Gardens' Bulletin Singapore 67(1): 51–60. 2015
doi: 10.3850/S238258121500006X

Novitates Bruneienses, 1. A background to the botanical survey of Brunei Darussalam, and a new species of *Jarandersonia* (Malvaceae)

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ABSTRACT. A brief introduction to research and botanical documentation of the Brunei flora, and the collaborative programme for a continuing botanical survey of the country, is given. An outline of the key biogeographical features of the Brunei area supports the premise that distinct geo-ecological enclaves occur which are special units of species richness, within which a significant level of undocumented plant diversity still exists. *Jarandersonia yahyantha* K.M.Wong, Joffre, Ariffin & Y.W.Low (Malvaceae), a new tree species so far only known in Brunei, is described.

Keywords. Biological hotspot, biogeography, Borneo, Malesia, new species, Southeast Asia

Introduction: The floristic richness of Borneo and Brunei Darussalam

This new series supports a recently established programme to further the botanical exploration of Brunei Darussalam, in northwestern Borneo, the third-largest island in the world and biologically the richest landmass of the Sundaland region (MacKinnon & MacKinnon, 1986; Ashton, 1989). The Malesian region as a whole (Malay Peninsula and Malay Archipelago, including the area from the Philippines through to New Guinea) has a diverse flora estimated to include 42,000 seed plant species (Roos, 1993). Myers et al. (2000) considered Sundaland, which includes the Malay Peninsula, Sumatra, Java and Borneo, one of tropical Southeast Asia's four biodiversity hotspots.

Estimates of the Bornean vascular flora have ranged from 9000 (Merrill, 1921) to 15,000 species (Merrill, 1950; Raes et al., 2009). However, although recent work completed by Beaman & Anderson (2004) enumerated more than 5000 vascular plant species in Kinabalu Park (Sabah) alone, further work has suggested that many more novelties were to be expected there (Chen et al., 2014), as well as generally with the *Tree Flora of Sabah and Sarawak* (e.g., Soepadmo & Wong, 1995 and further volumes). As such, Merrill's upper limit for Borneo, or a tally in excess of that, is to be expected. On the other hand, Brunei, with its land area of 5765 km^2 being less than a mere 1% of the whole of Borneo, was estimated to have close to 5000 species of

seed plants, including 2000 species of tree (Wong, 1997). A first intensive checklisting of the flora based on organised field collecting over some seven years, 1989–1995, much of it an active collaboration between the Brunei Forestry Department and the Royal Botanic Gardens, Kew (Coode et al., 1996), accounted for some 3500 species of indigenous seed plants, including 1900 tree species (Wong, 1999). Apart from the Dipterocarpaceae, which has been well treated by Ashton (1964, 1982) and is generally well collected, this checklist remains a first-stage investigation of the flora because (1) many families and genera still had significant numbers of undetermined specimens; (2) recent critical revisions were not available then for many genera; and (3) in the ensuing period the Brunei Herbarium continued to gather interesting taxa that had not been captured by earlier collecting effort. Thus it can be appreciated that the Brunei flora is a very rich one.

In 2013, the Government of His Majesty The Sultan of Brunei Darussalam and the National Parks Board, Singapore, entered into a collaborative programme for a new phase of botanical survey. This seeks to intensify fieldwork for biodiversity exploration and documentation, and to focus on the botanical inventory of Brunei, including taxonomic identifications by specialists from our own and outside institutions when possible.

Key biogeographical features of the Brunei area

In the same year as this new collaboration began, a review of the flowering plants endemic to Brunei was published (Henrot et al., 2013), listing 65 species of angiosperms hitherto known only from Brunei, and suggesting that, as with a number of other species generally occurring only in the Brunei area (which includes adjacent parts of SW Sabah or NE Sarawak), some of the so-called endemics could subsequently be found to be not so restricted. The latter category is exemplified by the aroids *Homalomena scutata* S.Y.Wong & P.C.Boyce, occurring in both the Belait and Temburong districts of Brunei but found also in the Limbang and Mulu areas in adjacent NE Sarawak (Wong & Boyce, 2014), and *H. cowleyae* P.C.Boyce & S.Y.Wong, known in the Temburong and Mulu areas (Boyce & Wong, 2014).

There are at least two biogeographic scenarios why this work on endemic plants is significant. One is that we could indeed expect there would be true Brunei endemics, as botanical experience has shown for, especially, herb species, including many *Begonia* or gesneriad taxa, as well as smaller plants in general. Henrot et al. (2013) found that most of the documented endemic taxa were smaller plants in the Begoniaceae (15 taxa), Araceae (8 taxa), Gesneriaceae (7 taxa), Orchidaceae (5 taxa), Zingiberaceae (5 taxa), and palms (Arecaceae: 5 taxa), so it could be true that many large flowering plants have better dispersal than small ones. Although it should be borne in mind that, thus far, the collecting and research effort has concentrated much on trees, rather than herbs, other reasons, including recent evolution, may restrict plant distribution. A slender bamboo, *Temburongia simplex* S.Dransf. & K.M.Wong, is the only known representative of this peculiar genus (Dransfield & Wong, 1996)

that is still entirely restricted to Brunei's Temburong valley, even after two decades of continuing botanical collecting in Borneo. There is a suite of similarly restricted *Begonia* and other species. Some others are borderline cases: for instance, the palm *Livistona exigua* Dransf., documented from Brunei's Batu Patam ridge, still has not been documented from adjacent parts in Sarawak.

Wong (1997, 1999) discussed how the Brunei area includes its own geographical and ecological enclaves within the geologically distinct (but relatively youthful) and larger northwest Borneo area, taking into consideration how its main area is hemmed in by either highlands (such as around inland Temburong, Tutong and Belait) or extensive swamp systems (as in the lower Belait and Baram drainage complex to its southwest) (Fig. 1). The western side of Brunei is largely the remains of an ancient syncline, now drained by the Belait and Tutong rivers, whereas the eastern Temburong district is mostly the drainage area of one major river system, the Temburong (Ashton, 1958). This, together with precipitous topography marked by steeply incised valleys in the hard sandstones of inner Temburong, or in the uppermost reaches of the Belait and Tutong, can conceivably bring about population isolation that engenders highly localised endemism (Coyne & Orr, 2004). Even in the Belait district, where topographic relief is generally lower than in the Temburong, hilly pockets isolated by swamps or river systems, or highly specific habitats such as moist sandstone bluffs, may harbour narrowly endemic or habitat-specialist taxa, such as *Homalomena* spp. documented only from the Teraja area of Belait (Wong & Boyce, 2011). Many of the flowering plants endemic to Brunei Darussalam are either very rare or undercollected: 15 are known from a single collection only and 83% are known from three sites or fewer.

The other significant dimension is that Brunei has maintained maximal levels of forest cover within the country (Bryan et al., 2013). Borneo's forest cover declined from 71% of the island (mid-1980s) to 54% by 2000, an alarming rate of deforestation (Stibig & Malingreau, 2003). With continuing rainforest degradation in the region, Brunei Darussalam could continue to serve as a critical refuge for Bornean plants impacted by such processes. Henrot et al. (2013) discussed the increasing importance of 'anthropogenic endemics' in refuge in Brunei from the wider Brunei area or beyond: it is a scenario we would not wish to see exacerbated, but the significance of conserved resources in Brunei becomes obvious. In upping the ante, the Brunei Ministry of Industry and Primary Resources phased out logging in all Forest Reserves (previously some had been classified for timber production) in 2014 (Brunei Times, 2014).

Continuing efforts

All this underscores how important it is now for authorities in Borneo to redouble efforts into biodiversity inventory and conservation planning, in order that as many specially diverse or unique areas as possible can be recognised in time and be brought under effective management. For our part, it brings us back to the special collaboration now in place between the Brunei National Herbarium (acronym BRUN; Thiers, continuously updated) and the Singapore Herbarium (SING), and their partner institutions, for continuing the Botanical Survey of Brunei Darussalam.

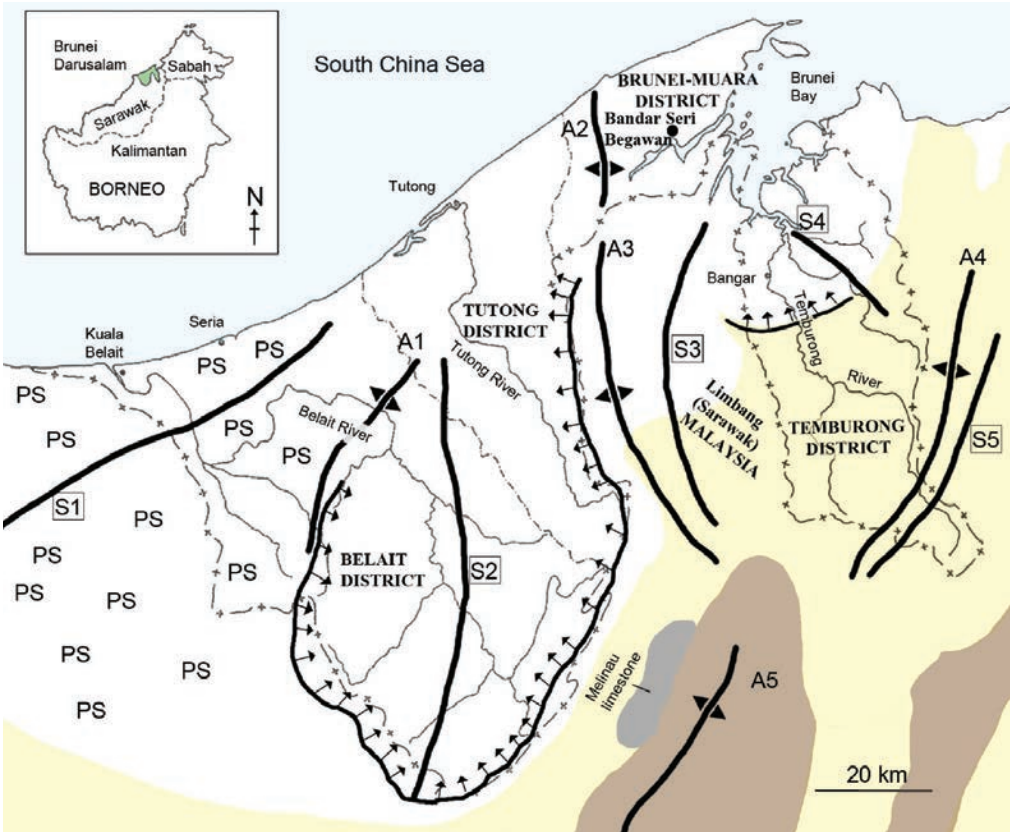

Fig. 1. The Brunei area: Key geological, tectonic and topographical features.
Uncoloured: Pliocene - Miocene Sediments, in places overlain by Pleistocene or more recent deposits. *Yellow*: Miocene - Oligocene Sediments. *Brown*: Rajang Group Deepwater Sediments (Late Cretaceous - Eocene). *Anticlines*: **A1.** Belait anticline. **A2.** Jerudong anticline. **A3.** Danau anticline. **A4.** Tangga anticline. **A5.** Mulu Uplift. *Synclines*: **S1.** Liku-Badas syncline. **S2.** Belait syncline. **S3.** Limbang syncline. **S4.** Labu syncline. **S5.** Tangga syncline. *Simple line with arrows*: Approximate boundary of synclinal basins within Brunei. **PS.** Peat body or peatswamp vegetation over low-lying ground. Map prepared by Alsa Moo & K.M. Wong, based on information from Liechti (1960), Wilford (1960) and Tate (2002).

In this series, we document new botanical findings in Brunei advanced through our research or that of our collaborators: the new taxa discovered or diagnosed, the new records of plants not previously documented in Brunei, and new and noteworthy observations. It is our hope, given the indications from past and ongoing studies, that the Brunei area continues to yield new and interesting plant taxa, and that such a series will help focus due attention on Brunei's floristic richness. As the present paper shows, both newer (post *Checklist*, Coode et al., 1996) as well as older (Ashton) collections from Brunei are still important for our continuing studies, attesting to the value of a good botanical archive in helping to attain further or newer biodiversity

documentation. All this is permitted only by sustained botanical effort and resources over the longer time frame, by necessity trans-generational in scope.

A new species of *Jarandersonia* (Malvaceae)

Jarandersonia yahyantha K.M.Wong, Joffre, Ariffin & Y.W.Low, **sp. nov.**
This new species is most similar to *Jarandersonia parvifolia* Kosterm. in having fruits with slender spines that are tuberculate and which bear tufted-hairy indumentum, but differs in its subcordate to cordate (not cuneate to rounded) leaf bases and fruit spines of 25–35 mm (not 10–15 mm) long. – TYPE: Brunei, Belait, Sg Liang, Andulau Forest Reserve, Compartment 18, Labi Road, 10 April 2014, *Ariffin, Jangarun & Rauzaidi BRUN 24174* (holotype BRUN; isotypes A, K, KEP, L, SAN, SAR, SING). (Fig. 2)

Medium sized tree 10–25 m tall, trunk slightly fluted; ***bark*** smooth, pale grey brown. ***Leaves*** broad-elliptic, 4.5–17(–22.7) cm long, 3.5–8(–11.5) cm wide; base subcordate to cordate; apex acute to rounded to obtuse to slightly emarginate; midrib flat to slightly sunken on upper surface, prominent on lower surface, secondary veins 6–8 pairs, making angular loops near the leaf margin, the basal 1–2 pairs making a smaller angle with the midrib than other secondaries (so resembling basal veins in a 3- to 5-nerved leaf base, but not reaching a fifth of the leaf length), flat to very slightly prominent on upper side, prominent on lower side; glabrous on entire upper surface, with dense, overlapping stellate scales completely occluding the lower surface; petioles 7–15 mm long, 1.5–2 mm diameter, densely stellate lepidote. ***Inflorescences*** axillary, borne in distal leaf axils, on young leafless innovations or more proximal twig portions that have lost their leaves, paniculate, to (1.5–)4–9.5 cm long, bearing (2–)4–9 flowers; bracts ovate, acute, 2–4 mm long, 1.5–2 mm broad; flower pedicels (3–)5–9 mm long (7–11 mm long in fresh material), scaly; calyx tube c. 2.5–4 mm long and 2.5–3.5 mm diameter (3–4.5 mm long and 5–6 mm diameter in fresh material), scaly outside (scale margins subentire-erose to short-fimbriate), lobes triangular, 2.5–3.5 mm long and 2.5–3.5 mm wide at base (6–7 mm long and 3–4 mm wide at base in fresh material), scaly outside; petals 5, obovate, (5.5–)7–9 mm long and 3–6 mm wide (16–18 mm long and 8–12 mm wide in fresh material), plane to slightly incurved, creamy white; stamens many, filaments 3–7 mm long (7–15 mm long in fresh material), pale greenish yellow, anthers knobby, c. 0.3 mm long, pale yellow; ovary subglobose, 5-lobed when dried, 1–1.5 mm diameter (2–3 mm diameter in fresh material), pale greenish yellow, short-hairy. ***Infructescence*** 3.5–13 cm long. ***Fruit*** subglobose, 6–10 mm diameter, 3-locular, outside covered with slender soft spines 25–35 mm long, spines tuberculate and bearing tufted hairs; seeds 1(–2), ovoid-elipsoid, 17 mm long, 4 mm wide, dark brown, smooth.

Distribution. The new species is apparently endemic to Brunei Darussalam. Of the other species in the genus, only *Jarandersonia parvifolia*, which has a widespread distribution in Sarawak, has been recorded in Brunei (*Jaamat & Tachun FMS 39640*, KEP) in the Labi Forest Reserve.

Fig. 2. *Jarandersonia yahyantha* K.M.Wong, Joffre, Ariffin & Y.W.Low. **A.** Tree in flower. **B.** Flowering branch. **C.** Fallen fruits (some germinating) and leaves. A & B from *Ariffin et al. BRUN 24087*; C from *Ariffin et al. BRUN 24174*. (Photos: A–B: Muhammad Ariffin, C: K.M. Wong)

Provisional IUCN conservation assessment. The provisional IUCN conservation status for *Jarandersonia yahyantha*, assessed with the aid of GeoCAT (Bachman et al., 2011), is Critically Endangered (CR B2ab(iii); D) (IUCN, 2012). The 'B2' designation results from an area of occupancy (AOO) estimated to be less than 10 km^2 (about 8 km2 for *J. yahyantha*); 'a' is due to a fragmented distribution as it occurs in only two populations, namely at Bukit Jerudong and Andulau Forest Reserve; 'b(iii)' is due to reductions in the area and quality of its habitat as *J. yahyantha* is so far known only in the Compartments 7 and 18 of the Andulau Forest Reserve, which has some disturbance along part of their boundary by adjacent road development, and on Bukit Jerudong near Kampung Peninjau, which is previously disturbed forest; 'D' is due to the small population size of only four mature individuals known so far.

Etymology. The new species honours Pehin Orang Kaya Seri Utama Dato Seri Setia Awang Haji Yahya bin Begawan Mudim Dato Paduka Haji Bakar, Brunei Darussalam's Minister of Industry and Primary Resources, for his interest in conservation and leadership in ceasing all timber production from Brunei's forest reserves.

Additional specimens examined. BRUNEI. **Belait:** Sungai Liang, Andulau Forest Reserve, Compartment 18, Labi Road, 200–300 m from roadside, 28 May 2014, *Ariffin, Watu & Khairul BRUN 24112* (A, BRUN, K, KEP, L, SAN, SAR, SING), *24113* (BRUN, K, SAN, SING). **Brunei-Muara:** Jerudong, Kampung Peninjau, Bukit Jerudong, 11 Mar 2014, *Ariffin, Watu, Azlan & Khairul BRUN 24087* (BRUN, K, L, SAN, SAR, SING).

Notes. There are six known species of this genus (Tan et al., 2011; Chung et al., 2012), established by Kostermans (1960), in which the fruits are typically covered with spines bearing setose hairs. Of these, the new species here is most like *Jarandersonia pentaceoides* R.C.K.Chung & H.S.Tan, *J. parvifolia* and *J. rinoreoides* Kosterm. in having slender soft fruit spines (the other species, *J. clemensiae* (Burret) Kosterm., *J. pursglovei* (Kosterm.) Kosterm. and *J. spinulosa* Kosterm., have short stout and stiff fruit spines.) The new species here differs from *Jarandersonia pentaceoides* in having short basal secondary veins that do not reach even a fifth of the length of the leaf (in that species the basal secondary veins are conspicuous in reaching halfway or more along the leaf length) and fruit spines that are 25–35 mm long (the fruit spines in that species are only 10–20 mm long). It differs from *Jarandersonia rinoreoides* in having subcordate to cordate (not typically cuneate) leaf bases and fruit spines that are 25–35 mm (not 6–28 mm) long and short-tuberculate (rather than non-tuberculate); and from *J. parvifolia* as mentioned above in the diagnosis. Leaf size is not a particularly reliable character because the flowering or fruiting material taken for herbarium specimens mostly occurs on higher branches bearing smaller leaves, although larger leaf blades may also be occasionally found on such branches.

Note that Tan et al. (2011) and Chung et al. (2012) refer to the tuberculate spines as "short-branched". Also, the regularly polygonal fine vein areoles on the lower leaf surface of *Jarandersonia pentaceoides*, which they described as "distinct honey comb-like quaternary veins", is not restricted to that species, being also found on occasion in *J. rinoreoides* (e.g., *Dewol SAN 99462* in SING); this feature is, however, absent

from the leaves of the new species described here, in which the lower leaf surface is completely occluded by dense, overlapping scales.

ACKNOWLEDGEMENTS. We would like to express our gratitude to Pehin Orang Kaya Seri Utama Dato Seri Setia Awang Haji Yahya bin Begawan Mudim Dato Paduka Haji Bakar, the Minister of Industry and Primary Resources, Brunei Darussalam for his interest and continuing support of the botanical survey in Brunei. Special thanks are due to Hajah Normah Suria Hayati binti Pehin Jamil (Permanent Secretary to the Ministry of Industry and Primary Resources), Hajah Hasnah binti Haji Ibrahim (Deputy Permanent Secretary), Haji Saidin Salleh (Director of Forestry), and Hajah Jamilah binti Haji Abdul Jalil (Acting Deputy Director of Forestry), as well as Mahmud bin Haji Yussof, Chief Executive Officer of Brunei's Heart of Borneo Centre. We are likewise grateful for the interest of past and present High Commissioners of Singapore to Brunei Darussalam, HE Joseph Koh and HE Jaya Ratnam, for facilitating the start of this collaboration, which is jointly funded by both the Brunei Forestry Department and the National Parks Board, Singapore. On the Singapore side, we thank the Ministry of National Development and National Parks Board (NParks), in particular Kenneth Er, CEO of NParks; Dr Leong Chee Chiew, Deputy CEO of NParks; Dr Nigel Taylor, Director of the Singapore Botanic Gardens; and Dr David Middleton, Deputy Director and Keeper of the Singapore Herbarium (SING). Many others have been most supportive and helpful to our programme: Roslinah binti Haji Mohsin and Noralinda binti Haji Ibrahim (Forestry Department, Brunei), Dr Kamariah Abu Salim (Universiti Brunei Darussalam); Serena Lee, Paul K.F. Leong, Paul Parusuraman Athen and Alsa Moo (SING); Watu bin Awok, Jangarun anak Eri, Azlan bin Pandai, Muhammad Waffiuddin bin Zainol Ariffin, Mediana binti Kampong and Rauzaidi bin Mureh (BRUN). Not least, the comments and suggestions of reviewers and the editor Dr David Middleton have helped improve the text of this paper.

References

Ashton, P.S. (1958). Notes on the primary vegetation and soils of Brunei. In: Anon. (ed) *Proceedings of the Symposium on Humid Tropics Vegetation, Tjiawi (Indonesia)*. Pp. 149–154. Djakarta: Unesco Science Cooperation Office for South East Asia.

Ashton, P.S. (1964). *A Manual of the Dipterocarp Trees of Brunei State.* 242 p. Oxford: Oxford University Press.

Ashton, P.S. (1982). Dipterocarpaceae. In: Steenis, C.G.G.J. van (ed) *Flora Malesiana*, ser. I, 9: 237–552.

Ashton, P.S. (1989). Sundaland. In: Campbell, D.G. & Hammond, H.D. (eds) *Floristic Inventory of Tropical Countries.* Pp. 91–99. New York: New York Botanic Garden.

Bachman, S., Moat, J., Hill, A.W., de la Torre, J. & Scott, B. (2011) Supporting Red List threat assessments with GeoCAT: Geospatial Conservation Assessment Tool. In: Smith, V. & Penev, L. (eds) e-Infrastructures for data publishing in biodiversity science. *ZooKeys* 150: 117–126. (Version BETA)* http://dx.doi.org/10.3897/zookeys.150.2109

Beaman, J.H. & Anderson, C. (2004). *The Plants of Mount Kinabalu 5: Dicotyledon Families Magnoliaceae to Winteraceae*. 609 p. Kota Kinabalu: Natural History Publications (Borneo) & London: Royal Botanic Gardens, Kew.

Boyce, P.C. & Wong, S.Y. (2014) Studies in Homalomeneae (Araceae) of Borneo XVI: Three new shale-obligated *Homalomena* species. *Webbia* 69(1): 59–67.

Brunei Times (2014). Logging no longer allowed in forest reserves. 23 March 2014, p. A3.

Bryan, J.E., Shearman, P.L., Asner, G.P., Knapp, D.E., Aoro, G. & Lokes, B. (2013). Extreme differences in forest degradation in Borneo: Comparing practices in Sarawak, Sabah, and Brunei. *PLOS One* 8(7): e69679. [doi:10.1371/journal.pone.0069679]

Chen, J., Wong, K.M., der Ent, A. van & Tan, H.T.W. (2014). Nine new species of *Timonius* (Rubiaceae) from Kinabalu Park, Borneo. *Phytotaxa* 181(3): 138–150.

Chung, R.C.K., Tan, H.S. & Soepadmo, E. (2012). A remarkable new species of *Jarandersonia* (Malvaceae – Brownlowioideae) from Central Kalimantan, Borneo. *Syst. Bot.* 37(1): 213–217.

Coode, M.J.E., Dransfield, J., Forman, L.L., Kirkup, D.W. & Idris, M.S. (eds) (1996). *A Checklist of the Flowering Plants and Gymnosperms of Brunei Darussalam.* 477 p. Brunei Darussalam: Ministry of Industry and Primary Resources.

Coyne, J.A. & Orr, H.A. (2004). *Speciation*. 545 p. Massachusetts, Sunderland: Sinauer Associates.

Dransfield, S. & Wong, K.M. (1996). *Temburongia*, a new genus of bamboo (Gramineae: Bambusoideae) from Brunei. *Sandakania* 7: 49–58.

Henrot, J., Joffre, A.A. & Wong, K.M. (2013). *The Flowering Plants Endemic to Brunei Darussalam 2012.* Bandar Sri Begawan: Brunei Forestry Dept, Korea Forest Service & ASEAN.

IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1.* 2nd ed. Switzerland, Gland and UK, Cambridge: IUCN.

Kostermans, A.J.G.H. (1960). *Jarandersonia* Kosterm., a new Bornean genus of Tiliaceae—Brownlowieae. *Reinwardtia* 5(3): 319–321.

Liechti, P. (1960). *Tectonic Map of Sarawak, Brunei and North Borneo.* Scale 1:1,000,000. Brunei: Brunei Shell Petroleum Co. Ltd.

MacKinnon, J. & MacKinnon, K. (1986). *Review of the Protected Areas System in the Indo-Malayan Realm.* Gland: IUCN.

Merrill, E.D. (1921). A Bibliographic Enumeration of Bornean Plants. *J. Straits Branch Roy. Asiat Soc.*, Special Number. 637 p. Singapore: Fraser & Neave Ltd.

Merrill, E.D. (1950). A brief survey of the present status of Borneon botany. *Webbia* 7: 309–324.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403(6772): 853–858.

Raes, N., Roos. M.C., Slik, J.W.F., van Loon, E.E. & ter Steege, H. (2009). Botanical richness and endemicity patterns of Borneo derived from species distribution models. *Ecography* 32: 180–192.

Roos, M.C. (1993). State of affairs regarding Flora Malesiana: progress in revision work and publication schedule. *Fl. Males. Bull.* 11: 133–142.

Soepadmo, E. & Wong, K.M. (eds) (1995). *Tree Flora of Sabah and Sarawak Volume 1.* Malaysia: Forest Research Institute Malaysia, Sabah Forestry Dept. & Sarawak Forestry Dept.

Stibig, H.J. & Malingreau, J.P. (2003). Forest Cover of Insular Southeast Asia Mapped from Recent Satellite Images of Coarse Spatial Resolution. *Ambio* 32 (7): 469–475.

Tan, H.S., Chung, R.C.K. & Soepadmo, E. (2011). A synopsis of *Jarandersonia* (Malvaceae – Brownlowioideae). In: Wong, K.M., Leong-Skornickova, J., Lee, S. & Low, Y.W. (eds) Proceedings of the 8th Flora Malesiana Symposium, Singapore, 23–27 August 2010. *Gard. Bull. Singapore* 63(1 & 2):137–144.

Tate, R.B. (2002). *The Geology of Borneo Island.* CD-Rom. Kuala Lumpur: Geological Society of Malaysia.

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 2014).

Wilford, G.L. (1960). *Geological Map of Brunei and Adjacent Parts of Sarawak.* Scale 1:125,000. Sheets I and II. Kuala Lumpur: Geological Survey Department, Federation of Malaya.

Wong, K.M. (1997). *In Brunei Forests. An Introduction to the Plant Life of Brunei Darussalam*, revised edition. 127 p. Kota Kinabalu: Natural History Publications & Brunei Darussalam: Forestry Department.

Wong, K.M. (1999). The nature of the Brunei flora. In: Wong, K.M. & Kamariah, A.S. (eds) *Trees and Forests of Brunei Darussalam.* Pp. 53–73. Bandar Sri Begawan: University of Brunei Darussalam, Forestry Department, Brunei & Brunei Shell Petroleum Co. Sdn. Bhd.

Wong, S.Y. & Boyce, P.C. (2011). Studies on Homalomeneae (Araceae) of Borneo X: Two new *Homalomena* species from Brunei, and a new informal species complex for supergroup Cyrtocladon. *Webbia* 66(2): 133–141.

Wong, S.Y. & Boyce, P.C. (2014). Studies on Homalomeneae (Araceae) of Borneo XVIII: *Homalomena prolixa* and *H. scutata*, two new species of doubtful affinity. *Willdenowia* 44: 279–285.