I interpret it. Specimens from ultramafic substrates, e.g. *SAN 138824*, Bukit Tawai summit, Karamuak, Telupid, Sabah, are particularly distinct on account of their large leathery somewhat glistening leaves.

Syzygium beccarii (Ridl.) Merr. & L.M.Perry (TFSS 7: 177). Collections from Tawai Forest Reserve, *FRI 41253*, *Mat-Salleh KMS 3398*, *Cheksum & al. 235*, from riparian forest (the same tree?) present a distinct appearance owing to their relatively small dark drying leaves and up to 8 cm long spreading terminal panicle clusters. I hesitate to recognize this form as a distinct entity within this variable species, awaiting further material.

Syzygium caudatilimum (Merr.) Merr. & L.M.Perry (TFSS 7: 186). An astonishing specimen from the Mt. Silam, Lahad Datu ultramafics, *SAN 135045*, has unusually large leaves, the veins distinctly elevated beneath with the intramarginal veins ascending from the base like subopposite basal veins; but the clustered axillary fruits are typical. The twig is massively

swollen, the swellings punctured with pores suggesting ant habitation.

Syzygium claviflorum Wall. ex Steudel, subspecies *tavaiense* P.S.Ashton (TFSS 7: 193). Based on two collections apparently simultaneously gathered from the same tree, the type and *Bojo & Cheksun OB 40*, from Tawai F.R., on ultrabasic substrate.

Syzygium dasyphyllum Merr. & L.M.Perry (TFSS 7: 200). A distinct species in the Jambos Group, distinguished by its relatively small leaves for this group, thickly coriaceous. Endemic to Mt. Kinabalu, in the lower facies of upper montane forest at 900–2300 m, apparently only on ultrabasic substrates.

Syzygium georgei P.S.Ashton (TFSS 7: 212), known only from the type locality, where it is common along a stony occasionally flooded riverbank on ultramafic substrate. Clearly related to *Syzygium castaneum*, I only recognize it from that variable species owing to its conspicuously different leaf shape with its venation distinctly furrowed on its upper surface. This is one more distinct sister ecospecies of ultramafic substrates, for which the Tawai Forest Reserve provides the richest repository.

Syzygium kinabaluense (Stapf) Merr. & L.M.Perry subspecies *exiguifolium* (Merr. & L.M.Perry) P.S.Ashton (TFSS 7: 231). Distinguished by the small size of its parts and distinct leaf shape, this form occurs on ultramafics in the Kinabalu lower montane *kerangas*. Subspecies *polycladum* (Merr. & L.M. Perry) P.S.Ashton (TFSS 7 *loc. cit.*), rarely collected but also once on Mt. Pagon Periok, Brunei, has yet smaller parts and shares the same lower montane habitat, but here over sandstone.

Syzygium roseomarginatum (C.B.Rob.) Merr. & L.M.Perry (TFSS 7: 278): The typical form occurs on the Kinabalu ultramafics; but *SAN 74896*, from ultramafic Mt. Silam, Lahad Datu so rich in point endemics, resembles this species in leaf though atypically large, but the up-to-3 axillary short congested inflorescences with up to 5 mm long acicular bracteoles are different. It may, with further collections, prove to be a separate species.

Syzygium soepadmoi P.S.Ashton (TFSS 7: 285). Endemic to the Bukit Tawai ultramafics, Sabah. Apparently allied to the Philippine cleistocalycine *Syzygium arcuatineris* Merrill of unknown ecology (see above).

Syzygium steenisii Merr. & L.M.Perry (TFSS 7: 287). The following collections from Mount Kinabalu, at 1500–3100 m in upper montane forest on ultramafic substrates, differ from the type in their more robust and larger parts. I do not regard these differences as being sufficiently consistent to merit formal status for this form: *Carr SFN 27654* Pakka Pakka, *RSNB 4748* (Chew & Corner) Mesilau Cave, *RSNB 7129* (Chew & Corner) Mesilau R., *RSNB 4421* (Chew & Corner) Bambang R., *RSNB 757* (Chew, Corner & Stainton) Eastern Shoulder.

Several ultramafic and karst entities within the Jambosa Group include the following:

Syzygium penibukanense Merr. & L.M.Perry (TFSS 7: 261). In mixed dipterocarp forest on sandy soils near the coast and on ultramafics, and in upper dipterocarp forest at 700–1500 m.

Syzygium silamense P.S.Ashton (TFSS 7: 284). One of several point endemics of the Silam, E. Sabah ultramafics; distinguished by its winged twigs, relatively small leaf, and very small young fruit indicating the flower (so far unknown) to be exceptionally small for this alliance.

Syzygium subisense P.S.Ashton (TFSS 7: 289). Another local endemic of the Jambu alliance, on the Niah limestone; distinguished by its terete twig, relatively long slender panicle and small flowers.

Syzygium ultramaficum P.S.Ashton (TFSS 7: 295). On ultramafic and limestone substrates in lowland mixed dipterocarp forest, coastal islands, and lower montane forest. On exposed cliffs and screes. A sister species of *Syzygium subisense*, which differs in its larger leaf with more veins, tertiaries visible beneath not above and black-drying stalk; and of *S. penibukanense*.

FIELD COMMENTS ON *TRISTANIOPSIS* SPECIES

Tristaniopsis species show similar variability to those of *Syzygium*, although their small dry narrowly winged seeds are wind-dispersed, in our case in a generally windless climate. There may be frequent hybridization. I have defined species primarily on the number of stamens in a cluster opposite each petal, combined with characters of leaf, notably shape. Their bark is often distinct at maturity, providing an invaluable additional field diagnostic character. I recognize subspecies when entities conform to these primary characters, and which resemble one another in general field character, but which differ in lesser characters of indumentum, and size of parts. *Tristaniopsis whiteana* ssp. *monostemon* presents a special case, differing in its number of stamens as well as bark, but impossible to identify in the herbarium without floral dissection (see below). The subspecies I recognize in *Tristaniopsis microcarpa* P.S.Ashton, a species distinguished by its sessile oblanceolate leaf blade and few stamens, do also differ in their inflorescence morphology and tree stature. They may, especially, prove to be distinct species on further study (TFSS 7: 308–322).

Tristaniopsis anomala (Merr.) P.G.Wilson & J.T.Waterh. (TFSS 7: 311). Difficult to distinguish from *Tristaniopsis bilocularis* in the field. The twig and leaf stalk of that species is somewhat stouter, the venation more distinctly raised on the leaf above.

Tristaniopsis beccarii (Ridl.) P.G.Wilson & J.T.Waterh. (TFSS 7: 313). *S 23704* and *S 19596*, from the Bukit Iju, Arip, Sarawak rhyolite differ in their short leaf stalks and caducously pubescent leaf and cyme. They may represent hybrids, or another entity.

Tristaniopsis bilocularis (Stapf) P.G.Wilson & J.T.Waterh. (TFSS 7:313). Close to and possibly hybridizing with *Tristaniopsis anomala*; at Bt Sampandai Sempurau. Kapit collection, *S* 76983, in flower, differs from *S* 40707 from the same locality, cited under *T. anomala*, only in the number of stamens.

Tristaniopsis kinabaluensis P.S.Ashton (TFSS 7: 315). Several collections, in fruit or young bud, differ in their less leathery, dull but not glaucous, leaf blades. These include *S* 30427 Chai, *S* 4289 Anderson, *S* 30818, Abg. Mochtar et al. G. Api, Mulu N. P.; *S* 38259 B. Lee, Bt. Berar, Mulu N.P.; *S* 49609 Abg. Mochtar et al., Mulu N.P.; *S* 41131 Yii, P.C., Sabal F.R., Serian; also *RSNB* 4148, J.H. Beaman 9381 Mesilau R., *SAN* 33924, road to Kamarangoh, Kinabalu N.P.. They were collected from organic soils on limestone up to 1500 m altitude at Mulu, and on sandstone up to 1800 m. Good flowering material is awaited before their identity can be confirmed.

Tristaniopsis whiteana (Griff.) P.G.Wilson & J.T.Waterh. subspecies *whiteana* (TFSS 7: 322): A generally easily recognized species owing to its pale smooth fresh bark making the groups of trees stand out on high steep slopes, and the glistening dark olive-drying leaves and dense subequal veins. Nevertheless, collections resembling it in their 3 stamens per cluster yet with somewhat duller smaller oblanceolate fewer veined leaves with shorter stalk, have been gathered from the Mulu, Sarawak, karst limestone (*S* 30427, 4289, 30818 G. Api, *S* 49609, G. Mulu N.P., *S* 38259 G. Berar) and from Kinabalu (*RSNB* 4432 Bambang R., Chew & al. 73 Kinabalu east shoulder, Clemens 28406 Tenompok, Clemens 32428 Colombon R.); both 900–1500 m in lower montane forest. They may represent a separate entity. Ssp. *monostemon* P.S.Ashton (TFSS *loc. cit.*) is at once recognizable in the field on account of its vivid russet-brown bark, overall smooth, gleaming against the overall grey-green of the *kerangas* habitat. But Kew botanists, with access only to herbarium collections, long vigorously denied its separate identity. Its solitary stamen opposite each petal suffices even here.

NOMENCLATRURAL CHANGES

I had the good fortune, at the Arnold Arboretum, to have access to fragments of the types of most species, obtained through the courtesy of the Director of the Rijksherbarium, Leiden in the interwar years of the last century. These, with the Harvard University Herbarium collection, and those of Kew and the Malaysian Forest Research Institute in recent years, and Kuching earlier, have provided the basis for my nomenclatural conclusions. Full citations are in my account for the Tree Flora 7 (2011) 87–330.

Syzygium elliptilimum (Merr.) Merr. & L.M.Perry (TFSS 7: 201). Merrill & Perry (Philip. J. Sc. 79 (1950) 388) recorded this species from Mindanao and the Sulu Archipelago, reducing *S. suluensis* Merr. here; but the type of that species has a much larger flower and short hardly branched rachis.

Syzygium formosum (Wall.) Masam. EPB (1942) 528 (TFSS 7: 208). Variable in leaf shape and size, I have concluded that our species, most commonly known under the name *Eugenia pseudoformosa* King can no longer be consistently distinguished from the Burmese and easternmost Indian species of seasonal evergreen forest, *Syzygium formosum*. I here reduce several more names, recognized as species by Merrill and Perry, to this widespread entity. The type of *Jambosa mappacea* Korth., based on Korthals *s.n.*, E. Kalimantan, lacks the cream corky petiole of mature *Syzygium pseudoformosum*, which is based on Wray 1809 (CAL, not seen), 3581 (CAL, K), King's collector 3401 (designated lectotype by Parnell & Chantaranonthai, Thai. For. Bull. 21 (1994) 99), 5389, 6254, (CAL, K), and *Scortechini s.n.*, (CAL, K) Perak; it also has ramiflorous flower clusters and unusually long peduncles. This variation occurs in other more recent collections from Borneo and the Peninsula, however. *Jambosa insignis* Bl. is based on Korthals *s.n.*, Martapura, Kalimantan (L, photo in A), with flowers on a terminal panicle; the leaves are unusually small, but otherwise typical. Merrill and Perry discuss its synonymy, with which I agree other than not recognizing it as separate from the present species. I have reduced *S. lilacinum* (Merr.) Merr. & L.M.Perry (holotype: Elmer 21280, Tawau, Sabah, UC, iso: A, NY) here too, as it differs in no consistent way from the the peninsular species. *S. formosum* differs from *S. scortechinii* (King) Chantar. & J.Parn. in its generally cream-white terete twig lacking distal shoulders on the nodes, and larger leaf blade.

Syzygium jambos (L.) Alston. (TFSS 7: 227). The type of *Jambosa leptostachya* Bl., *G. Mueller s.n.*, *loc. incert.*, Kalimantan (L, fragment at A) bears leaves, short terminal inflorescence, and $c.8 \times 7$ mm flower buds unmistakably of this species as I define it.

Syzygium leucophloium misnamed (TFSS 7: 307). The correct nomenclature is the following: *Syzygium cuneatum* (Bl.) Masam., Enum. Phan. Born. (1942) 527 *non S. cuneatum* Wall., Cat. (1828) 3598. Basionym: *Jambosa cuneata* Bl., Mus. Bot. Lugd.-Bat. 1 (1849) 106. Synonym: *Syzygium leucophloium* Merrill & L.M.Perry Mem. Amer. Ac. Arts 18 (1939) 174 *nom. superfl.*

Syzygium longiflorum Presl. Citations in TFSS 7: 87–330. (TFSS 7: 237). We have Masamune (1942) to thank for recognition of the current name as the first validly used in *Syzygium*. *Syzygium lineatum* (DC.) Merr. & L.M.Perry (*Myrtus lineata* Bl., 1827) is antedated by *Myrtus lineata* Swartz, 1788. Merrill and Perry (1937) retained *Syzygium lineatum*, *S. cerasiforme* (Bl.) Merr. & L.M.Perry, *S. javanicum* Miq. and *S. racemosum* (Bl.) DC. as separate species. Amshoff and Henderson united *Syzygium javanicum* and *S. racemosum*, Henderson under the name *Eugenia cerasiformis* which Kochummen (TFM 3 (1978) 185) followed; but Amshoff was right in regarding *S. cerasiforme* a synonym of the present species. Blume had originally recognized his *Myrtus cerasiformis* to be related to his *M. lineata*, but considered that it differed in more numerous veins drying dark purplish beneath, and in a single intramarginal vein. Blume's description implies that the type is in flower. Henderson based his conclusion on a fruiting specimen which he assumed to be the type, but did not indicate in which herbarium he saw it. In light of a fragment of a Blume collection,

which I believe to have been from the holotype, including a leaf and flower, now in the Harvard herbaria and named by Merrill (undated), and the many collections now available, I disagree. This fragment exactly matches Blume's description and distinguishing characters. The holotype, presumed to be at Leiden, was lost and had not knowingly been examined there by Merrill (Merrill & Perry 1939) or Amshoff (1945).

Syzygium medium (Korth.) Merr. & L.M.Perry. (TFSS 7: 241). I have reduced to this species *Jambosa linearis*, based on *Korthals s.n.*, G. Pamatton, S. Kalimantan (L, fragm. in A), with leafy twig and young flower, which unambiguously belongs to this species.

Syzygium pyrifolium (TFSS 7: 271). I have reduced to this species the somewhat enigmatic *Syzygium laevigatum*. The holotype of its basionym, *Eugenia laevigata*, *Korthals, s.n.*, Doesson, Kalimantan (L, photo and leaf in A), with leafy flowering twig, belongs here; but a second cited collection, *Korthals, s.n., loc. incert.* (L, photo in A), in bud, does not.

Syzygium racemosum (Bl.) DC. (TFSS 7: 273). Merrill and Perry distinguished *Syzygium racemosum* (holotype: *Blume s.n.*, L) and *S. javanicum* (holotype: *Horsfield s.n.*, near Surabaya, L) on the basis of twig colour and leaf base, and both from *S. cerasiforme* on the basis that they have a minutely lobed or undulate calyx, while *cerasiforme* bears sepal lobes >0.5 mm long. Henderson combined *S. racemosum* (Bl.) DC. and *S. javanicum* Miq. (ex syn. *S. euneuron* Miq.) considering that they differed only in the colour of the bark of the twigs, and the length and modes of branching of the inflorescence. He also included the following synonyms: *Eugenia cerasiformis* (Bl.) DC., *E. expansa* Wall. ex Duthie non Mart., *E. jamboloides* Koord. & Valeton, ?*E. laxiflora* K.& V., *E. javensis* Koord. & Valeton, *E. zippeliana* Koord. & Valeton, *E. robinsoniana* Ridl., *E. evansii* Ridl., *E. brunneoramea* Merr., *E. euneura* Craib non *Syzygium euneuron* Miq. I follow Amshoff in reducing *Eugenia cerasiformis* (Bl.) DC. to *Syzygium lineatum* (see under *S. longiflorum*). I adopt the name *Syzygium racemosum* over *S. javanicum*, which was published simultaneously because the name *S. javanicum* is also a synonym of *S. samarangense* and was formerly used for it.

Syzygium myrtifolium Walp., Repert. 2 (1843) 178; Masamune (1942) 534. (TFSS 7: 245). Cited by me as a generic change from *Eugenia myrtifolia* Roxb.; but Roxburgh's name is *nomen nudum*, therefore invalid. Wrongly named *Syzygium campanulatum* Korth. (1847) owing to the preemption of *Eugenia myrtifolia* Roxb. by *E. myrtifolia* Salisb.; but this does not invalidate Walpers' name, which validly uses the specific epithet for the first time in the present genus. Listed as *Syzygium syzygioides* (Miq.) Merr. in Anderson's Checklist (p. 239); referred to as *Eugenia oleina* Wight in the Tree Flora of Malaya 3 (1978) 205.

Syzygium subcrenatum Merr. & L.M.Perry (TFSS 7: 288). I have reduced to this species *Eugenia pseudocrenulata*, the new name given by Henderson for *E. crenulata* Duthie (1878) non Willd. (1799), based on Maingay 739 (K, iso SING). The type of Merrill's earlier name differs in its dull red-brown dry leaves, but the venation and flowers are defining.

S. cuneatum Wall., a *nomen nudum*, (*Eugenia lineata* Duthie) is synonymous with *Syzygium schmidtii* Rathakr. & N.C.Nair.

Tristaniopsis merguensis (Griff.) P.G.Wilson & J.T.Waterh. (TFSS 7: 316). I agree with the synonymy recommended by Kochummen (*ibid.* 252), but doubt whether *Tristania pontianensis* Henderson of southern Johor is distinct either. I formally reduced *Tristania grandifolia* Ridley, type: *Beccari 2489*, in fruit, whose large leaves are typical of immature trees; and *T. stellata* Ridley, type: *Haviland 1983*, Kuching, Sarawak, in which the leaves are at the small end of the observed range.

Tristaniopsis obovata (Benn.) P.G.Wilson & J.T.Waterh. (TFSS 7: 319). Apparently close to *Tristaniopsis ferruginea* (Merr.) P.G.Wilson & J.T.Waterh. of the Philippines, which differs in its more persistent tomentum; I have not seen its flowers. *Tristania clementis* Merrill is reduced here. Based on *Mary Clemens 9570*, 'Jesselton', it differs significantly only in the 5–6 stamens in a fascicle, rather than 4 in most peninsular collections; but this full range of variation is seen in other Borneo material. *Motley 33 & 320*, Bandjarmasin (K), type of *Tristania motleyi* Ridl., J. Bot. 68 (1930)37; Masamune (1942) 542 was not found, but appears from its description to belong here also.

ACKNOWLEDGEMENTS

I thank Kanchi Ghandi, David J. Mabberley and Rafaël Govaerts for nomenclatural corrections and advice on specific issues.

REFERENCES

- Amshoff, G.H.J. (1945) *Myrtaceae*. In: C.A. Backer, *Noodflora voor Java IV-B*, 1, Fam. 98: 22. Leiden.
- Anderson, J.A.R. (1980) *A Checklist of the Trees of Sarawak*. Sarawak Forest Department, Kuching.
- Ashton, P.S. (2004) *Dipterocarpaceae*. In: E. Soepadmo, L.G. Saw & R.C.K. Chung (eds), *Tree Flora of Sabah and Sarawak*, 5: 63–388.
- Ashton, P.S. (2011) *Myrtaceae*. *Ibid.* 7: 87–330.
- Ashton, P.S. (2015) *On the Forests of Tropical Asia, Lest the Memory Fade*. Kew Publishing and the Arnold Arboretum, Harvard University.

- Craven, L.A., E. Biffin & P.S. Ashton (2006) *Acmena*, *Acmenosperma*, *Cleistocalyx*, *Piliocalyx* and *Waterhousia* formally transferred to *Syzygium* (Myrtaceae). *Blumea* 51: 131–142.
- Hooker, J.D. (1855) Introduction, in Hooker and Thomson, *Flora Indica* 1: 1–44.
- Kamiya, K., Y.Y. Gan, K.Y. Lum, M.S. Khoo, S.C. Chua & N.H. Faizu (2011) Morphological and molecular evidence of natural hybridization in *Shorea* (Dipterocarpaceae). *Tree Genet. Genomes* 7: 297–306.
- Kaur, A., C.O. Ha, K. Jong, V.E. Sands, H.T. Chan, E. Soepadmo & P.S. Ashton (1978) Apomixis may be widespread among trees of the climax rain forest. *Nature* 271: 440–442.
- Kochummen, K.M. (1978) Myrtaceae. In: F.S.P. Ng (ed), *Tree Flora of Malaya*, 3: 169–253.
- Masamune, G. (1942) *Enumeratio Phanerogamarum Bornearum*. Taihoku.
- Merrill, E.D. & L.M. Perry (1937) Reinstatement and revision of *Cleistocalyx* Blume (including *Acicalyptus* A. Gray), a valid genus of the Myrtaceae. *J. Arnold Arb.* 18: 322–343.
- Merrill, E.D., & L.M. Perry (1939) The Myrtaceous genus *Syzygium* Gaertner in Borneo. *Mem. Amer. Acad. Arts Sci.* 18, 3: 135–202.
- Tiwary, N.K. (1926) On the occurrence of polyembryony in the genus *Eugenia*. *J. Indian Bot. Soc.* 5: 124–136.
- Van Steenis, C.G.G.J. (1957) Specific and infraspecific delimitation. *Flora Malesiana* 1, 5: clxviii–ccxxxiv.
- Wickneswari, R., I. Zawawi, S.L. Lee & M. Norwati (1995) Genetic diversity of remnant and planted populations of *Hopea odorata* in Peninsular Malaysia. In: Proceedings of the international workshop of Bio-Refor, Kangar, Malaysia, 1994, pp. 72–76.

**Four new species of *Ridsdalea* (Rubiaceae: Gardenieae)
from Borneo, Wallacea and New Guinea**

Joan T. Pereira

Forest Research Centre, Sabah Forestry Department,
P.O. Box 1407, 90715 Sandakan,
Sabah, Malaysia
joan.pereira@sabah.gov.my

Summary. Four new species of *Ridsdalea* are here described from Borneo, Wallacea and New Guinea. *Ridsdalea kassamensis* J.T.Pereira and *R. papuana* J.T.Pereira are endemic to Papua New Guinea; *R. puffiana* J.T.Pereira is endemic to Borneo and *R. sundaensis* J.T.Pereira is endemic to Sulawesi and the Lesser Sunda Islands. A key to the Malesian species of *Ridsdalea* is also included.

Rothmannia is typified by *Rothmannia capensis* from South Africa. Linnaeus in 1781 had transferred this species to the genus *Gardenia*, under the name *G. rothmannia* L.f. and following this, numerous conceptual changes have occurred, rendering *Rothmannia* species to be included within *Gardenia* s.l. or *Randia* s.l. Eventually, *Rothmannia* was accepted by most taxonomists as a distinct entity from the rest of the *Randia-Gardenia* complex but some generic limits were still arguable, as shown in Bremekamp (1957), Keay (1958), Wong (1984) and Bridson & Verdcourt (1988). Nearly all members of the *Rothmannia* complex, including in Asia and the SW Pacific, could be easily recognized in having sympodially developing branch units of two nodes which occur close together, in which one member of a leaf pair is vestigial, so that trifoliate leaf clusters result. Furthermore, the fruits are berry-like, indehiscent, medium to large (2–5 cm or more across), with many seeds immersed in a pulp-like tissue; all of which are distinctive characters shared by members of the group.

Pereira (2008) attempted to review the Asiatic (especially Malesian) taxa placed in or near *Rothmannia* against the type alliance and other species in Africa, by gathering comparative data based on morphology and fine structure. It was found that, among other features, the solely African type alliance of *Rothmannia* had truly solitary terminal flowers instead of a fundamentally cymose inflorescence. Wong & Pereira (2016) have considered various new

perspectives from molecular work that also demonstrate *Rothmannia* s.s. to be the group comprising the African type species and other species in Africa that have right-contorted corolla lobes. This group differs significantly from another African group with left-contorted corolla lobes, and even more fundamentally from the Asian members, all of which have left-contorted corolla lobes (Pereira 2008, Mouly et al. in prep.). Wong & Pereira (2016) demonstrated that the Asian alliance had sufficient morphological disjunctions that allowed recognition of three genera, *Kochummenia* K.M.Wong, *Ridsdalea* J.T.Pereira & K.M.Wong, and *Singaporandia* K.M.Wong. Of these, the largest genus is *Ridsdalea*, into which 25 pre-existing names have now been recombined. Here I describe a new species of *Ridsdalea* from Borneo, another from Sulawesi and Flores islands (in the central Malesian region also known as Wallacea, in between the Sunda and Sahul continental shelves), and another two from New Guinea. With these, the known species of *Ridsdalea* now number 29, one of the largest tree genera of the Gardenieae subtribe in the Southeast Asian region.

**THE MALESIAN SPECIES OF *RIDSDALEA*,
INCLUDING FOUR NEW SPECIES**

The four new species of *Ridsdalea* are distinguished from others so far known from Malesia in the following key. For species authorities other than taxa newly described here, refer to Wong & Pereira (2016).

KEY TO THE MALESIAN SPECIES OF *RIDSDALEA*

- 1a. Leaves (including young leaves of shoot tips) completely glabrous on both sides. Corolla tube glabrous both inside and outside [Papua New Guinea] **2. *R. papuana***, sp. nov.
- 1b. Leaves in early stages always hairy (at least on the veins on lower side, or both sides). Corolla tube glabrous either on the inside or outside, never both,
 - 2a. Stipules on leafy branches long, 10–23 mm long, apex (10–)15–20 mm long; inner surface of stipules with colleters in a central triangular area [Papua New Guinea] ***R. uvarioides***
 - 2b. Stipules on leafy branches shorter, less than 10 mm long, apex shorter, less than 10 mm long; inner surface of stipules with colleters all over except at the distalmost portion,
 - 3a. Calyx glabrous to scantily puberulous, the hairs if present, very minute and scattered (detectable only with × 10 magnification) on the surface,
 - 4a. Corolla throat glabrous inside; lobes narrow, 0.25–0.3 cm wide [Philippines] ***R. lagunensis***

4b. Corolla throat hairy inside; lobes wider, 0.5–1.7 cm wide,

5a. Inflorescence a much-branched cyme, typically branching 2–3 orders, typically more than 5 flowers per cyme. Corolla tube short, 2–3.5 cm long, mouth narrow, 3.5–4 mm wide, base 1–1.5 mm wide [Sulawesi & Lesser Sunda Islands] **4. *R. sundaensis***, sp. nov.

5b. Inflorescence unbranched or branched to at most 2 orders, typically up to 5 flowers per cyme. Corolla tube longer, 4–14.5 cm long, mouth wider, 5–20 mm wide, base wider, 2–5 mm wide,

6a. Leaf apex short- to long-acuminate. Corolla lobes 5. Calyx lobes 5. Anthers 5. Mature fruits large, 6–11.5 × 5–11 cm, pendulous; fruit wall 3–5 mm thick, very grainy [Borneo] **3. *R. puffiana***, sp. nov.

6b. Leaf apex acute to obtuse. Corolla lobes typically 6–8, rarely 5. Calyx lobes typically 6–8, sometimes reaching 10, rarely 5. Anthers 6–10. Mature fruits smaller, 2.5–4.5(–5) × 2.5–4.5(–5) cm, erect; fruit wall thinner, 2–3 mm thick, not grainy [Borneo & Philippines] ***R. merrillii***

3b. Calyx conspicuously (sparsely to densely pubescent) hairy on the surface, hairs *c.* 0.5 mm long, visible to the unaided eye,

7a. Flower pedicels long, (3–)5–15 mm long. Corolla campanulate with non-speckled throat. [Sulawesi] ***R. forsteniana***

7b. Flower pedicels shorter, typically 0.5–2 mm long, rarely 3 mm long. Corolla hypocrateriform to campanulate; if campanulate, with speckled throat,

8a. Corolla campanulate. Style sparsely hairy [Myanmar, Thailand, Malay Peninsula, Sumatra, and Java] ***R. schoemannii***

8b. Corolla hypocrateriform. Style glabrous,

9a. Corolla tube short, (0.6–)2–3(–3.5) cm long,

10a. Stipules short, 3–4.5 mm long, apex 0.5–1.3 mm long. Leaves thin-to thick-coriaceous. Corolla lobes hairy at the base on the inner surface. Corolla tube not distended at the upper half. Corolla throat with hairy zone covering part or all of the tube from the corolla mouth downwards [Papua New Guinea] ***R. nigrescens***

10b. Stipules longer, 5–8 mm long, apex 2–6 mm long. Leaves chartaceous. Corolla lobes glabrous on the inner surface. Corolla tube distended at the upper half. Corolla throat glabrous [Philippines]
..... ***R. graciliflora***

11a. Lamina (5–)6–8 cm broad; petiole 1.5–2 mm in diameter. Cymes much reduced or with only 1 order of distinct branching, 1–3 flowers per cyme. Calyx tube long, 9–11 mm long, outer surface hirsute with suberect hairs. Corolla lobes wide, 0.4–1 cm. Corolla mouth, 6–7.5 mm wide [Papua New Guinea] **1. *R. kassamensis***, sp. nov.

11b. Lamina (8–)9–18 cm broad; petiole thicker, (2.5–)3–4 mm in diameter. Cymes distinctly branched to 2–5 orders, 11–130 flowers per cyme. Calyx tube shorter, 3–8 mm long, outer surface velvety-hairy to pubescent. Corolla lobes narrower, 0.1–0.4 cm. Corolla mouth only 2.5–3.5 mm wide,

12a. Stipule outer surface sparsely pubescent to glabrescent. Upper leaf surface glabrous. Inflorescence a very compact cyme with condensed branches, 2–3 distinct branching orders, rachis 0.5–1 cm long; primary branches along rachis 2–3 pairs, 0.1–0.2(–0.4) cm long. Peduncle short, 0.1–0.2 cm long, 4–5 mm thick. Bracts 4–6 mm long, sparsely pubescent. Calyx lobes (4–)6–10 mm long, pubescent. Fruits drying smooth [Papua New Guinea]
..... ***R. macromera***

12b. Stipule outer surface velvety hairy. Upper leaf surface sparsely pubescent to glabrescent. Inflorescence a more laxly branched cyme, 3–4(–5) distinct branching orders, rachis 3–4 cm long; primary branches along rachis 3–4 pairs, 1–2.5 cm long. Peduncle longer, 0.5–2 cm long, 2.5–3.5 mm thick. Bracts 2–4 mm long, velvety hairy. Calyx lobes shorter, 0.5–1 mm long, densely tomentose or velvety hairy. Fruits drying with minute flakes [New Guinea] ***R. anisophylloides***

9b. Corolla tube longer, (3.5–)4–14.5 cm long,

13a. Corolla throat with hairy zone covering part or all of the tube from the corolla mouth downwards,

- 14a. Leaf apex cuspidate to caudate, to 1.5 cm long. Stipule apex short, to c. 0.5 mm long. Number of flowers 3–9. Calyx lobes typically 3–25 mm long, rarely 1 mm. Corolla lobes narrow, 0.6–1.4 cm wide [Sumatra, Peninsular Malaysia & Borneo] ***R. grandis***
- 14b. Leaf apex acute to short- acuminate, to 0.3 cm long. Stipule apex longer, 1–2.5 mm long. Number of flowers fewer, 2–3. Calyx lobes shorter, 0.5–1 mm. Corolla lobes wider, (1.5–)1.8–2.5 cm wide [Philippines] ***R. negrosensis***
- 13b. Corolla throat glabrous,
- 15a. Peduncle 0.2–0.4 cm long. Style and stigma 60–85 mm long, the stigma included but reaching just below or slightly above the corolla mouth and near or above the anthers [Philippines] ***R. leytenis***
- 15b. Peduncle longer, 0.5–6.5 cm long. Style and stigma shorter, 15–50 mm long, the stigma included but reaching less than 2/3 way along the corolla tube and well below the anthers [Borneo]
 ***R. pseudoternifolia***

THE NEW SPECIES

In the specimen listings below, the abbreviations FLO, FRU and ST are used to indicate flowering and fruiting material, as well as ‘sterile’ material (without flowers or fruits), respectively. Also, Prov. indicates Province and months of the calendar year are abbreviated by their first three letters.

1. *Ridsdalea kassamensis* J.T.Pereira, **sp. nov.**

A species related to *R. macromera* (Lauterb. & K.Schum.) J.T.Pereira and *R. anisophylloides* (Wernham) J.T.Pereira, differing in having a narrower ((5–)6–8 cm) lamina; a thinner (1.5–2 mm) petiole; much reduced cymes with at most 1 order of distinct branching; only 1–3 flowers per cyme; longer (9–11 mm) calyx tube that has an outer surface with hirsute with suberect hairs; broader (0.4–1 mm) corolla lobes; and a corolla mouth 6–7.5 mm wide. (The other two species have broader ((8–)9–18 cm) lamina; a thicker ((2.5–)3–4 mm) petiole; cymes distinctly branched to 2–5 orders; 11–130 flowers per cyme; a shorter (3–8 mm) calyx tube that has a velvety-hairy outer surface; narrower (0.1–0.4 mm) corolla lobes; and a corolla mouth only 2.5–3.5 mm wide.)

TYPE: *Brass* 32331, Papua New Guinea, Eastern Highlands Prov., Kassam Pass, 31 Oct 1959, FLO (holotype L).

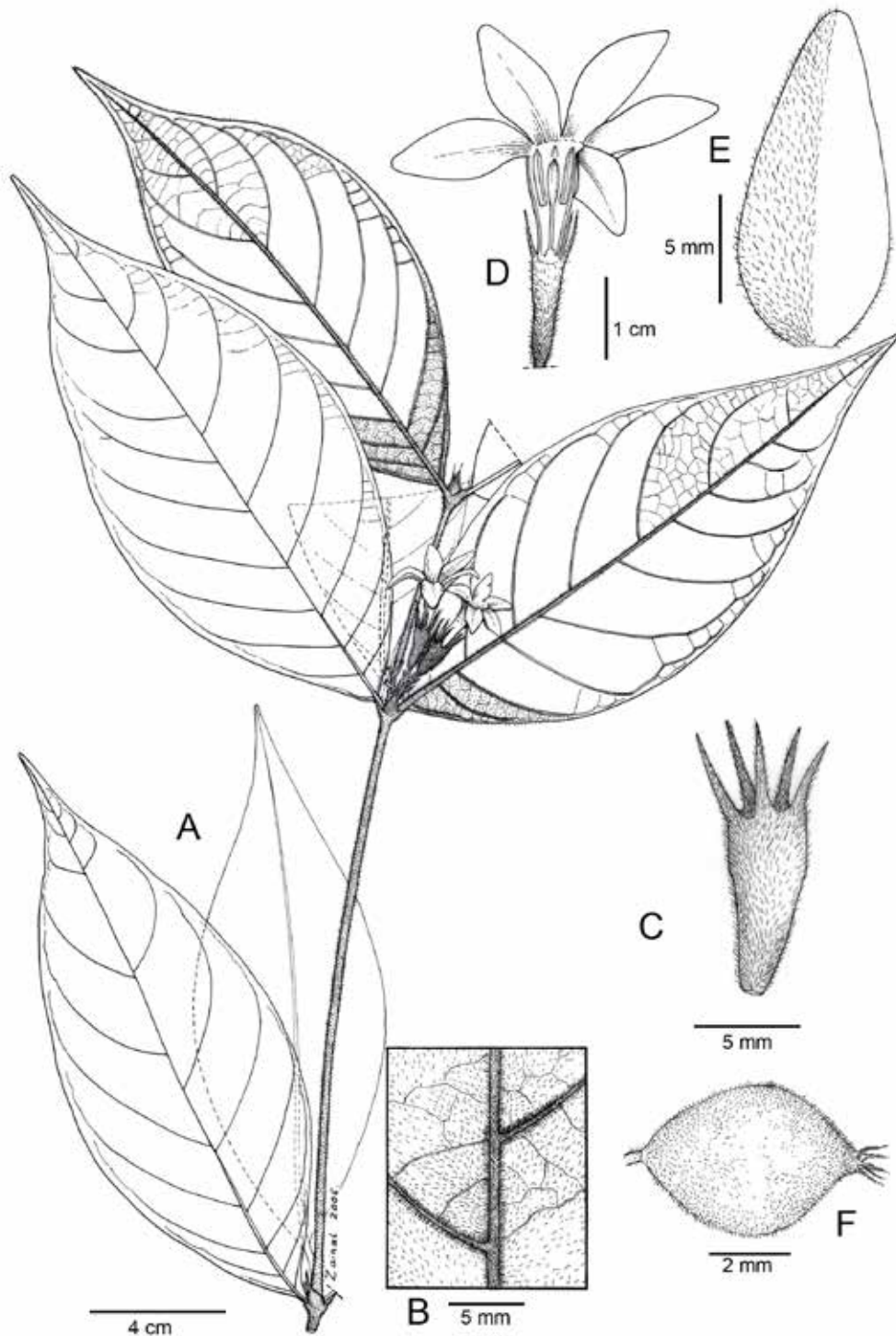


Fig. 1. *Ridsdalea kassamensis*. **A.** Leafy branch with inflorescences. **B.** Close-up of lower leaf surface with velvety hairs covering the midrib, secondary veins and entire surface. **C.** Calyx tube with long-linear lobes. **D.** Longitudinal section of flower. **E.** Outer surface of corolla lobe. **F.** Fruit. A–E from *Brass 32331* (holotype, L), F from *Forman LAE 60368 D* (BRI). (Drawing by Zainal Mustafa)

(Fig. 1)

Small tree, to 7 m high. Bark slightly peeling, blackish grey; inner bark wine red. Sapwood yellowish straw. Twigs velvety hairy when young, becoming sparsely pubescent when older. Branch leaves typically in groups of 3's, each trifoliate group based on a distal node with only one leaf normally developed (the other vestigial or very much reduced in size), and the proximal node with a pair of normal leaves. Stipules ovate-triangular, 4–6 mm long, 4–7 mm wide, outer surface sparsely pubescent, inner surface with colleters all over except at the distalmost portion; apex long-acuminate, 4–6 mm long. Young **leaves** on shoot tips velvety hairy on the lower surface, glabrescent on the upper surface. Mature leaves with petiole 0.2–0.3 cm long, 1.5–2 mm thick, pubescent to velvety hairy; lamina elliptic, lanceolate to oblanceolate, 14–18 cm long, (5–)6–8 cm wide, upper surface glabrous, lower surface velvety hairy; leaf base cuneate, symmetric to subrounded; leaf apex long-acuminate, acumen 1–2 cm long; thin-coriaceous to chartaceous when dry; midrib on upper side flat, glabrescent, on lower side raised, velvety hairy; secondary veins 6–9 pairs, on upper side flat to slightly sunken, glabrous, on lower side raised, velvety hairy; tertiary venation visible as a much-branched network between pairs of secondary veins. **Inflorescences:** peduncle 0.1–1 cm long, 1.5–2 mm thick, tomentose; habit compact, with 1 distinct branching order, rachis *c.* 0.5 cm long, primary branches along the rachis 1 pair, 0.15–0.3 cm long; bracts ovate 4–7 mm long, 4–5 mm wide, tomentose to pubescent. **Flowers** 1–3 per cyme; pedicels 2–3 mm long, *c.* 1 mm thick; calyx tube 9–11 mm long, 4–6 mm wide, hirsute, hairs erect, surface visible on the limb; calyx limb cup-shaped; calyx lobes 5, triangular at the base, becoming long-linear at the apex, 4–6 mm long, outer surface pubescent; corolla hypocrateriform, white to cream, the tube 1.5–2 cm long, 6–7.5 mm wide at the throat, 2–3 mm wide at the base; non-speckled inside, outer surface sparsely pubescent at the upper half, puberulous at the lower half, inner surface glabrous; corolla lobes 5, ovate-oblong to ovate, 1.4–1.8 cm long, 0.4–1 cm wide, outside pubescent on the uncovered half of the lobes, inside glabrous; anthers 5, fully included within the tube (inserted at the upper 1/3), 6–7 mm long; style and stigma 12–16 mm long, included but reaching just below the corolla mouth and the level of or above the anthers, style smooth, glabrous. **Fruits** ellipsoid, 4–5.5 cm long, 2.5–3.5 cm wide, velvety hairy, drying smooth; fruit wall 1–1.5 mm thick; peduncle *c.* 1 cm long, *c.* 1 mm thick. Mature seeds not seen.

ETYMOLOGY. It is named after the locality (Kassam Pass) of the type specimen.

DISTRIBUTION. Confined to the Eastern Highlands Prov. of Papua New Guinea (Fig. 2).

HABITAT. Found in *Castanopsis-Lithocarpus* forest, sometimes on ridges, to 1700 m alt.

SPECIMENS EXAMINED—PAPUA NEW GUINEA. Eastern Highlands Prov.: Kainantu subdistrict., Kassam Pass, *Brass 32331*, 31 Oct 1959, FLO (holotype L), 1400 m, *Forman LAE 60368D*, 25 Jun 1974, FRU (BRI, L), 4200ft [1280 m], *Vandenberg & Henty*

NGF 35004, 24 Jan 1968, FRU (BRI, L, SING), 5500ft [1676 m], Streimann NGF 47892, 11 July 1970, FRU (L).

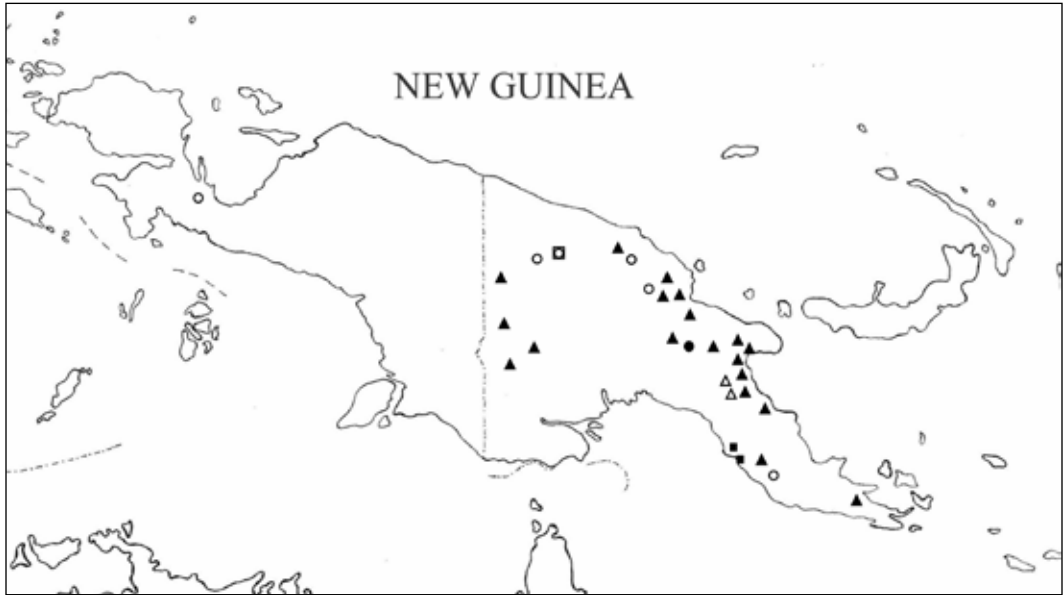


Fig. 2. Distribution of two new *Ridsdalea* species from New Guinea: *R. kassamensis* (solid circle) and *R. papuana* (solid squares). The distribution of *R. anisophylloides* (open circles), *R. macromera* (open triangles), *R. nigrescens* (solid triangles) and *R. uvarioides* (open square) is also depicted.

2. *Ridsdalea papuana* J.T.Pereira, **sp. nov.**

A species distinguished from all other Malesian species in having completely glabrous leaves on both sides (including young leaves of shoot tips) and a corolla tube that is glabrous both inside and outside. (The other species have hairy leaves, including in the early stages and a corolla tube that is glabrous either on the inside or outside, never both.)

TYPE: *Carr 11492*, Papua New Guinea, Central Prov., Lolorua, 24 Feb 1935, FLO (holotype A; isotypes BM, L).

(Fig. 3)

Tree, to 25 m high, to 45 cm diameter. Bark grey-brown; inner bark deep red. Sapwood olive green to light red. Twigs glabrous. Branch leaves typically in groups of 3's, each trifoliate group based on a distal node with only one leaf normally developed (the other vestigial or very much reduced in size), and the proximal node with a pair of normal leaves. **Stipules** broadly triangular, 5–9 mm long, 5–7 mm wide, outer surface glabrous; inner surface with

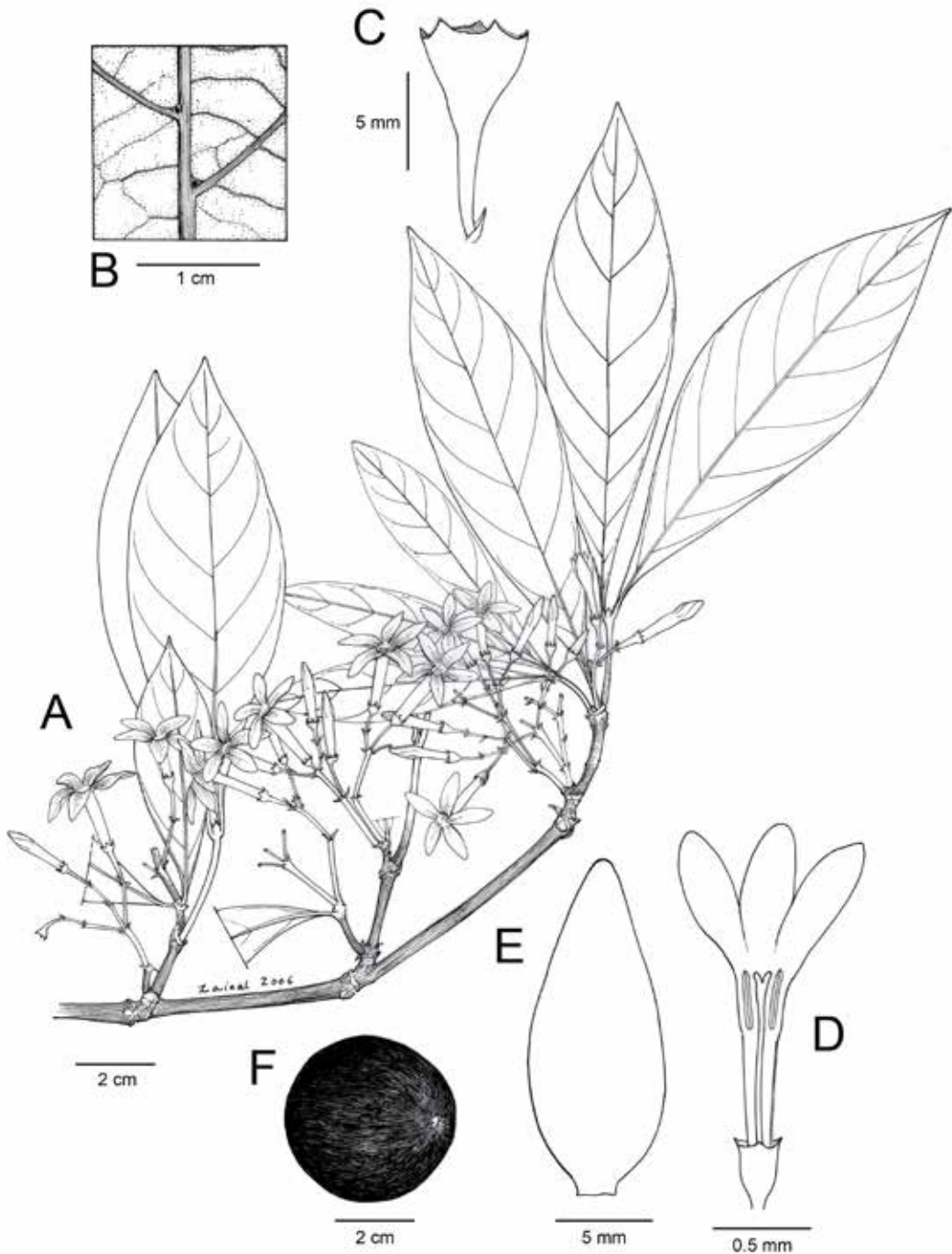


Fig. 3. *Ridsdalea papuana*. **A.** Leafy branch with inflorescences. **B.** Close-up of lower leaf surface showing domatia at the axils of the midrib and secondary veins. **C.** Glabrous calyx tube. **D.** Longitudinal section of flower. **E.** Outer surface of corolla lobe. **F.** Fruit. A–E from Carr 11492 (holotype, A), F from Streimann & Kairo LAE 51558 (BRI). (Drawing by Zainal Mustafa)

colleters all over except at the distalmost portion; apex acute to cuspidate, 1–3 mm long. Young **leaves** on shoot tips glabrous on both sides. Mature leaves with petiole 0.1–0.5 cm long, 1.5–2 mm thick, glabrous; lamina broadly elliptic, lanceolate to oblanceolate, 10–19 cm long, 5–7.5 cm wide, upper surface glabrous, lower surface glabrous; leaf base cuneate, sometimes attenuate; leaf apex acute, acumen 0.2–0.3 cm long; thin-coriaceous to chartaceous when dry; midrib on upper side flat, glabrous, on lower side raised, glabrous; secondary veins 6–9 pairs, on upper side flat, glabrous, on lower side raised, glabrous; tertiary venation visible as simple connections between pairs of secondary veins. **Inflorescences:** peduncle 0.1–1 cm long, 1.5–2 mm thick, glabrous; habit laxly arranged, with 3–4 distinct branching orders, rachis 3–3.5 cm long, primary branches along the rachis 1–2 pairs, 1–1.5 cm long; bracts short-triangular, 2–2.5 mm long, *c.* 2 mm wide, glabrous. **Flowers** 5–10 per cyme; pedicels 2–4 mm long, *c.* 1 mm thick; calyx tube 3–5 mm long, 3–5 mm wide, glabrous outside; calyx limb cup-shaped; calyx lobes 5, broadly short-triangular, 0.5–1 mm long, glabrous outside; corolla hypocrateriform, white, the tube 1–1.5 cm long, 4–5 mm wide at the throat, 2–2.5 cm wide at the base; non-speckled inside, outer surface glabrous, inner surface glabrous; corolla lobes 5, broadly elliptic to ovate, 1.2–1.5 cm long, 0.5–0.7 cm wide, outside and inside glabrous; anthers 5, fully included within the tube (inserted at the upper 1/3), 5–9 mm long; style and stigma 10–13 mm long, included but reaching just below the corolla mouth and the level of the anthers, style smooth, glabrous. **Fruits** globose, 3.5–4 cm long, 3–3.5 cm wide, glabrous, drying smooth; fruit wall *c.* 1 mm thick; peduncle *c.* 0.4 cm long, *c.* 5 mm thick. **Seeds** slightly to much flattened and broadly ovate or suborbicular to narrowly triangular, 6–7 mm long × 6–7 mm wide.

ETYMOLOGY. It is named after Papua New Guinea, from where it is thus far only known.

DISTRIBUTION. Confined to Papua New Guinea (Central Province only). Only known from three collections thus far (Fig. 2).

HABITAT. Recorded from seasonally dry evergreen rain forest, to *c.* 70 m alt.

SPECIMENS EXAMINED—PAPUA NEW GUINEA. Central Prov.: Lolorua, 100 ft [30 m], *Carr 11492*, 24 Feb 1935, FLO (holotype A; isotypes BM, L); Port Moresby subdistrict, Kuriva forestry area, near Veimauri River, 200ft [61 m], *Streimann & Kairo LAE 51558*, 6 May 1971, FRU (BRI, L, SING); near Port Moresby, 3 miles past Brown Bridge, 100ft [30 m], *White NGF 8262*, 4 May 1960, FRU (L, SING).

NOTES. In the type specimen, *Carr 11492*, which has flowers, the lateral branches of the ultimate vegetative node of a branch segment before terminal flowering are conspicuously elongated, 1–2 cm long. This character has not been observed in the fruiting specimens of this species or in the other Malesian species. Perhaps it is not a consistent feature. The species is distinct in having both sides of the leaves completely glabrous, even at the young shoot tips, and completely glabrous inflorescences.

3. *Ridsdalea puffiana* J.T.Pereira, **sp. nov.**

A species close to *R. merrillii* (Elmer) J.T.Pereira but differing in an acuminate leaf apex, five calyx and corolla lobes, pendulous large (6–11.5 × 5–11 cm) mature fruits with 3–5 mm thick, very grainy fruit wall. (*R. merrillii* has an acute to obtuse leaf apex, typically 6–8 (rarely 5) calyx and corolla lobes, erect smaller (2.5–4.5(–5) × 2.5–4.5(–5) cm) mature fruits with thinner (2–3 mm) non-grainy fruit wall.

TYPE: *Ridsdale PBU 396*, Indonesia, Kalimantan, Central Kalimantan, P.B.U. base camp and environs, side river of Rekut, riverside forest, 6 Jun 1990, FLO/FRU (holotype L; isotypes BO, K, KEP, SAN).

(Fig. 4)

Rothmannia sp. 1, Beaman & Anderson, *The Plants of Mount Kinabalu* (2004) 340.

Medium-sized tree, to 15 m high, to 15 cm diameter. Bark dark brown to dark grey; inner bark orange. Sapwood yellow. Twigs glabrous. Branch leaves typically in groups of 3's, each trifoliate group based on a distal node with only one leaf normally developed (the other vestigial or very much reduced in size), and the proximal node with a pair of normal leaves. **Stipules** shortly ovate-triangular, 1.5–4 mm long, 3–6 mm wide, outer surface glabrous, inner surface with colleters all over except at the distalmost portion; apex obtuse, acute to short-acuminate, to 1 mm long. Young **leaves** on shoot tips scantily pubescent on lower surface. Mature leaves with petiole (0.3–)0.5–1.5 cm long, 1–2 mm thick, glabrous; lamina obovate, elliptic to oblanceolate, 8–21(–26) cm long, 3.5–9(–13) cm wide, upper surface glabrous, lower surface glabrous to glabrescent; leaf base cuneate, attenuate, rounded to unequal; leaf apex short-to long-acuminate, acumen to 1.3 cm long; thin-coriaceous to chartaceous when dry, bullate on the upper leaf surface when fresh; midrib on upper side slightly raised, glabrous to glabrescent, on lower side raised, glabrous to sometimes pubescent; secondary veins 6–12 pairs, on upper side slightly raised, glabrous, on lower side raised, glabrous to scantily puberulous or pubescent; tertiary venation visible as simple connections between pairs of secondary veins or invisible. **Inflorescences:** peduncle 0.1–0.6 cm long, 1.5–3 mm thick, glabrous to glabrescent; habit compact, unbranched or with 1 distinct branching order, rachis 0.1–0.3 cm long, primary branches along the rachis 1 pair; 0.1–0.3 cm long; bracts ovate, 1.5–2 mm long, 2–3 mm wide, glabrous, hairy only at the margin. **Flowers** (1–)2–3 per cyme; pedicels *c.* 1 mm long, 1–1.5 mm thick; calyx tube 6–12 mm long, 5–8 mm wide, glabrous to scantily puberulous, hairs appressed, surface visible, calyx limb cup-shaped; calyx lobes 5, short-triangular, 0.5–2 mm long, glabrous but scantily hairy at the margin; calyx limb cup-shaped; corolla hypocrateriform, white, the tube (8–)10.5–14.5 cm long, 6–9 mm wide at the throat, 2–3 mm wide at the base, non-speckled inside, outer surface glabrous to glabrescent, inner surface with hairy zone covering part or all of the tube from the rim of the corolla mouth downwards; corolla lobes 5, ovate-elliptic to lanceolate, 2.3–4.5 cm long,

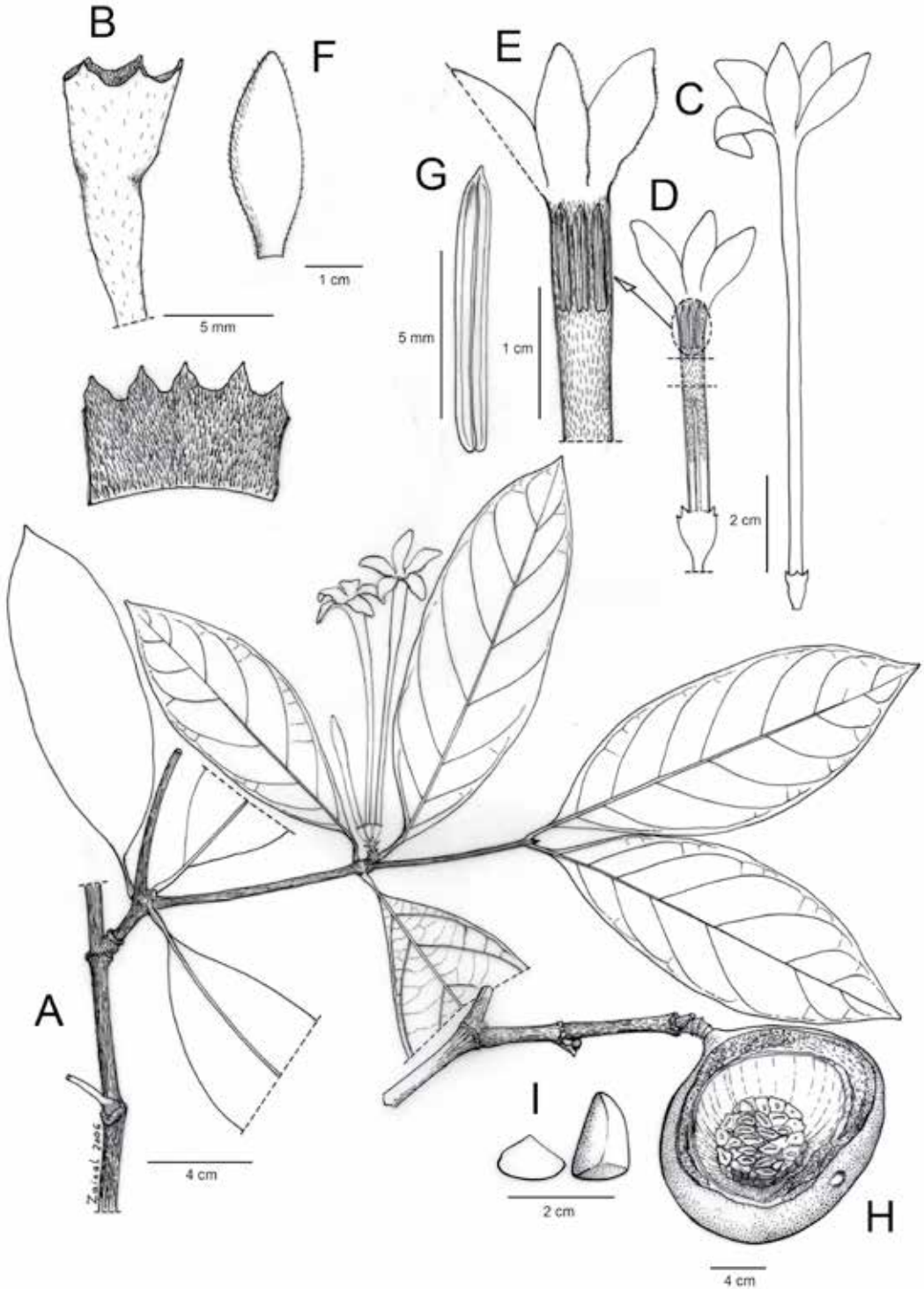


Fig. 4. *Ridsdalea puffiana*. **A.** Leafy branch with inflorescence. **B.** Scantly puberulous calyx tube. **C.** External aspect of flower. **D–E.** Longitudinal section of flower. **F.** Outer surface of corolla lobe. **G.** Anther. **H.** Fruit with seed mass. **I.** Seeds. A from *Ridsdale PBU 396* (holotype, L), B–G from *Clemens & Clemens 32201* (L), and H–I from *Carr 27221* (SING). (Drawing by Zainal Mustafa)

0.6–1.7 cm wide, outside scantily puberulous at the margin or fringes of the lobes, inside glabrous; anthers 5, fully included within the tube (inserted at the upper 1/3), 6–12 mm long; style and stigma 60–80 mm long, included but reaching less than 2/3 way along the corolla tube and well below the level of the anthers, style smooth, glabrous. **Fruits** globose, 6–11.5 cm long, 5–11 cm wide, glabrous, drying smooth; fruit wall 3–5 mm thick, very grainy; peduncle 0.1–0.3 cm long, 5–11 mm thick. **Seeds** slightly to much flattened and broadly ovate or suborbicular to narrowly triangular, 10–14 mm × 8–10 mm.

ETYMOLOGY. This species is named in memory of the late Prof. Christian Puff, University of Vienna, Austria, a Rubiaceae specialist who carried out fieldwork in Sabah and who had been a wonderful mentor to the author.

VERNACULAR NAME. Sarawak: *Eloh sa'nieng* (Kelabit).

DISTRIBUTION. Endemic to Borneo (Sabah, Sarawak, Brunei and Kalimantan) (Fig. 6).

HABITAT. From lowland and hill forest to lower montane forest, frequently near rivers, to 1500 m alt.



Fig. 5. *Ridsdalea puffiana*: leafy branch with flower (left), fruit (upper right) and corollas (lower right). (Photo: J.T. Pereira)

SPECIMENS EXAMINED—BORNEO. SABAH. Kota Belud: Kg Kiau Nuluh, *Jusimin* 369, 22 Apr 1993, FRU (SNP), 695 m, *Pereira, Noorsiha et al. JTP* 585, 24 Feb 1999, ST (SAN); Kandasau, 10 miles W of Ranau, 3500 ft [1067 m], *Wood & Kapis SAN* 16337, 14 Dec 1955, FRU (BRI, L, SING). **Ranau:** Mile 37.5 [Km 60.3], Ranau Rd., *Mikil SAN* 29250, 23 Feb 1962, FRU (L, SAN, SAR), Ranau Rd., 4550 ft [1387 m], *Badak SAN* 32341, 10 Nov 1962, FLO/FRU (L, SAN); Mile 38 [Km 11.6], Ranau Rd., 4500 ft [1371 m], *Tai SAN* 42535, 14 Jan 1965, FRU (K, SAN, SNP); Sosopodon F.R., 1360 m, *Pereira et al. JTP* 587, 25 Feb 1999, ST (SAN); Tenompok: below Tenompok, 4700 ft [1432 m], *Carr* 27221, 3 May 1933, FRU (SING), *Clemens s.n.*, Mar 1932, FLO (BM), 5000 ft [1524 m], *Clemens & Clemens* 28522, 22 Feb 1932, ST (L), *Clemens & Clemens* 28713, Mar 1932, FLO (BM, K, L), *Clemens & Clemens* 29661, 10 May 1932, FRU (BO, K, L), *Clemens & Clemens* 29661A, Apr–May 1932, FLO (BO, K, L), *Pereira & Sugau JTP* 591, 26 Feb 1999, ST (SAN), 800 m, *de Wilde et al. SAN* 142230, 8 Dec 2003, ST (SAN); Dallas: 3000 ft [914 m], *Clemens & Clemens* 26365, 12 Sep 1931, FRU (K, L, SING), *Clemens & Clemens* 27351, 2 Dec 1932, FRU (K, L), *Clemens & Clemens* 29251, 11 Apr 1932, ST (BM, K, L), *Clemens & Clemens* 29748, 26 May 1932, ST (K, L), *Clemens & Clemens* 30345, 1931–32, ST (K); Mt Kinabalu: Ulu Langanani, 3800 ft [1158 m], *Chew, Corner & Stainton RSNB* 1724, 11 Aug 1961, FRU (BO, K, L, SAN, SING); Penibukan, Penibukan ridge, 4000 ft [1219 m], *Clemens & Clemens* 51698, Sep 1933, FRU (BM), Dahobong river, 3500 ft [1067 m], *Carr SFN* 26382, 5 Mar 1933, FRU (SING), 900 m, *Nooteboom & Aban* 1510, 10 Mar 1970, FLO (K, L, SAN), 4000–5000 ft [1219–1524 m], *Clemens & Clemens* 31635, 15 Feb 1935 FLO (BO, K, L); 4000 ft [1219 m], *Clemens & Clemens* 32201, 17 Mar 1933, FLO/FRU (K, L), Penibukan ridge, 4000 ft [1219 m], *Clemens & Clemens* 40494, 28 Sep 1933, FLO (K, L). **Tambunan:** Crocker Range, Km 64, Kota Kinabalu–Tambunan Rd., 1250 m, *Beaman et al. 7318*, 30 Oct 1983, FLO (L); Mahua Waterfall, 400 m from the Reception Centre, 1099 m, *Jemson & Ubaldus SAN* 152502, 29 Aug 2010, FLO/FRU (SAN), trail to Mahua Falls, 1078 m, *Pereira et al. SAN* 155114, 20 Sep 2012, FLO (SAN, SNP, L), Mahua, Minduk Sirung trail from Mahua to Mt Alab, *Pereira et al. SAN* 155116, 20 Sep 2012, ST (SAN, SNP, L), *Pereira et al. SAN* 155118, 20 Sep 2012, FLO/FRU (SAN, SNP, L); Trusmadi, *Joseph et al. SAN* 109441, 20 May 1986, FRU (SAN); Mahua 1340 m, *Rimi et al. SP* 19265, 28 Aug 2003, FRU (SAN). **Sipitang:** Long



Fig. 6. Distribution of *Ridsdalea puffiana* (solid circles) in Borneo.

Pasia, *Postar & Davidson SAN 145771*, 3 Sep 2002, FLO (SAN). **BRUNEI. Temburong:** Amo, Kuala Belalong, Sg Belalong, 60 m, *Dransfield et al. JD 7077*, 15 Feb 1992, FRU (BRUN, K, SAN), Eastern slope of Bukit Bangar, 10–30 m, *Hotta 13095*, 19 Jan 1964, FRU (SAR). **SARAWAK. Sri Aman Div.** Lubok Antu: Sg Jelok, near Bukit Sengkajang, Lanjak-Entimau, 2100 ft [640 m], *Chai S 34038*, 18 Mar 1974, FRU (KEP, SAR). **Miri Div.** Miri: Sg Medalam, Gunung Mulu National Park, *Chai S 39473*, 13 Oct 1977, FLO/FRU (KEP, SAN, SAR); Sg Tinjar, Dulit Range, 860 m, *Dayang Awa & Yii S 46788*, 16 Oct 1983, FRU (KEP, L, SAN, SAR). **Limbang Div.** Limbang: Lawas, Kota F.R., Ulu Lawas, 800 ft [244 m], *Chai & Ilias S 31115*, 21 Oct 1971, FRU (SAR). **Kapit Div.** Kapit: Belaga, Rejang, *Haviland 2156*, Nov 1892, FLO (K, SING), Sg. Entulu, Sg Mengiong, near stream, *Lee S 54630*, 18 Aug 1987, FLO (SAR), Mujong, Temiai River, Hose mountain, submontane forest, 1260 m, *Lai, Jugah & Awang S 64099*, 6 Dec 1991, FRU (L, SAN, SAR); Baram, Kelabit Highland, at the foot of Apo Duat, 1300 m, *Sie S 35470*, 12 Nov 1974, FRU (SAN, SAR). **KALIMANTAN. E Kalimantan:** W Kutai, near Mt Kemoel, 1000 m, *Endert 3763*, 2 Oct 1925, FRU (BO, L), Central Kutei, Belajan River, Gunung Kelopak, near Tabang, 50 m, *Kostermans 10496*, 16 Apr 1955, FRU (A, K, L). **C Kalimantan:** P.B.U. base camp and environs, side river of Rekut, *Ridsdale PBU 396*, 6 Jun 1990, FLO/FRU (holotype L; isotypes BO, K, KEP, SAN).

NOTES. Vegetatively, this species is similar to *R. merrillii* but differs in the few characters mentioned in the key to Malesian species above.

4. *Ridsdalea sundaensis* J.T.Pereira, **sp. nov.**

TYPE: *van Balgooy 3946*, Indonesia, Sulawesi, between Soroako and Nickel Plant site, 500 m, 10 Jul 1979, FRU/FLO (holotype L).

Rothmannia merrilli sensu Kessler et al., Checklist of woody plants of Sulawesi, Indonesia, *Blumea Supp.* 14 (2002) 121, non (Elmer) J.T.Pereira.

(Fig. 7)

Small tree, to 15 m high, to 25 cm diameter. Twigs glabrescent when young, becoming glabrous when old. Branch leaves typically in groups of 3's, each trifoliate group based on a distal node with only one leaf normally developed (the other vestigial or very much reduced in size), and the proximal node with a pair of normal leaves. **Stipules** triangular to ovate, 2–3(–5) mm long, 4–5 mm wide, outer surface glabrous; inner surface with colleters all over except at the distalmost portion; apex obtuse, acute to cuspidate, to *c.* 1 mm long. Young **leaves** scantily pubescent on lower surface. Mature leaves with petiole 0.2–0.7(–1) cm long, 1–2 mm thick, glabrous; lamina elliptic, oblanceolate to obovate, (7–)9–16 cm long, (3–)4–9 cm wide, upper surface glabrous, sometimes shiny, lower surface glabrous;

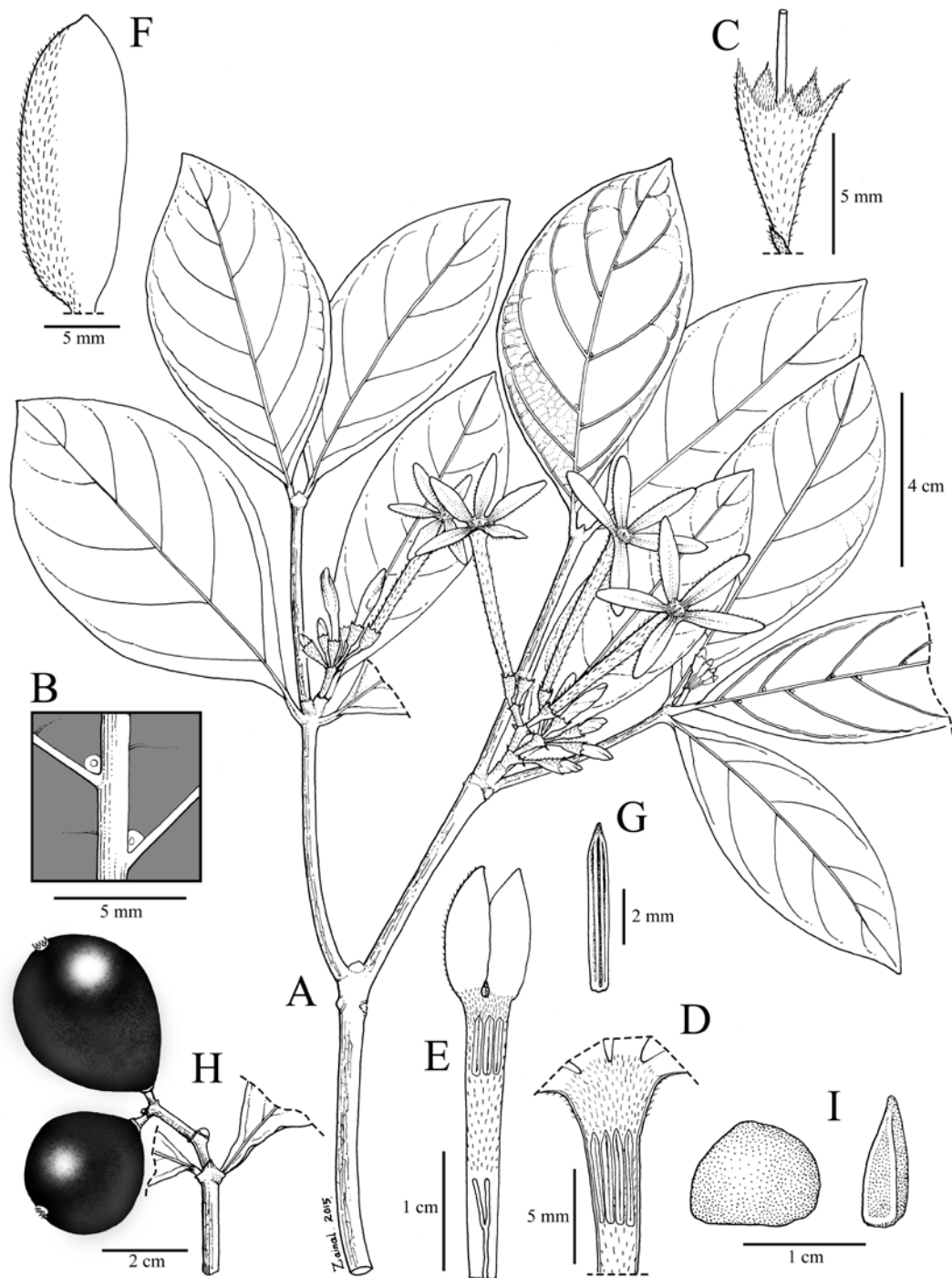


Fig. 7. *Ridsdalea sundaensis*. **A.** Leafy branch with inflorescences. **B.** Close-up of lower leaf surface showing pit-domatia in the axils of secondary veins along the midrib. **C.** Puberulous calyx tube. **D–E.** Longitudinal section of flower. **F.** Outer surface of corolla lobe. **G.** Anther. **H.** Infructescence. **I.** Seeds. A–G from *van Balgooy 3946* (holotype, L), H–I from *van Balgooy 4082* (L). (Drawing by Zainal Mustafa)

leaf base cuneate, attenuate to unequal; leaf apex acute to short-acuminate, acumen to 0.5 cm long; thin- to thick-coriaceous when dry; midrib on upper side flat, glabrous, on lower side raised, sparsely puberulous to glabrous; secondary veins 5–7(–8) pairs, on upper side flat, glabrous, on lower side raised, sparsely puberulous to glabrous; tertiary venation visible as simple connections between pairs of secondary veins. **Inflorescences:** peduncle 0.3–1.2 cm long, 2–2.5(–3) mm thick, glabrous; habit laxly arranged, with (1–)2–3 distinct branching orders, rachis 0.5–1.5 cm long, primary branches along the rachis (1–)2 pairs, 0.5–1 cm long; bracts narrowly ovate, 1–1.5 mm long, 1–1.5 mm wide, sparsely puberulous to pubescent at the apex. **Flowers** (4–)7–14 per cyme; pedicels obsolete to 1 mm long, *c.* 1 mm thick; calyx tube 4–6 mm long, 3.5–4 mm wide, glabrous throughout or puberulous at the limb and glabrous at the hypanthium, hairs appressed, surface visible; calyx limb cup-shaped; calyx lobes 5–6, short-triangular, 1–2 mm long, scantily puberulous to glabrous but sparsely puberulous on the margin; corolla hypocrateriform, white, the tube 2–3.5 cm long, 3.5–4 mm wide at the throat, 1–1.5 mm wide at the base; non-speckled inside, outer surface scantily puberulous, inner surface with hairy zone covering part or all of the tube from corolla mouth downwards; corolla lobes 5, elliptic to elliptic-oblong, 1.6–2(–2.5) cm long, 0.5–1 cm wide, outside scantily puberulous on the uncovered half of the lobes and near the margin, inside glabrous; anthers 5, fully included within the tube (inserted at the upper 1/3), 5–12 mm long; style and stigma 13–14 mm long, when included but reaching less than 2/3 way along the corolla tube, and well below the anthers but 30–35 mm long when partially exerted, style smooth, glabrous, stigma 10–17 mm long. **Fruits** globose to obovoid, 3.5–5 cm long, 2.5–4 cm wide, glabrous, drying smooth and sometimes shiny; fruit wall 1–1.5 mm thick; peduncle 0.5–1 cm long, *c.* 3 mm thick. **Seeds** slightly to much flattened and broadly ovate or suborbicular to narrowly triangular, 9–10 mm × 7–8 mm.

ETYMOLOGY. The species is named after Sunda Island, where the species is found.

DISTRIBUTION. Endemic to Sulawesi (Southeast, Central and South Provinces) and Lesser Sunda Islands (West Flores Island) (Fig. 8).

HABITAT. In primary and secondary forests, including heath forests, on sandy or ultrabasic soils, to 900 m alt.

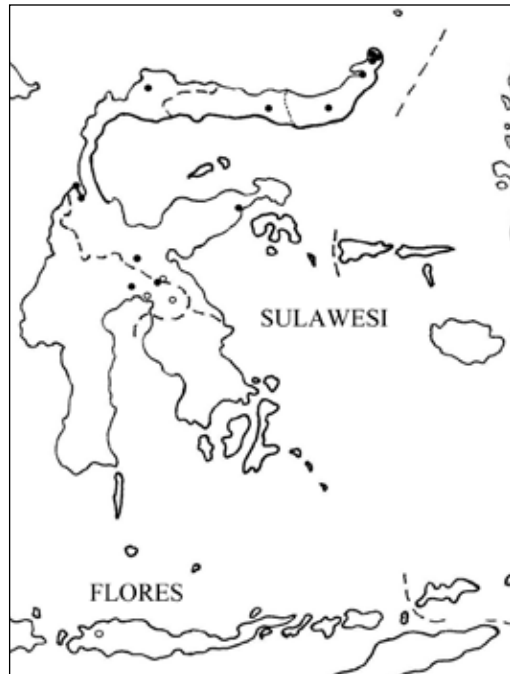


Fig. 8. Distribution of *Ridsdalea sumdaensis* (open circles) in Sulawesi and Flores. The distribution of *R. forsteniana* is also shown (solid circles).

SPECIMENS EXAMINED—SULAWESI. No locality. *Bosekwezen s.n.*, 6 Jun 1925, FLO (BO). **Southeast Sulawesi Prov.:** Tawanggo, Kolaka, Mt Poli-polia, 200 m, *Prawiroatmadjo & Maskuri 1449*, 22 Oct 1978, FRU (SAR), around Opa swamp, W of Poli-polia, primary forest, 200–300 m, *Prawiroatmodjo & Soewoko 1919*, 23 Nov 1978, FRU (L). **South Sulawesi Prov.:** en Onderh. Ond. Afd. Malili Oesoe, 100 m, *Boschproefstation CEL II 338*, 4 Apr 1931, FRU (L), Malili, *Boschwezen bb 1925*, s. datum, ST (BO), Oesoe, 100 m, *Maturandong 113*, 2 Oct 1931, FRU (BO), 100 m, *Neth. Ind. For. Service CEL II 306*, 10 Feb 1931, FLO/FRU (BO, L, SING), 200 m, *Neth. Ind. For. Service CEL II 395*, 10 Apr 1934, ST (L); Soroako road, 150 m, *Balgooy 3894*, 6 Jul 1979, FLO & FRU (L); between Soroako and Nickel Plant site, 500 m, *Balgooy 3946*, 10 Jul 1979, FRU/FLO, (holotype L); Batu Besi between Tabarano and Larona river, 300 m, *Balgooy 4082*, 19 Jul 1979, FLO/FRU (L). **Central Sulawesi Prov.:** west part of Batudaka Island, Kayome, *Sidiyasa et al. 1885*, 25 Dec 1999, FRU (BO). **LESSER SUNDA ISLANDS. Flores:** *Schmutz 3606*, 26 May 1905, FRU (L); Manggarai, 300 m, *Schmutz SVD 4017*, 28 Jan 1978, FRU (L), Naga, 900 m, *Schmutz SVD 4121*, 6 May 1978, FLO (L), 450 m, *Schmutz SVD 4781a*, 25 Feb 1981, ST (L).

NOTES. This is a species close to *R. merrillii*, with which it is probably vicariant. Many of the Celebes specimens had been misidentified as *R. merrillii*. However, this species is distinguishable from *R. merrillii* in having typically more flowers per cyme (7–14, rarely as few as 4) whereas *R. merrillii* typically has 3–5 flower per cyme, rarely reaching 9 flowers per cyme; in its peduncles that are 0.5–1 cm long (peduncles to 0.3 cm long in *R. merrillii*); the generally shorter corolla tube, to only 3.5–4 cm long (3.5–7.5(–12) cm long in *R. merrillii*); narrower corolla mouth, 3.5–4 mm wide (5–9 mm wide in *R. merrillii*); narrower corolla tube base, only 1–1.5 mm wide (2–3 mm wide in *R. merrillii*); and 5 anthers (6–10 in *R. merrillii*).

There is a collection, *Schmutz SVD 4121*, that has flowers with style and stigma partially exerted from the corolla mouth. The rest of the specimens have shorter styles, i.e., included and reaching less than 2/3 way along the corolla tube and well below the anthers. A heterostylous condition may occur in this species, but more material and observations are needed to substantiate this.

A fruiting collection, *Sidiyasa & Didi 1885*, is very close to this species but differs in having larger mature leaves, 20–25 × 10–12 cm, whereas the typical *R. sundaensis* has smaller leaves, (7–)9–16 × (3–)4–9 cm.

ACKNOWLEDGEMENTS

I would like to thank the Sabah Forestry Department and its Forest Research Centre (FRC) and also the University of Malaya for support and facilities leading to the completion of

this study. I also acknowledge the Keepers and Curators of various herbaria who have loaned specimens. This paper forms part of the author's doctoral dissertation research at the Institute of Biological Sciences, University of Malaya under the supervision of Dr K.M. Wong and Prof. A.L. Lim. I would also like to acknowledge the helpfulness of the late Prof. Christian Puff (WU), as well as Dr Colin Ridsdale, Dr W.J.J.O de Wilde and Dr B.E.E. de Wilde Duyfjes (L), and many more colleagues from afar for their help in sourcing important literature references, images and specimen material, and for many highly constructive discussions on the Rubiaceae. Past and present staff members of the Sandakan Herbarium are also acknowledged for their assistance in the field and in the herbarium. Zainal Mustafa (University of Malaya) kindly prepared the line drawings. Suzana Sabran and Alviana Damit (FRC) assisted with the labelling of the botanical illustrations and Louise Neo (National University of Singapore) assisted in the preparation of distribution maps.

REFERENCES

- Bremekamp, C.E.B. (1957) Some new Acanthaceae and Rubiaceae from Laos (Indo-China). *Proc. Kon. Ned. Akad. Wetensch. C* 60(1): 1–8.
- Bridson, D. & B. Verdcourt (1988) Rubiaceae. Part 2. In: R.M. Polhill (ed.), *Flora of Tropical East Africa*. A.A. Balkema, Rotterdam, Brookfield. Pp. 511– 519.
- Keay, R.W. (1958) *Randia* and *Gardenia* in West Africa. *Bull. Jard. Bot. État Bruxelles* 28: 15–72.
- Linnaeus, C. (1781) *Supplementum Plantarum Systematis Vegetabilium*. P. 165.
- Pereira, J.T. (2008) Systematic Studies in *Rothmannia* sensu lato (Rubiaceae) and a Revision of the Malesian Taxa. Ph.D. Thesis, University of Malaya, Kuala Lumpur, Malaysia. 468 p.
- Wong, K.M. (1984) The genera of Peninsular Malaysian Rubiaceae formerly confused with *Randia*. *Malayan Nat. J.* 38: 1–57.
- Wong, K.M. & J.T. Pereira (2016) A taxonomic treatment of the Asiatic allies of *Rothmannia* (Rubiaceae: Gardenieae), including the new genera *Ridsdalea* and *Singaporandia*. *Sandakania* 16: 21–64.

SANDAKANIA

Intending contributors should send their submissions to the Editor or Co-editor.

Manuscripts should be typed or printed on A4 paper, with double-line spacing, and should include a summary for each title. The text need not conform to any special structure but all figures and tables should be submitted on separate sheets, clearly marked. References should be cited as "Primack (1984)" or "(Primack 1984)" in the text and listed at the end as "Primack, R.B. (1984) Moraceae trees in the religious life of Borneo people. Sarawak Museum Journal (New Series) 33 (54): 69–74". Journal or book names should not be abbreviated in the manuscript. Original artwork and transparencies should not be sent — instead, good copies of these should be forwarded, unless otherwise requested.

Manuscripts cannot be returned. Material published may be freely reproduced with acknowledgement, unless special copyright has been indicated.

For each paper published, 25 copies of the work will be made available without charge for the use of the author(s) when published.

CONTENTS

Page

K.M. Wong & Soejatmi Dransfield

Ruhooglandia and *Widjajachloa*, two new genera of Malesian bamboos
(Poaceae: Bambusoideae) and their distinction from *Nastus* and *Chloothamnus* 1

K.M. Wong, W.L. Goh, Hathairat Chokthaweeapanich, Lynn G. Clark, Sarawood Sungkaew, Elizabeth A. Widjaja & Nian-He Xia

A subtribal classification of Malesian and Southwest Pacific
woody bamboos (Poaceae: Bambusoideae: Bambuseae) informed
by morphological and molecular studies 11

Elizabeth A. Widjaja & K.M. Wong

New combinations in *Chloothamnus*
(Poaceae: Bambusoideae), a genus of Malesian bamboos
formerly confused with *Nastus* 37

A.S. Kamariah & K.M. Wong

Novitates Bruneienses, 7.
Saurauia (Actinidiaceae) in Brunei Darussalam 41

Peter Ashton

Notes on northern Borneo Myrtaceae 55

Joan T. Pereira

Four new species of *Ridsdalea* (Rubiaceae: Gardenieae)
from Borneo, Wallacea and New Guinea 77

Front cover: The Bornean climbing bamboo *Dinochloa scabrida* builds up an amazing tangle of culms and branches at the Rimba Ilmu Botanical Garden, University of Malaya, where it is cultivated as a specimen. Photo: K.M. Wong.